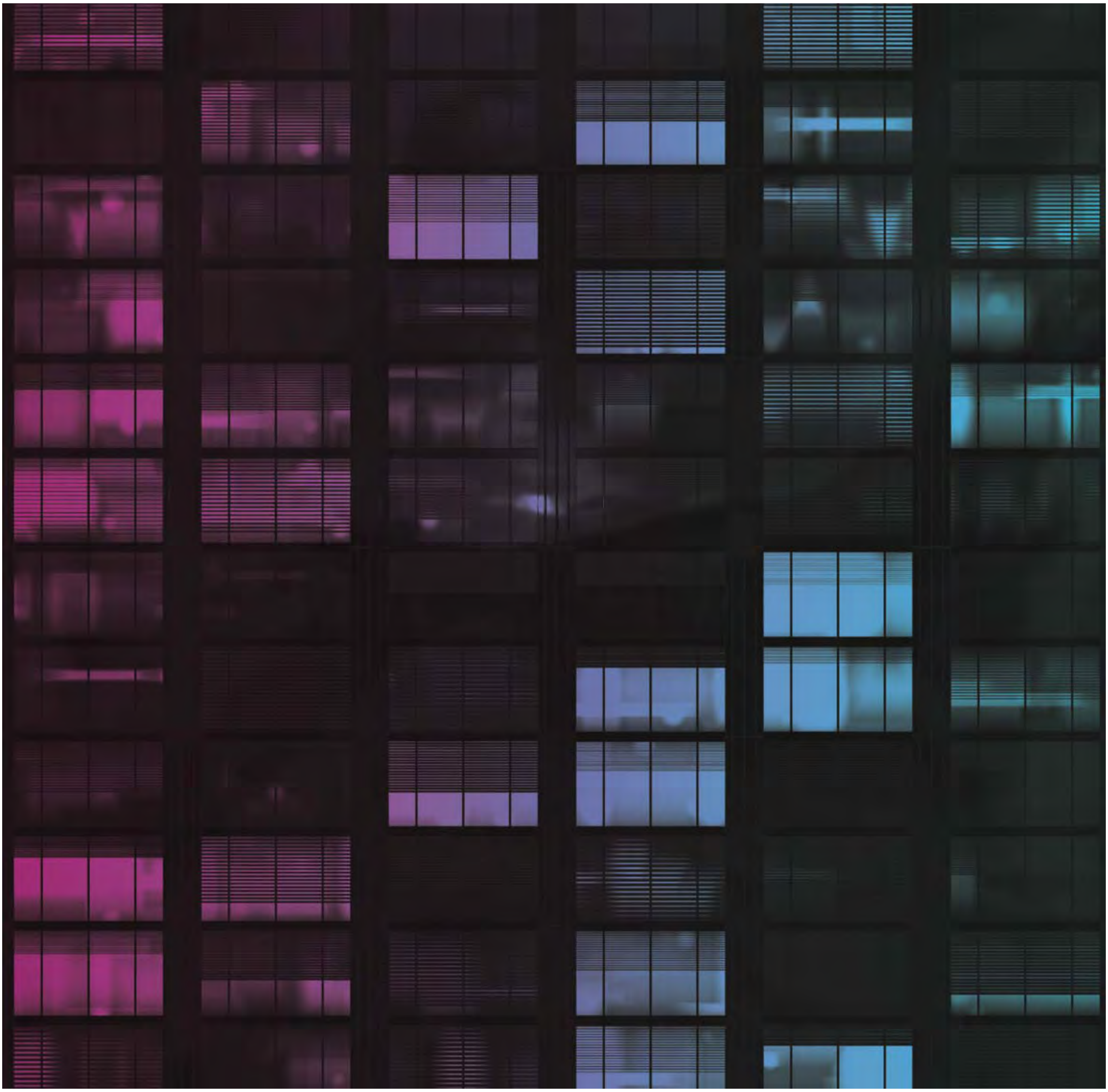
VMP HHERA, Barangaroo
Lend Lease (Millers Point) Pty Ltd
25 October 2012
Document No. 60153531 VMP RPT049

Human Health and Ecological Risk Assessment

VMP Remediation Works Area (Addressing the NSW EPA Remediation Site Declaration 21122, Millers Point)



Human Health and Ecological Risk Assessment

VMP Remediation Works Area (Addressing the NSW EPA Remediation Site Declaration 21122, Millers Point)

Prepared for

Lend Lease (Millers Point) Pty Ltd

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

25 October 2012

60153531

AECOM in Australia and New Zealand is certified to the latest version of ISO9001 and ISO14001.

Quality Information

Document Human Health and Ecological Risk Assessment

Ref 60153531

Date 25 October 2012

Prepared by Amanda Lee and Angela Ruthenberg

Reviewed by Kristi Hanson and Amanda Lee

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	18 June 2010	Draft for comment	Michael Jones Technical Director	
01	12 July 2010	Revisions in response to Lend Lease comments dated 25 June 2010	Michael Jones Technical Director	
02	4 August 2010	Revisions in response to Lend Lease comments dated 27 July 2010	Michael Jones Technical Director	
03	11 August 2010	Revisions in response to Lend Lease comments 10 August 2010	Michael Jones Technical Director	
04	9 February 2011	Revisions in response to BDA comments of 18th August and associated Lend Lease comments	Michael Jones Technical Director	
05	25 May 2011	Revisions in response to Lend Lease comments of 15 February 2011	Michael Jones Technical Director	
06	21 June 2011	Revisions in response to Lend Lease comments 31st May 2011	Michael Jones Technical Director	
07	1 March 2012	Revisions in response to BDA comments 25 October 2011	Michael Jones Technical Director	
08	21 March 2012	Final draft for review by the EPA and Auditor	Michael Jones Technical Director	
09	2 August 2012	Revised to address comments received from the NSW EPA and the Site Auditor	Michael Jones Technical Director	
10	13 August 2012	Revised to address comments received from the NSW EPA and the Site Auditor	Michael Jones Technical Director	
11	16 August 2012	Revised to address comments received from the Barangaroo Delivery Authority	Michael Jones Technical Director	
12	9 October 2012	Final Draft	Michael Jones Technical Director	
13	25 October 2012	Final	Michael Jones Technical Director	M.A. Jones

Table of Contents

List of Tables in Report

List of Tables

List of Figures

List of Acronyms

Term	Description
ADI	Acceptable Daily Intake
ADWG	Australian Drinking Water Guidelines
AGL	Australian Gas Light Company
ALS	Australian Laboratory Services Group
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standard
ASLP	Australian Standard Leaching Procedure
ASS	Acid Sulfate Soils
ATSDR	Agency for Toxic Substances and Disease Registry
Authority (the)	The Barangaroo Delivery Authority
B(a)P	Benzo-α-pyrene
BH	Borehole
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAD	Computer Aided Design
CCME	Canadian Council of Ministers of the Environment
CoPC	Chemicals of Potential Concern
cPAH	Carcinogenic PAHs
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
DAF	Dermal Absorption Factor
DEC	Department of Environment and Conservation NSW (superseded)
DECC	Department of Environment and Climate Change NSW (superseded)
DECCW	Department of Environment, Climate Change and Water, NSW (superseded)
DGI	Data Gap Investigation
DNR	Department of Natural Resources
DP	Deposited Plan
DQI	Data Quality Indicators
DQO	Data Quality Objectives
DSI	Detailed Site Investigation
EPA	Environment Protection Authority
EPAV	EPA Victoria
EPC	Exposure Point Concentrations
EQL	Effective Quantitation Limit
ERA	Ecological Risk Assessment

Term	Description
ESA	Environmental Site Assessment
GDS	Groundwater Discharge Study
GIL	Groundwater Investigation Level
HHERA	Human Health and Ecological Risk Assessment
HIL	Health Investigation Level
HHRA	Human Health Risk Assessment
IRIS	Integrated Risk Information System
ISQG	Interim Sediment Quality Guidelines
ITF	Intake Toxicity Factors
IUR	Inhalation Unit Risk
Kow	Octanol water partition coefficient
LL	Lend Lease (Millers Point) Pty Limited
LOR	Limit of Reporting
m AHD	Metres Australian Height Datum
mbgs	Metres Below Ground Surface
m bTOC	Metres Below Top Of Casing
MW	Monitoring Well
MWQC	Marine Water Quality Criteria
NAPL	Non-Aqueous Phase Liquid
NATA	National Association of Testing Authorities
NE	North East
NEPC	National Environment Protection Council
NEPM	National Environmental Protection (Assessment of Site Contamination) Measure
NHMRC	National Health and Medical Research Council
NSW	New South Wales
OCP	Organochlorine Pesticides
OPP	Organophosphorus Pesticides
ORWN	Other Remediation Works (North) Area
PAH	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulfate Soils
PCB	Polychlorinated Biphenyl
PEF	Particulate Emission Factor
PQL	Practical Quantitation Limit
PSH	Phase Separated Hydrocarbons
PSI	Preliminary Site Assessment
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control

Term	Description		
RAIS	Risk Assessment Information System		
RAP	Remedial Action Plan		
RfC	Reference Concentration		
RPD	Relative Percentage Difference		
RSL	Risk Screening Levels		
RWP	Remediation Work Plan		
SAQP	Sampling Analysis and Quality Plan		
SHFA	Sydney Harbour Foreshore Authority		
SHTC	Sydney Harbour Trust Commissioners		
SPGWT	Separated Phase Gas Works Tar, which includes Tar Containing Materials (TCM), and Dense Non Aqueous Phase Liquids (DNAPLs)		
SSTC	Site Specific Target Criterion or Criteria		
SVOC	Semi Volatile Organic Compound		
TC	Tolerable Concentration		
TCLP	Toxicity Characteristic Leaching Procedure		
TDI	Total Daily Intake		
TEF	Toxic Equivalency Factor		
TOC	Total Organic Carbon		
TPH	Total Petroleum Hydrocarbons		
TPHCWG	Total Petroleum Hydrocarbon Criteria Working Group		
USEPA	United States Environmental Protection Agency		
VF	Volatilisation Factor		
VMP	Voluntary Management Proposal		
VOC	Volatile Organic Compound		
WAD	Weak Acid Dissociable		
WHO	World Health Organisation		
Element Symbols			
As	Arsenic	I	Iodine
Be	Beryllium	Mo	Molybdenum
CN	Cyanide	Ni	Nickel
Cl	Chlorine	P	Phosphorus
Cd	Cadmium	Pb	Lead
Cr	Chromium	Sn	Tin
Cu	Copper	Th	Thorium
F	Fluoride	Zn	Zinc
Hg	Mercury		
Units of Measurement			
µg	Microgram	m	metres

Term	Description		
Units of Measurement			
cm	Centimetre	ML	Mega litre
ha	Hectare	mm	millimetre
hrs	Hours	ppm	parts per million
kg	Kilogram	%	Percent
km	kilometre		

Executive Summary

AECOM Australia Pty Ltd (AECOM) has been commissioned by Lend Lease (Millers Point) Pty Limited (LL) to undertake Human Health and Ecological Risk Assessments (HHERA) for selected areas within the Barangaroo Stage 1 Development Precinct (Barangaroo South), located at Hickson Road, Millers Point, New South Wales (NSW). The Site location is presented in **Figure F1** in **Appendix B**. The HHERA process will produce four reports focusing on areas designated by LL and the Barangaroo Delivery Authority (the Authority), as follows:

- ***HHERA Voluntary Management Proposal (VMP) Remediation Works Area*** – relates to the NSW Environment Protection Authority (EPA) Remediation Site Declaration Area (Declaration Number 21122) and is designed to develop remediation objectives that will facilitate removal of the NSW EPA Declaration. This area may also be referred to as the NSW EPA Declaration Area or Department of Environment, Climate Change and Water, NSW (DECCW) Declaration Area in this or other documents.
- ***HHERA Declaration Site (Development Works) Remediation Works Area***– relates to the same area as above but is designed to facilitate the development of remediation objectives as required by the Stage 1 Development (the Stage 1 Development is also referred to as Barangaroo South which incorporates the Site).
- ***HHERA Addendum Other Remediation Works (South) (ORWS) Area*** – relates to Blocks 1 to 3 of the Stage 1 Development area, outside the NSW EPA Declaration Area, and is designed to facilitate the development of remediation objectives as required by the Stage 1 Development.
- ***HHERA Other Remediation Works (North) (ORWN) Area*** – relates to the Stage 1 Development area that is outside the NSW EPA Declaration Area and is designed to facilitate the development of remediation objectives as required by the Stage 1 Development plans.

This report comprises the HHERA for the **Voluntary Management Proposal (VMP) Remediation Works Area - Barangaroo** (henceforth referred to as the 'Site'). The Site is also referred to in this and other documents as the "VMP Remediation Works Area", the "NSW EPA Declaration Site Remediation Works Area" and the "NSW EPA Declaration Area".

In May 2009, the NSW EPA determined that part of the Barangaroo site (the site of a former gas works) and part of Hickson Road was contaminated in such a way as to present a significant risk of harm to human health and the environment.

As a consequence, the NSW EPA declared the Site to be a remediation site (Declaration Number 21122; Area Number 3221) (here-in referred to as the NSW EPA Declaration) under the then section 9 of the Contaminated Land Management Act 1997. The Voluntary Management Proposal Remediation Works Area - Barangaroo (the 'Site') coincides with the area of the NSW EPA Declaration. The Site layout and surrounding area is presented on **Figure F2** in **Appendix B**.

The objectives of this HHERA were to:

- assess the risk to human health and the environment that the Site represents in its current form; and
- develop Site-specific human health target criteria (SSTC) for soil and groundwater for use in defining the remediation end-point for the Site, where this end-point is defined as removal of the NSW EPA Declaration relating to the Site.

AECOM understands that removal of the NSW EPA Declaration will require demonstration of no significant risk of harm to human health and the environment under the current land use scenario, or land use scenarios allowable at the Site without a development approval. Based on the current zoning of the developable portion of the Site (Zone B4 Mixed Use under the Environmental Planning Policy (Major Development) Amendment (Barangaroo) 2010)), no development is allowable without planning consent. Therefore, this risk assessment will be based on the current Site usage which is considered to comprise of limited use with the majority of the Site being vacant paved open space areas.

The focus of the VMP HHERA is on the chemicals specified within the NSW EPA Declaration, specifically:

- Polycyclic Aromatic Hydrocarbons (PAHs);
- Benzene, Toluene, Ethylbenzene and Xylene (BTEX);
- Total Petroleum Hydrocarbons (TPH);

- Ammonia;
- Phenol; and
- Cyanide.

Other contamination identified on the Site by previous investigations (for example heavy metals), which are not listed in the NSW EPA Declaration, will be assessed as part of the PDA HHERA. This HHERA has been undertaken in accordance with relevant Australian guidance for health and ecological risk assessment.

Available analytical data from the relevant reports were evaluated by AECOM for the appropriateness of their quality for use in the risk assessment process. The data used in this assessment were considered to be valid and representative of concentrations of the analysed compounds at the sample locations tested. Overall, reported data were considered to be of an appropriate quality for use in the HHERA.

Human Health Risk Assessment (HHRA)

The human health risk assessment comprised the following key steps:

- Refinement of the list of chemicals of potential concern (CoPC) in environmental media (from that in the NSW EPA Declaration), based on comparison to relevant human health based ‘Tier 1’ screening criteria.
- Qualitative and quantitative assessment of the toxicity of each CoPC.
- Development of the Conceptual Site Models (CSM) for land use scenarios allowable without development consent at the Site.
- Quantitative Exposure Assessment for each land use scenario, in order to estimate the extent to which human receptors may be exposed to CoPC at the Site, including vapour and dust migration modelling where relevant.
- Quantitative assessment of the risks to on-Site receptors, based on the selected exposure scenarios, and comparison to acceptable risk levels.
- Where unacceptable risks were identified, chemicals were assessed in terms of their contribution to the total threshold and non-threshold risks reported. Where CoPC were defined to “significantly” contribute to reported risk totals, site specific target criteria (SSTC) were derived.
- Derivation of media and chemical specific SSTC for each CoPC based on consideration of toxicity criteria, exposure parameters, contaminant transport modelling and acceptable risk levels.

The current Site use is vacant paved open space. The risk assessment has focussed on potential human health exposure scenarios which are considered to be relevant under the current zoning of the Site and uses which are allowed without planning consent. As such, the broad land use scenarios for which SSTC have been derived are:

- paved open space; and
- short term ground-intrusive maintenance.

Odour and Visual Impact Assessment

An odour assessment was included as a component of the human health risk assessment and derivation of the soil and groundwater SSTC based on the current land use scenarios for the Site.

A qualitative assessment of the potential visual and aesthetic considerations of the contamination identified beneath the Site was also undertaken.

Ecological Risk Assessment (ERA)

As required by the NSW EPA, the point of compliance for the purpose of assessing ecological risk is the down-hydraulic gradient boundary of the Site. In the absence of any other information, the level of protection of groundwater at the down hydraulic gradient boundary of the Site has been based on the level of protection required for the nearest surface water receptor, Darling Harbour. This approach is consistent with the policies of the NSW EPA, in particular:

- The *Contaminated Land Management (CLM) Act* (1997), section 9, which requires adoption of the precautionary principle where the lack of scientific certainty is not a reason for postponing measures. With respect to the Site, this relates to the protection of groundwater dependant ecosystems down hydraulic gradient of the Site and the requirement for remediation to the extent practicable (even in the absence of data demonstrating the presence, or otherwise, of such ecosystems now, or in the future).

- The Department of Environment and Conservation NSW (now the NSW EPA) *Guidelines for the Assessment and Management of Groundwater Contamination*, March 2007, which reemphasise the requirements of the *CLM Act* (1997) requiring protection of groundwater ecosystems according to the precautionary principle.
- The *ANZECC 2000 Water Quality Guidelines*, section 1, require that the protection of underground aquatic ecosystems and their novel fauna require the highest level of protection.
- The *National Environment Protection Measure Schedule B(6)* (NEPC, 1997) which states that determination of the point of use of groundwater is a jurisdictional matter and that the transfer of contaminated groundwater from a contaminated Site is not considered to be acceptable , even if the relevant guidelines are achieved at the point of use / discharge.

The ecological risk assessment (ERA) comprised of the following key steps:

- Identification of appropriate ecological receptors, including both terrestrial and aquatic ecosystems (including groundwater dependant ecosystems).
- Identification of relevant marine water quality criteria (MWQC) from a nationally adopted hierarchy of acceptable guidance documents plus consideration of additional international sources based on meeting the surface water quality at the nearest surface water receptor, Darling Harbour.
- Identification of Chemicals of Potential Concern (CoPC), through the application of a Tier 1 screening assessment, where groundwater quality across the Site and at the Site boundary was compared to the adopted MWQC.
- Assessment of whether (or not) the concentrations of CoPC within the Site and at the down hydraulic gradient Site boundary represent a risk to groundwater dependant ecosystems.

Conclusions

Previous investigations have reported gasworks related contamination of soil and groundwater within the Site boundary and beyond the Site boundary to the west and south.

Based on the human health risk assessment (**Section 5.0)** and ecological risk assessment (**Section 8.0**) and with consideration of the uncertainties and limitations of available data and information, the following conclusions are provided with respect to potential for human health, odour, aesthetic or ecological risks at the Site under the current land use scenario:

Human Health Risks

Unacceptable human health risks have been identified for the following scenario and remediation is required to make the Site fit for its current land use. The following specific issue was identified:

a) Scenario 2 (Intrusive Maintenance): The highest reported soil and groundwater concentrations of benzene, carcinogenic PAHs, fluoranthene, naphthalene, phenanthrene, pyrene , TPH C_{10}-C_{14}, TPH C_{15}-C_{28} and TPH C_{29}-C_{36} have the potential to result in adverse health risks to short-term intrusive maintenance workers who come into direct contact with soil and groundwater during trenching activities. Locations in Hickson Road where free tar has been reported are of particular significance, based on the potential for direct contact and indirect groundwater-derived vapour exposures.

Unacceptable human health risks are not expected to be associated with Scenario 1 (Paved Recreation). It is also noted that the number of exposure routes for this scenario are significantly less than for the intrusive maintenance worker.

The development of human health SSTCs has considered the potential for mixtures of chemicals to be present at the Site.

AECOM understands that potential health risks to residents or other occupants of buildings adjacent the Site (e.g. on the east side of Hickson Road) associated with existing groundwater contamination have been assessed, that the assessment was endorsed by a NSW EPA accredited site auditor and that the risks are currently being effectively managed (as referenced by the NSW EPA Declaration 21122). Furthermore, it is expected that remediation of Hickson Road will further reduce the potential for risk to occupants of adjacent buildings. Potential health risks associated with existing soil and groundwater contamination identified west (in the Other Remediation Works North [ORWN] Area) and south (in the Other Remediation Works South [ORWS] Area) of the Site will be or have been addressed as part of the risk assessments relating to those specific areas.

Odour Risks

No exceedances of theoretical odour-based SSTC for Scenarios 1 and 2 have been reported in soil and groundwater, however:

- gasworks waste is inherently odorous material; and
- it is possible that some odorous material could remain at the Site following remediation.

Visual Amenity Issues/Risks

Visual amenity issues are not considered significant on the Site under current land use scenarios.

Ecological Risks

Exceedances of the MWQC have been identified in groundwater within the Site and at the Site boundary, indicating the potential for an unacceptable risk to the environment (see **Section 8.1**). Remediation is required to minimise the risk of adverse impact to the environment.

It is noted that the analytical composition of chemicals of potential concern within the Site are: (a) consistent with those expected in association with historic gasworks; and, (b) similar in composition to those reported in areas down hydraulic gradient of the Site (ORWN), suggesting that impacted groundwater is migrating off Site.

Recommendations

Based on the above conclusions, and with consideration of the uncertainties and limitations of available data and information, the following recommendations are provided in relation to addressing the NSW EPA Remediation Site Declaration 21122:

a) The results of the HHERA indicate that there are multiple lines of evidence that soil and groundwater concentrations within the Site and at the Site boundary represent an unacceptable risk to human health and ecological receptors and that remediation is required to address both human health and ecological protection with respect to the Remediation Site Declaration 21122.

b) Removal and/or remediation of separate phase gasworks waste and tar, to the extent practicable, should be undertaken as the primary remediation objective to minimise the risk to environment and human health.

c) Following remediation, groundwater should meet the Groundwater SSTC (**Table 23**), and to the extent practicable, approach the MWQC (**Table 29**), at the Site boundary.

d) With respect to the protection of the environment, the objective of meeting MWQC is for the ultimate protection of ecosystems within groundwater, which will also be protective of surface water quality at Darling Harbour. As such, remediation of the soil within the unsaturated and saturated zones is required, to the extent practicable, as a secondary remediation objective to protect groundwater quality leaving the Site.

e) Soil within the unsaturated zone (<2.0 meters below ground surface [mbgs]) at the Site should be remediated, where practicable, to the Soil SSTC (which were derived to protect of human health) presented in **Table 24**.

f) The Remedial Action Plan (RAP) should include consideration of mitigation measures for the appropriate management of asbestos that may be potentially encountered during the remediation works.

g) Validation of groundwater will be undertaken by comparison of:

    - individual groundwater monitoring results with the lowest of the derived SSTC (presented in **Table 23**); and
    - groundwater monitoring results at the down-hydraulic gradient Site boundary with the MWQC (presented within **Table 29**), to the extent practicable.

h) The Rap will describe the validation of soil following remediation which will be undertaken in accordance with the following:

    - use of systematic sampling patterns;

- collection of an appropriate number of samples for estimation of the arithmetic average concentration of contaminant(s) within relevant environmental media and exposure areas; and
- estimation of the 95% upper confidence limit (UCL) of the arithmetic average concentration.

1.0 Introduction

1.1 Background

AECOM Australia Pty Ltd (AECOM) has been commissioned by Lend Lease (Millers Point) Pty Limited (LL) to undertake Human Health and Ecological Risk Assessments (HHERA) for selected areas within the Barangaroo Stage 1 Development Precinct (Barangaroo South), located at Hickson Road, Millers Point, New South Wales (NSW). The Site location is presented in **Figure F1** in **Appendix B**. The HHERA process will produce four reports focusing on areas designated by LL and the Barangaroo Delivery Authority (the Authority), as follows:

- **HHERA Voluntary Management Proposal (VMP) Remediation Works Area** – relates to the NSW Environment Protection Authority (EPA) Remediation Site Declaration Area (NSW EPA Declaration Number 21122) and is designed to develop remediation objectives that will facilitate removal of the NSW EPA Declaration. This area may also be referred to as the NSW EPA Declaration Area or Department of Environment, Climate Change and Water, NSW (DECCW) Declaration Area in this or other documents.
- **HHERA Declaration Site (Development Works) Remediation Works Area** – relates to the same area as above but is designed to facilitate the development of remediation objectives as required by the Stage 1 Development (the Stage 1 Development is also referred to as Barangaroo South which incorporates the Site.).
- **HHERA Addendum Other Remediation Works (South) (ORWS) Area** – relates to Blocks 1 to 3 of the Stage 1 Development area, outside the NSW EPA Declaration Area, and is designed to facilitate the development of remediation objectives as required by the Stage 1 Development.
- **HHERA Other Remediation Works (North) (ORWN) Area** – relates to the Stage 1 Development area that is outside the NSW EPA Declaration Area and is designed to facilitate the development remediation objectives as required by the Stage 1 Development plans.

The location of the Barangaroo precinct and boundaries of the above areas are shown in **Figure F2** in **Appendix B**.

This HHERA focused on the **Voluntary Management Proposal (VMP) Remediation Works Area - Barangaroo** (henceforth referred to as the ‘Site’). The Site is also referred in this and other documents as the “VMP Remediation Works Area”, the NSW EPA “Declaration Site Remediation Works Area” and the “NSW EPA Declaration Area”.

While this report focused on the Voluntary Management Proposal (VMP) Remediation Works Area (the Site), the following is noted:

- The Voluntary Management Proposal (VMP) and the Declaration Site (Development Works) Remediation Works Area (also referred to as the PDA Remediation Works Area) occupy the same footprint. It is noted, however, that the focus of this risk assessment is to determine potential risks to human health and the environment from the existing Site use.
- The objective of the HHERA VMP Remediation Works Area is to facilitate the removal of the NSW EPA Declaration, therefore the report will focus on the “contaminants” associated with gasworks waste and identified within the NSW EPA Declaration. These comprise: polycyclic aromatic hydrocarbons (PAHs; benzene, toluene, ethylbenzene and xlyenes (BTEX); total petroleum hydrocarbons (TPHs; ammonia; phenol and cyanide. It is noted, that additional “contaminants” have been identified by previous investigations at the Site and that these will be assessed separately within the HHERA Declaration Site (Development Works) Remediation Works Area.
- Information relating to the adjacent ORWN Area has been included in some locations within this report to provide a more comprehensive picture of the Site setting and contamination status adjacent to the Site, particularly between the Site and Darling Harbour.

This HHERA has been prepared in order to inform the VMP Remedial Action Plan (RAP), the successful implementation of which is expected to facilitate the removal of the NSW EPA Declaration.

Based on the current zoning of the developable portion of the Site (Zone B4 Mixed Use under the Environmental Planning Policy (Major Development) Amendment (Barangaroo) 2010)), no development is allowable without planning consent. The risk assessment was therefore based on the risk posed to:

- human health, based on the current use of the Site as a paved open space. The assessment also considered intrusive maintenance works associated with underground services at the Site; and
- the aquatic ecosystem of groundwater down hydraulic gradient from the Site, and the requirements to improve the quality of these waters over time.

Figure F2 in **Appendix B** shows the location of the Barangaroo precinct and shows the precinct layout including the boundaries of the NSW EPA Declaration Area (the Site), the ORWS Area, the ORWN Area and Barangaroo South.

Discussions with the NSW Department of Health and with the NSW EPA were undertaken prior to completion of the HHERA, these discussions were undertaken in order to clarify several aspects of HHERA and to ascertain an agreed approach and methodology.

1.2 Objectives

The specific objectives of the HHERA for the Site were to:

- assess the risk to human health and the environment that the Site represents in its current form; and
- develop Site-specific human health target criteria (SSTC) for soil and groundwater for use in defining the remediation end-point for the Site, where this end-point is defined as removal of the NSW EPA Declaration relating to the Site.

AECOM understands that removal of the NSW EPA Declaration would require demonstration of no significant risk of harm to human health and the environment under the current land use scenario, or land use scenarios allowable at the Site without a development approval. As stated in **Section 1.1**, no development is allowable without planning consent and the risk assessment will therefore be based on the current Site usage which is considered to comprise of limited use with the majority of the Site being unused paved open space areas (note that some parts of the Site are temporarily being used as a staging area for construction works in the ORWS Area).

1.3 Assumptions

The HHERA for the Site is based on a number of assumptions, namely:

- Contaminants of potential concern (CoPC) considered in the HHERA are limited to those identified within the NSW EPA Declaration (PAHs, BTEX, TPH, ammonia, phenol and cyanide). The distribution of these CoPC, along with other chemicals which have been identified at the Site during historic Site investigations, are detailed within this report.
- The quantitative assessment of risk and development of SSTC have not considered the presence of tar, which is required by policy of the EPA (NSW DEC (2007)) to be removed from the Site to the extent practicable (refer also to **Section 4.2.4**).
- There are significant biodegradation processes occurring within sub-surface soils based on measured oxygen concentrations beneath the sub-surface. To account for these biodegradation processes, a 10 fold factor (Davis 2009) has been adopted for the assessment of risk and development of soil SSTC (human health) for the paved areas of the Site, where biodegradation processes are considered to be significant.
- The assessment of threshold risk for each scenario and the development of SSTCs have accounted for the presence of mixtures of chemicals at the Site within the same media (refer to **Section 5.2.5**).
- The current theoretical estimation of vapour concentrations within indoor and outdoor air is based on partitioning modelling which has been demonstrated to overestimate concentrations between 10-1,000 fold. To account for this conservatism, an adjustment factor of 10 has been applied to all modelled soil results for BTEX, TPH C_6-C_9 and C_{10}-C_{14} for the human health SSTC. These compounds have been selected based on a number of studies which are described further in **Section 5.3.5.5.**

1.4 Framework and Methodology

1.4.1 Human Health Risk Assessment

The assessment of risk to human health and derivation of SSTC for the protection of human health have been undertaken in accordance with the following nationally adopted guidance documents:

- *Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards.* Department of Health and Ageing and enHealth Council, Commonwealth of Australia (enHealth, 2004);
- National Environmental Protection (Assessment of Site Contamination) Measure 1999, Schedule B(4), Guideline on Health Risk Assessment Methodology. National Environment Protection Council (NEPC, 1999a);
- National Environmental Protection (Assessment of Site Contamination) Measure 1999, Schedule B(7), Guideline on Health-Based Investigation Levels. (NEPC, 1999b); and
- Guidelines for the NSW Site Auditor Scheme (2nd edition), Appendix VII Human Health Risk Assessment Checklist. Department of Environment and Conservation, NSW (NSW DEC, 2006).

The general framework of risk assessment recommended in the above documents comprises the following four stages:

- **Data collection and evaluation**. This includes the acquisition, assessment of the reliability and analysis of information about chemicals present at the Site that may adversely affect human health and identification of those chemicals that will be the focus of the risk assessment.
- **Toxicity assessment**. This entails evaluation of both qualitative and quantitative information to describe the nature and incidence of adverse effects occurring in humans at different exposure levels.
- **Exposure assessment**. This involves identification of exposed human populations (receptors) and pathways via which receptors may be exposed to chemical contaminants on or derived from the Site. Environmental monitoring data and/or predictive fate and transport models are combined with estimates of the frequency, extent and duration of receptor exposure to derive quantitative estimates of human exposure to contaminants.
- **Risk characterisation.** This involves comparison of estimated exposure levels to relevant toxicity (dose-response) criteria to estimate the potential incidence and nature of adverse health effects to human receptors. An important component of the risk characterisation stage is the interpretation of risk estimates in the context of the uncertainties and assumptions of the risk assessment process.

In the case of SSTC derivation, the methodology, approach and assumptions are similar to the forward risk calculation process described above, with the exception that the exposure and risk algorithms are reversed in order to back-calculate acceptable concentrations in environmental media based on a set acceptable risk level.

1.4.2 Ecological Risk Assessment (ERA)

The ecological component of the risk assessment for protection of ecological receptors has been undertaken with consideration to the following Australian guidance documents:

- *National Environmental Protection (Assessment of Site Contamination) Measure 1999, Schedule B(5), Ecological Risk Assessment*. (NEPC, 1999c); and
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (ANZECC, 2000).

As required by the NSW EPA, the point of compliance for the purpose of assessing ecological risk is the down hydraulic gradient boundary of the Site. In the absence of any other information, the level of protection of groundwater at the down hydraulic gradient boundary of the Site has been based on the level of protection required for the nearest surface water receptor, Darling Harbour. This approach is consistent with the policies of the NSW EPA, in particular:

- The *Contaminated Land Management (CLM) Act* (1997), section 9;

- The Department of Environment and Conservation NSW (now the NSW EPA) *Guidelines for the Assessment and Management of Groundwater Contamination*, March 2007;
- The *ANZECC 2000 Water Quality Guidelines*, section 1; and
- The *National Environment Protection Measure Schedule B(6)* (NEPC, 1997) (refer to **Section 8.0**).

1.5 Scope of Work

The scope of work for this HHERA was the following:

- **Historical Report Review and Data Evaluation**: Review and evaluation of data from the:
    - Other Remediation Works (South) Area Data Gap Investigation (DGI) (AECOM, 2010a);
    - Data Gap Investigation EPA Declaration Area (Parts of Barangaroo Site and Hickson Road), Millers Point, NSW (AECOM, 2010b);
    - the proposed Other Remediation Works (North) Area DGI (AECOM, 2010c); and
    - Supplementary VMP Data Gap Investigation (AECOM, 2012).
- **Human Health Risk Assessment:**
    - Refinement of the list of CoPC for human health (from that in the NSW EPA Declaration), based on comparison of Site data to relevant 'Tier 1' screening criteria;
    - Review of toxicological data for CoPC and identification of appropriate toxicity values to use in the HHERA;
    - Review of chemical and physical properties of each CoPC for risk assessment purposes;
    - Development of Conceptual Site Models (CSMs) for the current status of the Site, including:
        - summarising the sources, nature and extent of contamination at the Site;
        - description of Site physical conditions (including Site geology and hydrogeology, existing physical structures) to be used in assessment of contaminant fate and transport modelling; and
        - identification of current human receptors and who may be exposed to Site contaminants and the pathways via which they may be exposed;
    - Quantitative exposure assessment:
        - establishment of relevant exposure parameters for identified receptors and exposure pathways; and
        - application of vapour and dust transport modelling to predict chemical concentrations in air which may result from identified soil and groundwater contamination;
    - Comparison of risk estimates with risk acceptance criteria recommended and/or adopted by state and federal regulatory agencies.
    - Characterisation of the nature and potential incidence of adverse health effects to receptors based on comparison of estimated contaminant intake or exposures to relevant toxicity (dose-response) criteria.
    - Where unacceptable risks were identified, chemicals were assessed in terms of their contribution to the total threshold and non-threshold risks reported. Where CoPC were defined to "significantly" contribute to reported risk totals, site specific target criteria (SSTC) were derived.
    - SSTC for soil and groundwater were derived for those CoPC which were identified to "significantly" contribute to the total risk. Estimation of SSTC based on consideration of toxicity, exposure, contaminant migration modelling and acceptable risk levels.
    - Comparison of SSTC for current scenarios to chemical concentrations reported at the Site.
    - Consideration of aesthetic risks or issues including odour.

- **Ecological Risk Assessment:**
    - Identification of appropriate ecological receptors, including both terrestrial and aquatic ecosystems (including groundwater dependant ecosystems).
    - Identification of relevant marine water quality criteria (MWQC) from a nationally adopted hierarchy of acceptable guidance documents plus consideration of additional international sources, based on the protection of the nearest surface water receptor, Darling Harbour.
    - Identification of potential risk associated with the CoPC based on the comparison of the concentration of CoPC (reported both within the Site and at the Site boundary) with the adopted MWQC.
    - Assessment of whether (or not) the concentrations of CoPC within the Site and at the down hydraulic gradient Site boundary represent a risk to groundwater dependant ecosystems.
- **Provision of recommendations for application of the SSTC.**
- **Reporting and Meetings**, including:
    - preparation of this report; and
    - attendance at meetings with the NSW EPA, the Site Auditor, LL or other stakeholders as required.

The scope of work also included a physical inspection of the Site by the risk assessors to gain an understanding of the local conditions and Site layout.

2.0 Site Characterisation

2.1 Site Details

The Site identification details are provided in **Table 1** below.

Table 1 Site Identification Details

Item	Description
Site Owner	The Barangaroo Delivery Authority
Client	Lend Lease (Millers Point) Pty Ltd (LL)
Site Address	Hickson Road (Sussex Street), Barangaroo, NSW 2000
Legal Description (Lot and Deposited Plan [DP])	Part Lot 3, Lot 5 in DP 876514 Section of Hickson Road in State Plan 118 and 162
County and Parish	County of Cumberland, Parish of Saint Phillip
Local Government Authority	City of Sydney
Current Zoning	Site within Hickson Road: Maritime and Transport Zone [a] Site within Barangaroo: Zone B4 Mixed Use [a]
Current Land Use	Barangaroo: Unused (note that some parts of the Site are temporarily being used as a staging area for construction works in the ORWS Area). Partial access for public recreation (walking and bike riding) (specifically the Harbour Walk). Hickson Road: Public Roadway All areas of the Site may be accessed by intrusive maintenance workers.
Site Area**	20,933 m^2, made up of: - Part Block 3: 183 m^2 - Part Block 4: 10,498 m^2 - Part Block 5: 4,583 m^2 - Part Hickson Road: 5,729 m^2
Approximate Average Elevation	2 - 3 meters Australian Height Datum (m AHD)
Site Location	**Figure F1** in **Appendix B**
Site Layout	**Figure F2** in **Appendix B**

Notes:
** Site Area is approximate and derived from Computer Aided Design (CAD) plans provided by LL. Areas are based on Blocks as defined in the Barangaroo Stage a Development Precinct which fall within the Site boundaries.
[a] – NSW Department of Planning 2010. *State Environmental Planning Policy (Major Development) Amendment (Barangaroo)*, 16 December 2010.

2.2 Site Description and Current Land Use

The Site covers an irregular shaped area of approximately 2.4 ha (based on existing LL supplied Site plans). The location of the Site is presented on **Figure F1** in **Appendix B** and the layout of the Site and surrounding areas is presented on **Figure F2** in **Appendix B**.

The Site is open, currently vacant and variably paved with concrete and asphalt concrete. The concrete ground surface was observed to be in generally good condition with some cracking noted on the surface of the asphalt concrete. A two storey building (referred to as the ‘amenities building’) was formerly present on the eastern portion of the Site adjacent to Hickson Road. The building was present at the Site at the time of the AECOM DGI (AECOM, 2010b) and was vacant, although it is understood the upper floor was occasionally used for Site meetings by the Authority personnel. The building has now been demolished.

Access to the Site (excluding Hickson Road) is limited by the presence of a cyclone wire fence on the eastern side. Three gatehouses are present along the fenced area to permit access to Barangaroo, which is controlled by a 24 hour security presence. During the field investigation undertaken as part of the DGI, a harbour walk was opened to the public. The publicly accessible area was controlled by the presence of temporary fencing. The harbour walk is currently accessible to the public when the temporary ferry terminal is not operating (i.e. a non-ship day).

A section of Hickson Road forms the easternmost portion of the Site. The road is actively used as a vehicle thoroughfare and for parking, and pedestrians use the footpaths on the eastern and western sides of the road.

AECOM notes that under the current land use scenario, or land use scenarios allowable at the Site without a development approval, public recreation land uses (specifically the harbour walk and Hickson Road) are known to occur and intrusive maintenance work for road repair, Site infrastructure development or maintenance of underground services may be expected to occur.

2.3 Surrounding Land Use

The Site is surrounded by the following land use:

- North: Barangaroo Central, including but not limited to the remainder of Block 5 (open space/concrete hardstand). A temporary cruise ship terminal is also located northwest of the Site.
- South: Barangaroo South Blocks 1 to 3 and the southern portion of Hickson Road followed by Sussex Street (public roads).
- East: Commercial and high density residential buildings with Jenkins Street beyond.
- West: The ORWN Area comprising the remainder of Blocks 4, 5, and the Public Domain followed by Darling Harbour.

The location and layout of sub-sites and sampling are presented on **Figure F2** in **Appendix B**.

2.4 Site History

The Overarching Remedial Action Plan (RAP) (ERM, 2010) provides detail of historical activities at the Site, as summarised below:

- 1839 to 1921: A gasworks operated by The Australian Gas Light Company (AGL) was located on part of the Site and extended across what is now Hickson Road. The remainder of the Site was owned by merchants, manufacturers and various shipping companies. It is likely that the Site was also used for ship berthing and associated activities. Ownership was largely transferred to Sydney Harbour Trust Commissioners (SHTC) in approximately 1912, however, it is understood that the gasworks site was leased to AGL until September 1921. The Hickson Rd portion of the Site was owned by a tin smelter and engineer during 1875. Other owners include ship builders, a licensed victualler, shipowners and merchants.
- 1922 to 1925: The gas holders and purifier beds associated with the AGL gasworks were demolished to ground level and the gas holding tanks were backfilled. The fill in the gas holder pits has been reported to contain tarry material and exhibit odours from a depth of 2 m bgl. The Site was used for workshops and stores, with many warehouse buildings constructed on the former gasworks area.
- 1925 to 1936: The majority of the Site continued to be owned by the SHTC and was used for ship berthing and associated activities. According to the title search records, the Hickson Road portion of the Site has been used since 1925 as a road under the control and management of the City of Sydney Council.
- 1936 to 1998: Part of the Site was owned by the Maritime Services Board of NSW and subject to various commercial leases. The majority of the remainder of the Site initially consisted of finger wharves, which were removed over time with a significant portion of land reclaimed from the harbour with unclassified fill between 1951 and 1972. In 1996 a vehicle maintenance area including wash bay, waste oil store and above ground diesel fuel tanks was identified.
- 1998: Martine Ministerial Holding Corporation was the proprietor of Lots 1 and 6 in Deposited Plan 876514. SPC was proprietor of Lots 2, 3, 4 and 5.
- 2007–2008: The majority of the Site was vacated by Patrick Stevedores Operations. Four large warehouses were demolished and the Site cleared and levelled in preparation for future redevelopment.

2.5 Declaration as Remediation Site

The Site has been declared a remediation site under the Contaminated Land Management Act 1997, as follows:

Declaration Number 21122; Area Numbers 3221

The Environmental Protection Authority (EPA) declares the following land to be a remediation site under the Contaminated Land Management Act 1997 ("1997"):

a) Land to which this declaration applies ("the site"):

- *Part Lot 5 and Part Lot 3 in Deposited Plan (DP) 876514, Hickson Road, Millers Point;*
- *The part of Hickson Road adjacent to:*
  - *30-34 Hickson Road being Lot 11 DP1065410;*
  - *36 Hickson Road being Lot 5 DP873158 and Lot 12 DP1065410; and*
  - *38 Hickson Road being SP72797 Millers Point.*

  In the City of Sydney local government area, the site coincides with the known footprint of the former gasworks facilities. A map of the site is available for inspection at the offices of the Department of the Environment and Climate Change, Level 14, 59-61 Goulburn Street, Sydney, NSW.

b) Nature of contamination affecting the site:

The EPA believes that the site is contaminated with gasworks waste and particularly waste tar as a result of the previous use of the site as a gasworks plant. The chemical composition of gasworks waste includes the following substances ("the contaminants"): polycyclic aromatic hydrocarbons (PAHs); benzene, toluene, ethylene and xylene (BTEX); total petroleum hydrocarbon (TPHs); ammonia; phenol and cyanide.

c) Nature of harm that the contaminants may cause:

The EPA has considered the matters in S.9 of the Act and for the following reasons has determined that the site is contaminated in such a way as to present a significant risk of harm to human health and the environment:

- *Groundwater on the site has been found to be contaminated by TPHs, PAHs, BTEX, ammonia, phenol and cyanide at concentrations significantly exceeding the relevant trigger values for the protection of human health and aquatic ecosystems in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000).*
- *These groundwater contaminants include human carcinogens and substances toxic to aquatic ecosystems.*
- *The contaminated groundwater is likely to be migrating from the site to Darling Harbour and could ultimately affect aquatic ecosystems.*
- *Contaminated groundwater is impacting on the surrounding areas including the basement of a residential building adjacent to the site, potentially exposing humans in that building to vapours; however it is currently being effectively controlled.*
- *Contaminated groundwater is likely to be migrating from the site to Darling Harbour and could ultimately affect aquatic ecosystems.*

d) Further action under the Act

The making of this declaration does not prevent the carrying out of a voluntary remediation of the site and any person may submit a voluntary remediation proposal for the site to the EPA. If the proposal satisfies the requirements of S.26 of the Act, the EPA may agree not to issue a remediation order to the person or persons bringing the proposal.

2.6 Previous Investigations

Previous investigations relating to the Site and adjacent areas are summarised in **Table 2** below. Investigations undertaken by AECOM and others over the last two years which have included the Site and/or immediately surrounding areas are further described in **Section 2.6.1** to **Section 2.6.8.**

Table 2 Previous Investigations

Date of Publication	Consultant	Report Title and Key Issues
January, 1986	ARUP Geotechnics	*Upgrading Wharf 7/8 Darling Harbour, Geotechnical Site Investigation* – detail of rock/soil design parameters, geotechnical analysis and recommendations on foundations for proposed development of Wharves 7 and 8.
June, 1996	Noel Arnold & Associates Pty Ltd	*Initial Environmental Assessment, Sydney Ports Corporation, Darling Harbour Berths 3-8 Hickson Road, Darling Harbour* – details results of an initial contamination assessment and provides options for remedial management of the site. Known and potential contamination was not determined to be a risk to the ongoing use of the site by the then occupant providing subsurface materials were not disturbed. Impact was identified in the area of the former gas works.
March, 1998	Coffey Partners International Pty Ltd	*Wharf 8 Darling Harbour Environmental Soil Quality Assessment* – A limited site assessment including soil sampling at Wharf 8 to identify contamination and provide options for disposal of excavated soil associated with proposed development. The Environmental Site Assessment (ESA) reported low level polycyclic aromatic hydrocarbons (PAH) contamination and identified material required for off-site disposal that would likely require industrial or hazardous waste classification.
July, 2001	URS Australia Pty Ltd	*Contamination Review for Darling Harbour – Berths 3/8* – Comprised a review of the contamination issues collated from 11 reports produced between 1993 and 2001. The review identified soil and groundwater contamination associated with the former gas works, including off-site migration and soil contamination associated with current vehicle maintenance operations.
August, 2006	Jeffery and Katauskas Pty Ltd	*Geotechnical Investigation for Proposed Redevelopment of Wharves 3-8 at Hickson Road, Darling Harbour East, NSW* – Geotechnical investigation intended to identify the subsurface conditions of the site in preparation for the proposed redevelopment.
June, 2007	ERM Australia Pty Ltd	*Environmental Site Assessment, East Darling Harbour, Sydney, NSW Final Report – Revision 1* – ESA intended to identify and report the environmental site conditions in preparation for the development planning. Works included the completion of a Stage 1 Investigation and Stage 2 ESA comprising drilling and sampling of soils and groundwater at 150 locations (inclusive of Lots 1, 2 , 4 and Northern portion of Lot 5). Gasworks chemicals were identified in groundwater in the vicinity of the former gas works. Refer to **Section 2.6.1** for further detail regarding the report findings.
May 2008	Coffey Environments Pty Ltd	*Preliminary environmental investigation at 30-38 Hickson Road,* conducted for the City of Sydney Council. Included the drilling and sampling of 15 boreholes and the installation of 6 groundwater monitoring wells. Area of investigation included Hickson Road and the courtyard area between 30 and 38 Hickson Road. Refer to **Section 2.6.2** for further detail regarding the report findings.

Date of Publication	Consultant	Report Title and Key Issues
July, 2008	ERM Australia Pty Ltd	*Additional Investigation Works at Barangaroo, Hickson Road, Millers Point, NSW – Revision 3* – intended to address data gaps remaining following the Stage 2 ESA and included an additional 55 boreholes and construction of 13 monitoring wells across the site (inclusive of Lots 1, 2 , 4 and Northern portion of Lot 5). The report identified the former gas works and reclaimed areas between the finger wharves as key areas of concern. Exceedances of assessment criteria for soil were identified for lead, total petroleum hydrocarbons (TPH), PAH, benzene, toluene, ethylbenzene, xylenes (BTEX) and sulphate. The highest levels were identified in the vicinity of the former gas works and included the identification of phase separated hydrocarbons (PSH) in monitoring well (MW)204D located within the gas works footprint. Refer to **Section 2.6.3** for further detail regarding the report findings.
August, 2008	ERM Australia Pty Ltd	*Preliminary Sediment Screening Works at East Darling Harbour, Adjacent to Barangaroo, NSW, Draft, Rev 03* – preliminary sediment screening works were conducted at East Darling Harbour to identify potential migration of contamination off the site to sediments in Darling Harbour. Sediments cores were collected from the harbour adjacent to the site along 7 transects. Screening identified PAH, tributyl tin and metals exceeding ANZECC (2000) and elevated levels of organochlorine pesticides (OCPs) and TPH C_{10}-C_{36}. Refer to **Section 2.6.4** for further detail regarding the report findings.
May 2010	AECOM	*Data Gap Investigation, Other Remediation Works (South) Area Hickson Road, Millers Point NSW* (AECOM, 2010a). The purpose of the DGI was to reduce uncertainties which existed in the data set, to assess the characteristics of soil and groundwater underlying the Site, provide additional data for a quantitative HHERA and facilitate the development of an RAP and Remediation Work Plan (RWP) describing the remediation strategy to be implemented by LL as part of its proposed Stage 1 Development of the Barangaroo Precinct. Refer to **Section 2.6.5** for further detail regarding the report findings.
September 2010	AECOM	*Data Gap Investigation, EPA Declaration Area (Parts of Barangaroo Site and Hickson Road), Millers Point NSW* (AECOM, 2010b). Refer to **Section 2.6.6** for further detail regarding the report findings.
October 2010	AECOM	*Data Gap Investigation, Other Remediation Works (North) Area, Hickson Road, Millers Point NSW* (AECOM, 2010c). Refer to **Section 2.6.7** for further detail regarding the report findings.
2012	AECOM	*Supplementary Data Gap Investigation, EPA Declaration Area (Parts of Barangaroo Site and Hickson Road), Millers Point NSW* (AECOM 2012). Refer to **Section 2.6.8** for further detail regarding the report findings.

2.6.1 ERM (2007)

ERM was commissioned by Sydney Harbour Foreshore Authority (SHFA) to undertake an ESA which consisted of a Stage 1 Preliminary Site Investigation (PSI) and Stage 2 Detailed Site Investigation (DSI) for the East Darling Harbour property (Barangaroo). The following provides information related to the Site.

The PSI component of the investigation reported that the Site was historically used for port/wharf activities and workshops. The AGL gasworks site was also located to the north of the Site (off-Site) and reclamation activities had historically occurred at the Site for the construction of the wharfs.

Based on the historical information ERM concurred with URS (2001) investigation that the contaminants which required further consideration for the Site were TPH, BTEX, Heavy Metals, PAHs, polychlorinated biphenyl (PCBs), Cyanide, Sulfates, OCPs and organophosphorus pesticides (OPPs).

The ESA made the following conclusions:

- Impacts to soil and groundwater were identified predominantly within the area of the former gasworks infrastructure and the reclaimed northwest portion of the Site, with the primary contaminants of concern confirmed as lead, TPH/BTEX and PAH.
- No Non aqueous phase liquids (NAPLs) were observed during the investigation, however concentrations of organic contaminants such as TPH indicated that NAPL was likely present in the vicinity of the former gasworks area located immediately north of the Site.
- The groundwater regime within the Site was likely strongly influenced by tidal fluctuation.
- There appeared to be potential for both migration of contamination onto the Site from the east and migration of contamination from the Site into adjacent properties and into Darling Harbour.

The ESA included the following key recommendations:

- the extent of the risks to human health and the environment should be assessed through further investigations and a Site specific quantitative risk assessment; and
- additional delineation investigations and assessment of vapour flux from impacted areas and further assessment of hydrogeological conditions should be undertaken before developing a RAP.

2.6.2 Coffey (2008)

Coffey Environments Pty Ltd (Coffey) was commissioned by the Council of the City of Sydney to undertake a Preliminary Environmental Investigation (PEI) at the segment of Hickson Road (between numbers 30 to 38), Millers Point, NSW, which is located immediately northeast of the Site.

Soil samples were analysed for Heavy Metals, TPH, BTEX, PAH, phenols, chlorinated hydrocarbons and asbestos. Groundwater samples were analysed for Heavy Metals, TPH, BTEX, PAH, phenols, chlorinated hydrocarbons and ammonia.

The general ground conditions encountered during the intrusive investigation comprised asphalt overlaying concrete and fill ranging in depth between 3.1 and 9.4 m bgl. The fill generally consisted of gravelly sand and sandy gravels with minimal anthropogenic inclusions. The fill was generally underlain by sandstone, with the exception of residual clayey sand and sand soils at two locations (Borehole (BH) 3 and BH2).

Tar was encountered in two boreholes which were located in the southern portion of the investigation area.

Concentrations of heavy metals, phenols and chlorinated hydrocarbons were either less than the laboratory limit of reporting (LOR) or the adopted assessment criteria in all samples analysed. Asbestos fibres were not detected in any sample analysed.

2.6.3 ERM (2008a)

ERM was commissioned by SHFA to undertake additional soil and groundwater investigation works at Barangaroo. The objectives of the works were to fill in data gaps in soil and groundwater data to enable a RAP to be developed for the Site.

A summary of the results from within the Site are provided in **Table 3** below, which also includes the ERM (2007) ESA results.

Table 3 Summary of soil analytical results from ERM 2007 and 2008 investigations and ERM (2007) groundwater results

Analyte	No. Soil Results	Soil Results	Groundwater Results
Heavy Metals	73	Concentrations of metals in samples were all less than NSW (DEC) SIL_4 Criteria with the following concentration ranges: Lead (<5 -1320 mg/kg) Arsenic (<5 – 16 mg/kg) Cadmium (<1– 2 mg/kg) Total Chromium (<2 – 81 mg/kg) Copper (<5 – 228 mg/kg) Mercury (<0.1 – 5.9 mg/kg) Nickel (<2 – 22 mg/kg) Zinc (<5 - 1890 mg/kg)	Arsenic – all results <LOR Cadmium – all results less than LOR with exception of MW09 (1.3 ug/L) Chromium - all results less than LOR with exception of MW20 (2 ug/L) Copper – all results less than LOR with exception of MW17 (2 ug/L) Mercury – all results less than LOR Nickel – results ranged between <10 to 24 ug/L Zinc – Concentrations ranged between 0.015 (MW10) and 0.128 (MW09)
TPH C_6-C_9	53	All concentrations were <LOR with exception of 3 results BH117_10-10.5 (10mg/kg) BH117_15-15.5 (244 mg/kg) BH110_23.3-23.8 (46 mg/kg)	All concentrations < LOR with exception of: MW21 – 60 ug/L
TPH C_{10}-C_{36}	53	All concentrations were <LOR with exception of 13 results which ranged between 150 mg/kg to 5580 mg/kg. Results greater than EPA (1994) Criteria were from BH100_3-3.45 (1005 mg/kg), BH117_15-15.5 (5580 mg/kg) and BH195_10.5 (2215 mg/kg).	All concentrations < LOR with exception of: MW09 – 985 ug/L MW20 – 2870 ug/L MW21 – 385 ug/L
BTEX	53	Benzene: All <LOR with exception of 2 results BH110_23.3-23.8 (7.8 mg/kg) and BH117_15-15.5 (19.4 mg/kg) which exceed the NSW EPA (1994) Criteria. Ethylbenzene, Toluene and Total Xylene were detected in 3 samples at concentrations less than the NSW (EPA) 1994 Criteria.	All concentrations < LOR with exception of: MW21 – Benzene (3 ug/L), Toluene (8 ug/L), Ethylbenzene (2 ug/L) and Total Xylene (21 ug/L)
PAHs	38	Concentrations of Total PAHs ranged between 4.35 mg/kg and 826.3 mg/kg. One sample exceeded the NSW (DEC) SIL_4 Criteria (BH117_15-15.5 – 826.3 mg/kg). Benzo(a)pyrene [B(a)P] ranged between <0.5 and11.4 mg/kg. Three samples exceeded the NSW (DEC) SIL_4 Criteria (BH100 3.0_3.45, BH117_15-15.5 and BH195_10.5).	All concentrations < LOR with exception of: MW21- Total PAH (25.1 ug/L) and B(a)P (0.7 ug/L) MW18 - Total PAH (8.65 ug/L) and Naphthalene (0.7 ug/L)
Phenols	18	Concentrations of Phenols were < LOR in all samples.	-
PCBs	8	Concentrations of PCBs were < LOR in all samples.	All results less than LOR
OCPs/ OPPs	1	Concentrations were all < LOR.	All results less than LOR in MW20

The ERM Additional Investigation made the following recommendations:

- A quantitative human health and ecological risk assessment (HHERA) should be undertaken once further details of future redevelopment are known.
- Results of the investigation should be assessed with reference to previous investigations undertaken for Barangaroo.
- Routine groundwater monitoring should be considered to assess temporal variations in chemicals identified at the Site.
- Considering asbestos was identified in only one sample, it was unlikely that asbestos contamination was wide spread, however it was recommended that further work is required to determine the extent and nature of asbestos in fill.
- A RAP should be developed and following completion of a RAP, a RWP should be developed.

2.6.4 ERM (2008b)

ERM undertook sediment sampling in the area adjacent to Barangaroo in seven transects. The objectives of the sediment screening works were to assess if chemicals identified at the Site have migrated from Barangaroo and accumulated in sediments on the Harbour floor.

The results of the study compared historical data collected on Barangaroo with that collected within the adjacent sediments. The study concluded that the source of elevated chemicals present in the sediment may be from contaminated soil and groundwater identified on Barangaroo.

ERM reported that impacts reported within sediment were in close proximity to free phase hydrocarbons and elevated concentrations of metals, PAHs and TPH C_{10}-C_{36} that were identified in soils at depth at Barangaroo. They also noted that additional sediment assessment works would require an assessment of background sediment concentrations in the wider Harbour area. AECOM has presented such a comparison within **Section 8.2** of this report.

2.6.5 AECOM (2010a)

AECOM was engaged by LL to undertake a DGI for the proposed Blocks 1, 2 and 3 (including associated Public Domain areas) within Stage 1 of the Barangaroo Stage 1 Development precinct, that is immediately south of the current Site (also referred to as the ORWS Area).

The purpose of the DGI was to reduce uncertainties which existed in the available data set, assess the characteristics of soil and groundwater underlying the site, provide the additional data required for a quantitative HHERA to be developed and facilitate the development of a RAP and RWP describing the remediation strategy to be implemented by LL.

The results of the DGI intrusive investigation are briefly summarised as:

- Fill was encountered at the site overlying natural sands, gravelly sands, clays, weathered and sandstone bedrock. The fill was generally shallower (up to 3 meters below ground surface (mbgs) in the eastern portion of the site (near Hickson Road) and trending deeper (up to 19.2 mbgs) towards Darling Harbour.
- Soil impacts appeared to be associated with the historical presence of the former gasworks north of the site (located within the Site) and the presence of fill materials used for land reclamation activities.
- Soil vapour results indicated some gasworks-derived impacts in locations closest to the former gasworks area and low concentrations of chemicals (below soil vapour and ambient air guidelines) in some locations.
- Groundwater was present beneath the site within fill materials at approximately two metres below the ground surface and was subject to tidal fluctuation. Tidal influence extended as far east (inland) as Hickson Road.
- Groundwater impacts associated with the former gasworks infrastructure were limited to the north-eastern corner of the Blocks 1, 2 and 3 site. Groundwater contamination associated with the remaining gasworks infrastructure located to the north of the Blocks 1, 2 and 3 site did not appear to be migrating into the harbour in the area of the site.

The DGI assessment of risk presented the following findings based on considerations of future land use and environment:

- ***Residential/Commercial Land Use at the development area***: Whilst the asphaltic concrete and concrete ground surface was considered adequate to limit exposure by site users to underlying contamination, future earthworks/remediation/development at the site may complete the exposure pathway.
- ***Passive Recreation Land Use at the Public Domain:*** The area designated as Public Domain was covered with concrete and/or asphalt concrete with no complete exposure pathway to underlying soil or groundwater. Given the limited extent of contamination identified within the Public Domain, AECOM considered this area of the site presented a low risk to human health in its current condition.
- ***Environment:*** The DGI identified potential risks to the down hydraulic gradient environmental receptor (Darling Harbour). Based on the proposed development plan (i.e. excavation of basements), up gradient contaminant sources will be removed and therefore reduce the potential risk in the future.

The following recommendations were made:

- A RAP should be prepared to address hotspot remediation and potentially impacted materials that may be encountered during the excavation of the site for future development.
- Additional assessment of the materials should be undertaken in accordance with the RAP in the event that materials may be encountered during the excavation and remediation works that are different to those found during the DGI and/or previous investigations.
- An Acid Sulfate Soil (ASS) Management Plan may be required for the management of Potential Acid Sulfate Soils (PASS) during future excavation works in natural materials.

2.6.6 AECOM (2010b)

AECOM was engaged by LL to undertake a DGI for NSW EPA Declaration Area 21122 (also known as the former Millers Point gasworks), at Hickson Road, Millers Point. This area is designated as the “VMP Remediation Works Area”.

The purpose of the DGI was to reduce uncertainties which existed in the available data set, assess the characteristics of soil and groundwater underlying the site, provide the additional data required for a quantitative HHERA. The HHERA would assist in the development of a RAP and RWP.

The NSW EPA had previously determined this area to be contaminated in such a way as to present a significant risk of harm to human health and the environment. The reported results of this DGI and previous investigations were found to support this determination.

The DGI confirmed that elevated concentrations of contaminants in soil and groundwater associated with the former gasworks site, notably BTEX, naphthalene and PAHs, were present in locations which included areas near the boundaries of the NSW EPA Declaration Area.

The results of this DGI intrusive investigation as they apply to the Site are discussed in further detail in **Sections 3.2** and **Section 3.3** of this report.

In summary, the DGI identified elevated concentrations of chemicals in soil and groundwater exceeding the adopted Site investigation criteria. The reported results were considered to be primarily associated with the area’s former land use as a gas manufacturing plant and with the importation of fill materials to level the Site.

The DGI recommended completion of the following:

- Site-specific HHERAs addressing remediation of the NSW EPA Declaration Area in order to address the significant contamination, the NSW EPA Declaration removal and for the proposed future land use.
- RAPs detailing options for remediation and/or management and recommended preferred strategy to facilitate removal of the NSW EPA Declaration and render the area suitable for their intended land use.
- RWPs providing a technical specification that is suitable for issue by LL to its contractors and that provides specific details of the work that must be completed to facilitate delivery of the remediation works prescribed by the RAP for the Site; and
- An Acid Sulphate Soil Management Plan may be required for the management of PASS during future excavation works.

2.6.7 AECOM (2010c)

AECOM was engaged by LL to undertake a DGI of the Barangaroo Other Remediation Works (North) Area (ORWN Area). The ORWN Area covers a portion of the Barangaroo Block 4 and proposed Southern Cove areas (including associated Public Domain areas) outside the NSW EPA Declaration Area.

The purpose of the DGI was to reduce uncertainties which existed in the available data set, assess the characteristics of soil and groundwater underlying the site, provide the additional data required for a quantitative HHERA. The HHERA would assist in the development of an RAP and RWP.

The results of the investigations conducted by AECOM and others across the ORWN Area indicated the following:

- Encountered fill depths ranged from 10.0 to 23.5 mbgs. Fill materials were generally shallower in the eastern portion of the ORWN site closest to Hickson Road and deeper in the western portion of the ORWN site closest to Darling Harbour. The thickness of fill material generally increased from east to west across the ORWN site.
- Natural soils encountered across the ORWN site comprised silty sands, gravelly sands, clays, weathered sandstone and sand with components of clay. Sandstone bedrock was encountered across the ORWN site with encountered depths ranging from 10.0 mbgs to 25.0 mbgs. Bedrock was generally shallower in the eastern portion of the ORWN site closest to Hickson Road and deeper in the western portion of the ORWN site closest to Darling Harbour.
- The reported chemicals were generally consistent with those identified during previous reports encompassing the ORWN site and surrounding gasworks, variably exceeding the adopted ORWN site investigation Criteria across the ORWN site.
- The maximum concentrations of chemicals were generally located in proximity to and down hydraulic gradient from the former gasworks infrastructure in the NSW EPA Declaration Area.
- A reported concentration of naphthalene above the adopted soil vapour screening guidelines was detected in the single soil vapour well within the ORWN Area located down-gradient of the former gasworks, indicating the potential presence of gasworks-derived impacts. Concentrations of toluene (below soil vapour guidelines) were also detected.
- Groundwater was encountered at depths ranging from 1.823 to 2.975 m bgs and was subject to tidal influence.

The most significant groundwater contamination was reported for wells screened deeper within the aquifer, across the base of the fill and natural sediments immediately overlying bedrock. The identified contaminants are considered to be associated with the footprint of the former gasworks within the NSW EPA Declaration Area. Monitoring wells screened entirely within the top 10 m of the aquifer generally reported TPH, PAH and BTEX concentrations less than the laboratory Limit of Reporting (LOR).

2.6.8 AECOM (2012)

AECOM was engaged by LL to undertake a Supplementary VMP DGI for areas adjacent to the western and southern boundaries of the NSW EPA Declaration Area (the Site).

The Supplementary DGI was undertaken to provide improved delineation of the vertical and lateral extent of identified contaminated materials around (both within and outside) the Site and to assess whether these impacts will require remediation to facilitate removal of the NSW EPA Declaration. The objectives of the investigation were to:

- refine the extent of remediation works required within the Site;
- refine the extent of remediation works required outside the Site;
- further assess groundwater quality immediately down hydraulic gradient of the Site; and
- assess the opportunity for beneficial reuse of materials that might be removed from the Site.

The scope of work undertaken included:

- Advancing a total of 14 boreholes (BH400 to BH413) to bedrock generally across the ORWN (west of the Site);

- Conversion of one borehole into a groundwater monitoring well (BH401/MW401) and five boreholes into bundled piezometers (BH405/IT03, BH410/IT04, BH411/IT05, BH412/IT06 and BH413/IT07) (refer to **Figure F3** in **Appendix B**);
- Groundwater sampling of four existing monitoring wells (MW62, MW68, MW69 and MW210) and six newly installed monitoring wells (MW410, IT03, IT04, IT05, IT06 and IT07); and
- Analysis of selected soil and groundwater samples for the following contaminants of concern by National Association of Testing Authorities (NATA) accredited laboratories.
- The following to provide data required for the HHERA:
  - Leachability (Toxicity Characteristic Leaching Procedure [TCLP] and Australian Standard Leaching Procedure [ASLP]) analysis of selected soil samples collected from BH400 to BH413;
  - Analysis of selected soil samples for phenols;
  - Groundwater sampling of groundwater from five additional monitoring wells (MW198, MW200, MW204S, MW209 and MW08);
  - Standard laboratory analysis of additional groundwater samples from the five additional monitoring wells;
  - Laboratory analysis following laboratory double filtering of selected groundwater samples (filtrate analysis);
  - Laboratory analysis of residue on filter papers from all filtrate samples for PAHs and phenols.

The Supplementary VMP DGI has made the following findings:

- Tar impacted soil was identified at and below the fill and natural soil interface in boreholes BH400 to BH406 (outside the Site in the ORWN Area).
- Concentrations of chemicals including lead, TPH, BTEX, and PAHs were reported at each location (BH400 to BH413), with the exception of BH412.
- Observations of contamination and PID readings were consistent with analytical results.
- Asbestos fibre bundles were identified in fill materials BH405 and BH401. Potential asbestos containing material such as fibre cement fragments were not observed in any sample collected.
- Concentrations of chemicals were reported in existing and newly installed monitoring wells, with the highest concentrations within the vicinity of the Site.

2.7 Geology

2.7.1 Regional Geology

Reference to the *1:100 000 Geological Survey of NSW (Sydney) Sheet 9130 (Ed 1) (*Herbert, 1983*)* indicated that the stratigraphy of the Site comprised man-made fill material, marine clays and Hawkesbury Sandstone.

Information from previous investigations indicated that the former 1880s shoreline ran approximately along the western edge of Hickson Road (i.e. along the eastern edge of the proposed Stage 1 Development). The area to the west of Hickson Road is understood to have been progressively reclaimed. Aerial photographs from the 1950s indicate that the area between Hickson Road and the current shoreline was occupied by a number of finger wharves, extending from Hickson Road. It is understood that the space between the historical finger wharfs and seawalls was infilled in several stages between the 1960’s and 1980’s with various types of material. The former Southern Cove is understood to have been filled in 1988.

2.7.2 Local Geology

ERM (2008a) identified and summarised the following subsurface conditions across the wider Barangaroo precinct:

- hardstand (0 to 0.46 mbgs): consisting of concrete and asphalt concrete, generally in good condition with minimal staining;
- road base fill (0 to 0.5 mbgs);

- fill (0 to 18 mbgs): fill materials consisting of sandstone, building rubble, bricks and concrete, silty gravelly sand. Black staining and odours (particularly around the former gasworks);
- marine clay/sand (3.0 to18.4 mbgs): interbedded clayey sand and sandy clay, dark greyish brown, saturated, some shell fragments and organic matter, sandy clay (soft, high plasticity), clayey sand and sand (lose to dense, low plasticity, fine to coarse sand, low to no plasticity);
- marine clay/sand (4.9 to 32.75 mbgs): interbedded clayey sand, sandy clay and sand, pale yellowish brown, white, reddish brown or dark greyish brown. Sandy clay-stiff to hard, medium to high plasticity. Clayey sand and sand – loose to dense, fine to coarse sand, low or no plasticity;
- bedrock (1.3 to 32.75 mbgs): weathered sandstone, white, light yellowish, brown, olive brown and reddish brown, white, wet, fine to coarse grained, some fracturing noted;
- recent intrusive investigations within Barangaroo Block 3 (located adjacent and south of the Site AECOM (2010a) encountered the following lithological profile:
  - surficial hardstand consisting of asphalt concrete;
  - fill extending to 3 mbgs on the eastern portion and 17.3 mbgs on the western portion of Block 3. Fill consisted of mixed materials including road-base gravel, sandstone, building rubble, bricks and concrete, silt, clay, sand and gravels. Black staining and odours were noted in a number of borehole locations across Block 3, notably in the proximity of the original gasworks, and to a lesser extent at Blocks 1 and 2;
  - interbed natural clays and sands extending to 14.2 mbgs across the centre of Block 3 and up to 24.0 mbgs on the western portion of Block 3; and
  - sandstone bedrock from 3.0 mbgs on the eastern portion and from 20.4 mbgs on the western portion of Block 3. Shale bedrock was also encountered on the western portion of the block, from 12.5 mbgs.

AECOM (2010b) reported variable stratigraphic conditions across the Site (corresponding to the NSW EPA Declaration Area footprint); however, stratigraphy generally comprised fill material overlying natural weathered sandstone with clay components. Sandstone bedrock was generally present underlying natural weathered bedrock materials or in some instances directly underneath fill materials.

Fill material

The depth of fill materials encountered during the conduct of the VMP and PDA DGI was variable and ranged from 0.43 mbgs (AECOM BH67) to 19.0 mbgs (AECOM BH60/MW60). Fill materials were generally shallower in the eastern portion of the Site closest to Hickson Road, thickening toward the western portion of the area.

Natural material

Natural soils underlying the Site (AECOM, 2010b) comprised silty sands, gravelly sands, clays, weathered sandstone and sand with components of clay. It is expected that similar material will be encountered beneath the greater Site footprint.

Bedrock underlying the Site consisted of sandstone with some shale. The depth to bedrock was variable across the Site and ranged from 3.0 mbgs (BH11) to 19.2 mbgs (BH28). Bedrock was generally shallower in the eastern portion of the Site closest to Hickson Road and deeper in the western portion of the Site.

2.8 Hydrogeology

The following groundwater conditions have been described at Barangaroo in previous investigations (ERM, 2007):

- measured groundwater elevations in July 2006 during a high tide ranged between 0.083 m AHD (MW21) and 0.64 m AHD (MW10);
- measured groundwater levels ranged between 2.094 m below Top of Casing (m bTOC) (MW09) and 2.545 (m bTOC) (MW20) in July 2006 during a high tide;
- the water table across the Site has been shown to be influenced by tidal fluctuations;
- groundwater flow direction has been shown to flow to the west towards Darling Harbour and to the east, towards Hickson Road in the south eastern portion of the Site; and
- subsurface trenches may present preferential pathways for transport of contaminants in groundwater.

It is noted that, in the opinion of AECOM, the current dataset and conceptual site model indicate that the shallow subsurface trenches are unlikely to act as preferential pathways for contaminant migration as the contamination is present at depths below the likely depth of the service trenches.

Results of the recent AECOM DGI (AECOM, 2010b) indicated groundwater was present beneath the Site within the fill and underlying natural materials. Groundwater was encountered at depths ranging from 1.38 to 2.92 mbgs and was subject to tidal fluctuation. Water level monitoring within selected wells over a three day period confirmed that groundwater underlying the area was tidally influenced as far east (inland) as Hickson Road, although the degree of fluctuation lessens toward the east.

The hydrogeological conditions encountered during previous investigations within the Site are generally consistent with those encountered within the ORWS Area and across the broader Barangaroo precinct.

A search of the NSW Department of Natural Resources (DNR) groundwater bore data base was reported in ERM (2007) and indicated that there were 32 registered groundwater bores within a 4 km radius of Barangaroo. Groundwater bore information indicated that the bores were registered for either recreation, irrigation or monitoring purposes and none of the identified bores are considered to contain groundwater that had discharged from the Barangaroo site.

2.9 Soil Vapour

AECOM (2010a, 2010b and 2010c) conducted sampling of soil vapour from across the Site (six locations) and from outside the Site (five locations) at depths ranging from 0.6 mbgs to 1.7 mbgs. The soil vapour wells were installed using permanent soil gas implants with construction details of each soil vapour well being contained within the various reports.

The soil vapour sampling was conducted on one occasion using summa canisters sampled over an eight hour period by a modified United States Environmental Protection Agency (USEPA) TO-14 method utilising the USEPA TO-15 analyte list. The results collected indicated exceedances of the adopted ambient air guidelines (converted Agency for Toxic Substances and Disease Registry (ATSDR) 2005 MRL) for naphthalene at locations SV05 and SV11 located within the NSW EPA Declaration Area and SV08 located in the public domain and SV01 and SV02 located within the other remediation works south area.

Prior to sampling, the oxygen measurements within the subsurface ranged from 4.2% to 17.6%, indicating that oxygen is present within the upper soil profiles at the site. All of the eleven locations were located beneath the existing slab across the site.

High oxygen measurements were recorded at the end of one sampling day in two of the nested soil vapour wells located at the site. These high oxygen measurements correlated with expected ambient air levels >20% and have been removed from the data set. It has been determined that the landfill gas meter, used for recording the in-situ parameters, must have deviated from its original calibration. It is considered that the data set (excluding the anomalies) is suitable and representative for interpretative use.

3.0 Data Evaluation

3.1 Data Used in the Risk Assessment

In preparing this HHERA, AECOM has included data from the following reports:

- ERM, 2007. *Environmental Site Assessment, East Darling Harbour, Sydney, NSW*. June 2007.
- Coffey Environments, 2008. *Preliminary Environmental Investigation, 30-38 Hickson Road, Millers Point*, NSW 2000. May 2008.
- ERM, 2008a. *Additional Investigation Works at Barangaroo, Hickson Road, Millers Point, NSW*. July 2008.
- AECOM, 2010b. *Data Gap Investigation, Data Gap Investigation, EPA Declaration Area (Parts of Barangaroo Site and Hickson Road), Hickson Road, Millers Point, NSW*. September 2010.
- AECOM, 2010c. *Data Gap Investigation, Other Remediation Works (North) Area, Hickson Road, Millers Point, NSW*. November, 2010.
- AECOM, 2012. *VMP Supplementary Data Gap Investigation, Site, Millers Point, NSW*, March 2012.

The quality and quantity of the analytical data collected as part of the above investigations are discussed in the following sections.

3.2 Data Quality

Available analytical data from the above reports were evaluated by AECOM for compliance with method requirements and project specifications. The data evaluation process comprised the review of the analytical procedure compliance and an assessment of the precision, accuracy, representativeness, completeness and comparability of the analytical data from a range of quality control measurements generated from both the sampling and analytical programs.

Data useability for the risk assessment process was assessed against criteria as recommended in the *NSW EPA Auditor Guidelines, Appendix VII* (2006), AS4482.1 (*Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds*) and the United States Environment Protection Agency (USEPA, 1990) *Guidance for Data Useability in Risk Assessment.*

This page has been left blank intentionally.

Table 4 Data Confirmation

Considerations	Coffey (2008)	ERM (2007)	ERM (2008)	AECOM (2010b)	AECOM (2010c)	AECOM (2012)
Data Quality Objectives (precision, accuracy, representativeness, completeness and comparability).	Quality Assurance/Quality Control (QA/QC) program generated as outcome of the seven-step Data Quality Objectives (DQO) process, with reference to NSW DEC (2006).	QA/QC program generated as outcome of the seven-step DQO process, with reference to NSW DEC (2006).	QA/QC program generated as outcome of the seven-step DQO process, with reference to relevant guidelines published by the NSW DEC (2006), ANZECC and National Environment Protection Council (NEPC).	The QA/QC program implemented as part of the AECOM DGIs (AECOM 2010b, 2010c, 2012) were generated as the outcome of the seven-step DQO process, as described in the Sampling Analysis and Quality Plan (SAQP) (AECOM, 2010e) and as in accordance with NSW DEC (2006).		
Representativeness	The Coffey sampling locations were targeted to assess specific potential areas of concern such as historical gas holder and tar wells the presence of site wide fill and to provide general coverage of accessible areas on site.	The scope included 100 geotechnical and environmental boreholes in a grid pattern, with, 25 boreholes located in the vicinity of the former gasworks site. The remainder were located across other areas of concern. Locations of monitoring wells targeted the site boundary with the harbour and the gasworks.	Strategy for soil sampling involved grid based drilling and locations targeted to address data gaps.	The strategy for soil, groundwater and soil vapour sampling involved intrusive investigations at targeted locations to further address data gaps associated with previous environmental investigations. Analysis for the contaminants of concern was selectively conducted on soil samples as indicated in analytical tables. Assessment of soil leachabilities for metals and PAHs was selectively conducted to be suitably representative of the Site, includes a suitable concentration range of chemicals including assessment at or near maximum soil chemical concentrations for the Site, and is considered adequate for graphical and statistical analysis. Results as a whole were considered more representative of subsurface Site conditions than previous reports		The strategy for a supplementary DGI was to inform the risk assessment process with respect to the nature and extent of contaminant discharge from the Site to Darling Harbour. Analysis for the contaminants of concern was selectively conducted on soil samples as indicated in analytical tables. Assessment of soil leachabilities for metals and PAHs was selectively conducted to: be suitably representative of the Site; and, include selection of a suitable concentration range of chemicals, including assessment at or near maximum soil chemical concentrations for the Site. The data set is considered adequate for graphical and statistical analysis.
Chain of Custody protocols	Signed chain of custody forms, laboratory analytical reports, calibration certificates, soil and well logs and well sampling sheets were present.	Signed chain of custody forms, laboratory analytical reports, calibration certificates, soil and well logs and well sampling sheets were present – refer to Appendix I of the report.	Signed chain of custody forms, laboratory analytical reports, selected calibration certificates, soil and well logs and well sampling sheets sighted.	Signed chain of custody forms, laboratory analytical reports, calibration certificates, soil and well logs and well sampling sheets were present.		
Analytical Laboratories	Analyses of primary and intra-laboratory duplicate soil and groundwater samples were undertaken by Australian Laboratory Services Group (ALS). Triplicate samples were analysed by SGS Laboratories. All laboratories were National Association of Testing Authorities (NATA) accredited for the analyses undertaken.	Analyses of primary and intra-laboratory duplicate soil and groundwater samples were undertaken by ALS. Triplicate samples were analysed by Labmark Laboratories. All laboratories were NATA accredited for the analyses undertaken.	Analyses of primary and intra-laboratory duplicate soil and groundwater samples were undertaken by ALS. Triplicate samples were analysed by Labmark Laboratories. All laboratories were NATA accredited for the analyses undertaken.	Analyses of primary and intra-laboratory duplicate soil and groundwater samples were undertaken by ALS. Triplicate samples were analysed by Labmark Laboratories. SGS undertook the analysis of soil vapour samples and Australian Soil Testing analysed samples collected for geotechnical purposes. All laboratories were NATA accredited for the analyses undertaken.		Analyses of primary and intra-laboratory duplicate soil and groundwater samples were undertaken by ALS Environmental. Triplicate samples were analysed by MGT Labmark. Laboratories. All laboratories were NATA accredited for the analyses undertaken.
Collection of quality control samples	Collection rate of Quality Assurance (QA) samples as listed under Data Quality Indicators (DQI) was considered adequate.	Collection rates are detailed in Annex J of the ERM report.	Collection rate of QA samples was considered adequate.	Collection rate of QA samples as listed under DQIwas considered adequate.		Collection rate of QA samples as listed under Data Quality Indicators was considered adequate.

Considerations	Coffey (2008)	ERM (2007)	ERM (2008)	AECOM (2010b)	AECOM (2010c)	AECOM (2012)
Chemical analytes considered	Metals (arsenic [As], copper [Cu], chromium [Cr], cadmium [Cd], mercury [Hg], lead [Pb], nickel [Ni], zinc [Zn]), TPH, BTEX, PAH, polychlorinated biphenyl (PCB), OCP, organophosphorus pesticides (OPP), phenols, asbestos, acid sulphate soils (ASS), cyanide (CN), ammonia/ammonium salts, S compounds, tin smelting analytes (tin [Sn], fluorine [F],chlorine [Cl], iodine [I], thorium [Th], beryllium [Be], molybdenum [Mo],Arsenic [As],phosphorus [P]) ***Results***: No tin smelting analytes detected above criteria. No asbestos detected. ***Groundwater*** Metals, TPH, BTEX, PAH, phenols, chlorinated hydrocarbons and ammonia detected above groundwater criteria. ***Soil*** TPH, BTEX, phenols and chlorinated hydrocarbons detected above soil criteria.	Metals (As, Cu, Cr, Cd, Hg, Pb, Ni, Zn),CN, sulphates, TPH, BTEX, PAH, phenols. PCBs, OCP/OPP, asbestos ***Results:*** No OCP/OPP, phenols or PCBs detected. ***Groundwater*** Metals, TPH, BTEX, PAH, CN detected above groundwater criteria. ***Soil*** Metals, TPH, BTEX, sulphate detected above soil criteria	Metals (As, Cu, Cr, Cd, Hg, Pb, Ni, Zn),CN, sulphates, TPH, BTEX, PAH, phenols, PCBs, asbestos . ***Results***: No PCBs detected. ***Groundwater*** Largely TPH, BTEX, CN,PAH, ammonia detected above groundwater criteria ***Soil*** Lead, TPH, PAH, BTEX, sulphate, detected above soil criteria.	Metals (As, Cu, Cr, Cd, Hg, Pb, Ni, Zn), sulphates, CN, ammonia, TPH, BTEX, PAH, phenols. PCBs, OCPs, asbestos, VOCs, semi volatile organic compounds (SVOCs), ASS ***Results***: No PCBs, OCPs detected. ***Groundwater*** Largely metals, BTEX, PAH detected above groundwater criteria. ***Soil*** Largely metals, BTEX, PAH, SVOC, VOC detected above soil criteria. ***Soil Vapour*** Naphthalene above soil vapour guidelines detected.		Metals (As, Cu, Cr, Cd, Hg, Pb, Ni, Zn), sulphates, CN, ammonia, TPH, BTEX, PAH, phenols. PCBs, OCPs, asbestos, VOCs, SVOCs, ASS ***Results***: No PCBs, OCPs detected. ***Groundwater*** Largely metals, Benzene, Naphthalene and Phenols (sum of total) detected above groundwater criteria. ***Soil*** Lead, BTEX, TPH, asbestos, PAH (sum of total) and Benzo(a)pyrene detected above soil criteria.
Data Validation	Data validation procedure employed is summarised in Section 10 and Appendix G of Coffey (2008) and was considered to be sufficient.	All rinsate blanks utilised reported trace metal content; however ERM (2007) did not consider the results as significant as they were below groundwater criteria concentrations. Overall data reported was judged to have met the DQOs adopted for the investigation.	Data validation procedure employed is summarised in Annex F of ERM (2008). Sample integrity and handling requirements were met. Few sample holding times, some Relative Percentage Difference (RPD) result and some laboratory QA/QC samples were either reported outside acceptable margin or did not meet criteria in some cases but were not considered to jeopardise data reliability. Overall data were considered to be of sufficient quality to comply with ERM quality protocols and the QAQC data was free of systematic and method biases.	The data validation procedure employed for the assessment of the AECOM (2010b, 2010c, 2012) field and laboratory QA/QC data indicated that the reported analytical results are representative of soil conditions at the sample locations and that the overall quality of the analytical data produced is acceptably reliable for the purpose of the DGI.		
Further comment	The Practical Quantitation Limit (PQLs) for, benzo(a)pyrene and anthracene in groundwater were greater than the investigation levels for marine water. However, this is unlikely to affect the outcome of the assessment as the reported detectable levels exceed the Groundwater Investigation Levels (GIL's) such that these compounds have been further evaluated based on detected concentrations. The PQLs for trichlorophenol (2-4-5 and 2-4-6), in groundwater was greater than the recreational water quality guidelines.	Refer to rinsate blank comment, above.	Sulphate concentrations from the inter-laboratory reported significantly lower than the primary lab results, and has been earmarked as needing further investigation. The ERM dataset was reported to have been reviewed by an independent expert on behalf of Sydney Harbour Foreshore Authority (SHFA), including data quality. Preceding the DGIs, AECOM randomly assessed and verified a portion of the ERM data including data from ERM (2008) by cross-checking the ESDAT result database against survey data obtained from LL. AECOM accepts the ERM dataset based on the random review and the review of SHFA's independent expert.	Some holding time, RPD result and some laboratory QA/QC samples were either reported outside acceptable margin or did not meet criteria in some cases, but in the majority of cases were not considered to jeopardise data reliability. Laboratory LORs for some VOCs (1,3-butadiene, trichloroethylene , 1,2-dichloroethane, hexachlorobenzene and 1,2-dibromomethane) were greater than the adopted air and soil screening criteria but these were not considered to be site contaminants and results would not significantly affect the dataset interpretation. Total organic carbon (TOC) soil results for approximately 50% of samples were reported outside analytical holding times due to laboratory delay. Results were used for reference only and not for quantitative purposes. A number of CN compound soil and water samples were reported outside analytical holding times, results were not expected to affect data quality as. CN was not detected in samples.		Some field RPD's, laboratory duplicate RPD's, laboratory control sample recoveries, matrix spike recoveries and surrogate recoveries outside the AECOM DQI's and rinsate blank detections. There were some holding time exceedances for additional laboratory leachate testing requested after the initial analysis was completed.

Based on the assessment presented in **Table 4**, there are no significant potential impacts to the overall DQIs (precision, accuracy, representativeness, completeness and comparability) of the primary data set. Data evaluated were considered to be valid and representative of concentrations of the analysed compounds at the sample locations tested. AECOM considers that the data set generated by the previous reports complies with the reporting quality protocols, addresses identified existing data gaps and confirms the general characteristics of soil, fill, soil vapour and groundwater underlying the Site sufficiently to allow for development of a Site specific HHERA.

In summary, reported data were therefore considered to be of an appropriate quality for use in the HHERA.

3.3 Data Representativeness and Completeness

The ERM (2007) *Environmental Site Assessment, East Darling Harbour, Sydney, NSW*, comprised the following scope of work:

- advancement of environmental soil bores to maximum depth of 13 mbgs; and
- advancement of environmental soil bores for conversion to monitoring wells to a maximum depth of 33.65 mbgs.

The ERM (2008a) *Additional Investigation Works at Barangaroo, Hickson Road, Millers Point, NSW,* was undertaken to fill in data gaps in the historical soil and groundwater data set to enable an RAP to be developed for Barangaroo. The scope of work for the additional investigation comprised:

- Advancement of 55 boreholes, of which 34 were cited as systematic (grid based) sampling locations and 21 were cited as judgemental (targeted) sampling locations within previously identified areas of concern and soil samples were analysed for a range of potential Site contaminants.
- Rock coring in 13 targeted boreholes within the former gasworks area, to maximum depth of 22.5 mbgs and analysis for potential Site contaminants.
- Installation of 13 new monitoring wells, gauging, sampling and analysis for potential Site contaminants.
- Gauging and sampling of the 13 new monitoring wells and 23 existing monitoring wells for a range of potential Site contaminants.

AECOM notes that only a proportion of these sampling locations were situated across the Site. Rock coring was undertaken where the potential for impact into bedrock was considered high, this being within the former gasworks area.

The Coffey (2008) *Preliminary Environmental Investigation 30-38 Hickson Road Millers Point NSW* was undertaken at the segment of Hickson Road (between numbers 30 to 38), Millers Point, NSW, located on the eastern portion of the Site. The scope of work from this investigation that relates to the part of the Site within Hickson Road included:

- Advancement of 15 boreholes, ranging from 6 to 12 m in depth, sampling and analysis for potential site contaminants.
- Conversion of 5 boreholes into new monitoring wells, gauging, sampling and analysis for potential site contaminants.

The Coffey sampling locations were targeted to assess specific potential areas of concern such as historical gas holder and tar wells and presence of site wide fill and to provide general coverage of accessible areas on site.

The DGI intrusive investigations undertaken by AECOM (AECOM, 2010b) were designed to acquire targeted data to address potential data gaps at a number of locations across the Site:

- advancement and sampling of a total of 25 boreholes across the Site;
- conversion of nine boreholes to groundwater monitoring wells;
- installation and sampling of seven soil vapour wells;
- sampling of a further five groundwater monitoring well locations located down hydraulic gradient of the Site;
- monitoring of groundwater including completion of rising head tests and tidal fluctuation monitoring within selected groundwater monitoring wells; and
- Installation and sampling of six soil vapour wells to maximum 2.2 m depth. Analyses of soil vapour for VOCs (TO14A list plus naphthalene).

The data from AECOM (2012) is not presented below as these locations were outside the Site.

The AECOM investigation points were selected on a judgemental (targeted) basis to attempt to fill data gaps and to target known or suspected areas of contamination to try to capture worse case soil, groundwater and soil vapour concentrations.

The spatial coverage of soil and groundwater investigation locations (see **Figure F3** in **Appendix B**) is considered generally sufficient to characterise the nature and extent of contamination within the Site. The available bulk soil data include samples from 86 locations. While it is noted that the overall sampling pattern of 86 borehole locations was not entirely grid-based, if it had been grid based then it could be expected to detect circular hot spots of greater than 9 m^2 diameter with 95% confidence (AS4482.1-2005). In addition, given that a high proportion of the soil samples were collected from locations targeted towards suspected source areas, the data are likely to be biased towards hot spots and areas where highest contaminant concentrations might be expected.

It is noted that, while a number of soil bores have extended into bedrock within the Site, the lateral and vertical extent of gasworks-derived contamination within the fractured bedrock underlying the Site is not known with certainty.

The available groundwater monitoring data include a network of 23 on-Site groundwater monitoring bores, of which nine were screened entirely in fill material, two entirely in natural soils (sands and clays overlying sandstone bedrock), five entirely in sandstone, four across the fill/natural interface and two across fill, natural and bedrock (sandstone) lithologies. **Table 5** below details the groundwater screening depths and lithologies.

Table 5 Summary of On-Site Groundwater Screening Depths and Lithologies

Bore ID	Approximate Screen Interval (mbgs)	Screened Lithology	Report
BH45/MW45	1 - 12.8	FILL/NATURAL/SANDSTONE	AECOM (2010b)
BH52/MW52	1.5 - 4.9	FILL	AECOM (2010b)
BH53/MW53	1.1 - 5.4	FILL	AECOM (2010b)
BH54/MW54	1.9 - 2.8	NATURAL	AECOM (2010b)
BH58/MW58	10.2 - 11.4	FILL	AECOM (2010b)
BH61/MW61	0.75 - 3.4	FILL/NATURAL	AECOM (2010b)
BH62/MW62	1.5 - 5.5	FILL	AECOM (2010b)
BH64/MW64	1.5 - 10	FILL	AECOM (2010b)
BH68/MW68	1.2 - 7.5	FILL/NATURAL	AECOM (2010b)
BH10	2 - 9.5	FILL	Coffey (2008)
BH15	2.5 - 12	SANDSTONE	Coffey (2008)
BH3	1 - 3	FILL/NATURAL	Coffey (2008)
BH6	1 - 4.6	FILL	Coffey (2008)
BH7	1 - 5.5	FILL	Coffey (2008)
BH198/MW198	1.6 - 6.8	FILL/NATURAL	ERM (2008a)
BH200/MW200	4.5 - 7.3	SANDSTONE	ERM (2008a)
BH204/MW204	2.8 - 4.4	SANDSTONE	ERM (2008a)
BH204D/MW204D	1 - 4	FILL	ERM (2008a)
BH205/MW205	15 - 19.4	SANDSTONE	ERM (2008a)
BH206/MW206	7 - 8	NATURAL	ERM (2008a)
BH209/MW209	1.8 - 8.6	FILL/NATURAL/SANDSTONE	ERM (2008a)
BH210/MW210	14.8 - 17.6	SANDSTONE	ERM (2008a)
BH87/MW15	3 - 9	unknown	ERM (2007)

In addition to the on-Site groundwater monitoring wells, three additional off-Site monitoring wells have been considered within the ecological risk assessment. In the absence of sufficient on-Site groundwater data (refer to **Section 3.4**), these monitoring wells are considered representative of groundwater quality at the down hydraulic gradient boundary of the Site. **Table 6** details the off-Site groundwater screening depths and lithologies.

Table 6 Summary of Off-Site Groundwater Screening Depths and Lithologies

Bore ID	Approximate Screen Interval (mbgs)	Screened Lithology	Report
BH40/MW40	14.3 – 20.5	NATURAL	AECOM (2010b)
BH69/MW69	9 -12	FILL / SANDSTONE	AECOM (2010b)
BH401/MW401	14.5 – 20	NATURAL	(AECOM, 2012)

Overall the data which has been reviewed is considered to be representative and complete and therefore appropriate to be used within the HHERA. Where data gaps have been identified, the potential significance to the HHERA and the manner in which they are addressed is discussed in **Section 3.4** below.

3.4 Data Gaps

Some observed data gaps which may impact this HHERA have been identified based on review of the available reports and data, these are summarised in **Table 7**. The manner in which data gaps have been addressed in the HHERA is also summarised below.

Table 7 Summary of Identified Data Gaps

Identified Data Gap or Issue	Potential Significance to HHERA	Manner in Which Addressed in HHERA
Vertical extent of gasworks derived material (e.g. tar) within fractured bedrock underlying the Site is not known with certainty (due to practical constraints).	The vertical distribution of gasworks derived material in fractured bedrock underlying the Site is not considered to influence the assessment of risk to human health or the environment or the ability to derive SSTC for CoPC. This is because potential impacts in fractured bedrock are unlikely to represent a complete pathway to current site receptors or the environment. Contaminant impacts in the vadose zone and shallow groundwater, which do represent complete pathways, are considered to be adequately characterised.	The tar has generally been identified within the natural clays, located within the saturated zone. The maximum observed concentration of CoPC within the vadose zone and the dissolved phase will be considered as exposure point concentrations for the quantitative risk assessment. Vertical distribution of CoPC will be noted as an uncertainty; potential for impacts to be present needs to be considered as part of the remedial planning for the Site because tar impacts need to be removed to the extent practicable.
Groundwater sampling locations are not located immediately adjacent to the Site boundary. Groundwater monitoring wells are variably screened in the fill and/or in the underlying natural material. Depending on the location or the groundwater monitoring wells, and the timing of the sampling activities relative to the tide, the groundwater sampled in the wells may not be representative of groundwater quality leaving the Site.	Available on-Site groundwater data may not be representative of the groundwater conditions at the Site boundary (considered to be the point of discharge for the ecological risk assessment).	Groundwater monitoring wells off-Site locations (BH40/MW40, BH401/MW401 and BH69/MW69) have been included as part of the ecological risk assessment, as these locations are considered to be down-gradient of the site and therefore augment the assessment of groundwater conditions at the Site boundary. It is not considered appropriate to rely <u>solely</u> on the existing (limited) groundwater monitoring data set from groundwater monitoring wells located near the Barangaroo site boundary. Consequently, groundwater concentrations both at the Site boundary and across the Site have been compared to the MWQC to assess risk to the environment.
Determination of the presence of groundwater dependant ecosystems	The precautionary principle has been applied, in consultation with the NSW EPA, in the absence of scientific data to confirm the presence of groundwater dependant ecological systems and their novel fauna. According to the precautionary principle irrespective of whether there are groundwater ecosystems present at the Site currently or not, the level of protection is required to be the highest that is practicably achievable based on the protection of the potential for such ecosystems to occur in the future.	The HHERA has been based on the requirement that groundwater quality both within the Site and at Site down hydraulic gradient boundary is required to comply with the adopted MWQG (as outlined in **Section 8.4**)

4.0 Nature and Extent of Contamination (Conceptual Site Model)

4.1 Contamination Sources

The Site is largely situated over the inferred footprint of the former Millers Point gasworks and includes part of the Barangaroo Stage 1 Development Precinct and Hickson Road (**Figure F2** in **Appendix B**).

Buried gasworks infrastructure is understood to remain underlying the Site. URS (2001) estimated the footprint of the former gasworks to encompass approximately 5420 m^2 and comprise the following structures:

- Retort House;
- Meter House;
- Gasholders;
- Purifier Beds.

Other historical structures associated with the former gasworks site included but are not limited to miscellaneous storage sheds, warehouses and roadways. Gasworks infrastructure underlying Hickson Road includes part of the annulus of the former gasholder, a smaller secondary gasholder and a tar well (Broomham, 2007; Coffey, 2008).

The former gasworks are recognised as a key source of contaminants at Barangaroo (i.e. NA&A, 1996; ERM, 2007; Coffey, 2008; ERM, 2008a; AECOM, 2010a; 2010b; 2010c). This and other chemical sources on Site have been identified by historical studies, as summarised in **Table 8**.

Table 8 Summary of Potential Contamination Sources on Site

Description of Potentially Contaminating Activity	Chemicals	Comments
Former gasworks	Metals, TPH, BTEX, PAHs, phenols, sulphate, cyanide, ammonia and asbestos	Associated with gasworks waste and identified as potential chemicals within *Information for the assessment of former gasworks sites* (NSW DEC, 2005). Gasworks contamination is likely to be concentrated in the vicinity of the former gasworks infrastructure across the Site.
Importation of fill materials for reclamation activities	Metals, TPH, BTEX, PAHs, PCBs, OCPs, VOCs, SVOCs, asbestos.	Fill materials of unknown origin have been used for land reclamation of the existing wharf areas.
Demolition of former buildings potentially containing hazardous materials	Lead, PCBs, asbestos.	Hazardous materials, including asbestos cement sheeting and lead based paints, may have been used in the construction of historical warehouses, buildings and/or industrial infrastructure on the Site and may have been introduced to the sub-surface during demolition works or as a result of leaching or weathering while the building structures were still in place.
Reclamation activities	ASS	Given the proximity of the Site to Darling Harbour the potential for ASS is present. Potential ASS (PASS) is likely to be present in the natural silts, sands and clays overlying the bedrock at depth on the Site.

Notes:
[a] Source: AECOM (2010b)
Metals – arsenic (As), copper (Cu), chromium (Cr), cadmium (Cd), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn).
PAHs – polycyclic aromatic hydrocarbons.
TPH – total petroleum hydrocarbons.
BTEX – benzene, toluene, ethylbenzene and xylenes
OCPs – organochlorine pesticides
OPPs – organophosphorus pesticides
PCBs – polychlorinated biphenyls

SVOC – semi volatile organic compounds
VOCs – volatile organic compounds
ASS – acid sulphate soils

The focus of the VMP HHERA is on the chemicals specified within the NSW EPA Declaration, specifically PAHs, BTEX, TPH, ammonia, phenol and cyanide. Other contamination identified on the Site by previous investigations (for example heavy metals), which are not listed in the NSW EPA Declaration, will be assessed as part of the PDA HHERA.

It should also be noted that the area east of the Site was historically occupied by a mixture of commercial, industrial and residential facilities, which may currently or could have historically been a source of contaminants. Potential contaminants are likely to include those summarised above.

As shown on **Figure F2** in **Appendix B**, a small portion of the historical gasworks infrastructure is located outside the Site boundary to the east of the Site. It is noted that contamination has been identified to extend beyond the Site boundaries. AECOM understands that potential health risks to residents or other occupants of buildings adjacent the Site (e.g. on the east side of Hickson Road) associated with existing groundwater contamination have been assessed, that the assessment was endorsed by a NSW EPA accredited Site Auditor and that the risks are currently being effectively managed (as referenced by the NSW EPA Declaration 21122). Furthermore, it is expected that remediation of Hickson Road will further reduce the potential for risk to occupants of adjacent buildings.

Assessment and remediation of contamination extending outside the Site will be addressed as follows:

- Contamination identified to the east of the Site has been appropriately assessed and managed by previous investigations and work in these areas (as discussed above).
- Potential health risks associated with existing soil and groundwater contamination identified west (in the Other Remediation Works North [ORWN] Area) and south (in the Other Remediation Works South [ORWS] Area) of the Site will be or have been addressed as part of the risk assessments relating to those specific areas.
- Contamination identified to the south of the Site will be managed as part of the Remedial Action Plan for the ORWS Area (AECOM, 2011c).

Contamination identified to the west of the Site within Barangaroo South (Block 4) and Barangaroo Central (Block 5) will be managed in accordance with the remediation objectives established by this HHERA (that is the contamination will be remediated as part of the VMP RAP that is to be prepared as an outcome of this HHERA). **Figure F6** in **Appendix B** depicts the conceptual site model (CSM) for the Site and illustrates the extent of contamination both within the Site and outside of the Site.

4.2 Impacted Media

4.2.1 Soil

AECOM (2010b) reported odour, staining and sheen in soil samples as being common in fill materials across the Site.

AECOM (2010b) reported that the maximum concentrations of chemicals were generally located in proximity to and down hydraulic gradient of the former gasworks infrastructure in Block 4 and Hickson Road. Chemicals including: lead, TPH (C_6-C_9 and C_{10}-C_{36}), BTEX compounds, PAHs (including benzo(a)pyrene [B(a)P]) and sulphate variably exceeded the adopted Site investigation criteria. The reported results were generally consistent with the findings of previous investigations (i.e. ERM, 2007; ERM, 2008; Coffey, 2008) with respect to the identified gasworks related chemicals, concentrations and/or impacts concentrated within the former gasworks area.

Separated phase gasworks waste and tar (SPGWT) was identified at nineteen locations at the Site (BH61, BH15, BH6, BH53, BH59, BH54,BH204s, BH141, BH55, BH019, BH204D, BH87, BH49, BH205, BH10, BH119, BH42, BH206, BH408) confirming the former gasworks as a source of contamination AECOM (2010b) notes that eight of these locations (MW204D, MW205, MW206, MW53, MW15, BH7, BH10 and BH6) are located within Hickson Road and Block 4 in close proximity to the former tar tank purifying beds and 1870 gasholder, indicating these locations are source areas of contamination. SPGWT was also identified at other locations, beyond the historic gasworks infrastructure, but within the Site, as shown on **Figure F8** in **Appendix B**. These findings were consistent with historical reports (specifically, samples from Hickson Road reported in Coffey 2008, and samples from MW204D reported in ERM 2008). SPGWT was observed within wells installed at varied depths, indicating SPGWT is present at the Site both within the fill materials and natural sediments (AECOM, 2010b).

Elevated concentrations of gasworks related chemicals were also reported outside the Site, particularly to the west (AECOM, 2010c) and south (AECOM, 2010a). SPGWT was also identified at ten locations to the west of the Site (BH401, BH74, BH400, BH402, BH403, BH404, BH406, BH48, BH40 and BH60) in areas down hydraulic gradient of the former gasworks area.

A total of five samples (collected from locations where buried fill and rubble were identified) were analysed for asbestos during the AECOM DGI. No asbestos was detected in the samples analysed. A single result (AECOM BH48_11.5-11.7) reported the presence of unidentified mineral fibres. The corresponding bore log for this sample noted the presence of plastic, minor silt, crushed brick and road base gravels. No visual evidence of bonded fibre cement or possible asbestos fibres was observed by AECOM during the DGI investigation. ERM (2008a) previously analysed a total of 39 samples (12 samples from the Site) and detected chrysotile and amosite asbestos in a single location (BH203_1.5). Consequently, asbestos containing materials are not considered to be widespread within fill materials at the Site. Therefore asbestos has not been considered further with respect to human health risks from the proposed future development of the site. It is considered that the RAP currently being prepared for the Site will determine appropriate field screening and management tools should asbestos be noted to be present during remediation. It is noted that the majority of the Site is currently covered in hardstand and therefore the potential for exposure to asbestos present on the Site during normal activities is considered to be minimal.

SPGWT was also identified at ten locations to the west of the Site in areas down hydraulic gradient of the former gasworks area.

Soil Leachability

ASLP analysis was undertaken to assess the leachable concentration of chemicals which may leach from soils at the Site under neutral conditions. There has been a total of forty five ASLP analysis conducted on soil samples collected within the Site. 9. Samples were selected based on field observations including odour, colour/staining and PID readings to select samples representative of chemical impact.

The initial 39 samples were collected during investigations conducted at the Site from 2008 until 2010 and are summarised within AECOM 2010(b). The results from ASLP testing are presented in **Table T8** in **Appendix A**. Concentrations of metals including As, Ba, Cd, Cr, Co, Cu, Hg, Pb, Mn, Ni, Vn and Zn and PAHs including acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene and pyrene were reported to be leaching at concentrations above the laboratory LOR.

The remaining ASLP analysis was conducted during the AECOM Supplementary DGI, 2012 and included six locations within the Site. The additional locations were analysed for ultra-trace (low level) PAH, phenols, BTEX, inorganics and metals. The results of these ASLP tests are presented in **Table T8** in **Appendix A**. The additional analyses were undertaken on soil samples taken from locations selected to be representative of significant contamination identified from previous field observations (PID, visual and odour). The soil samples selected for the additional analyses were taken from locations where it was expected (based on field notes) that high leach results would correspond with high soil concentrations.

Based on the samples analysed, the soil and fill material at the Site are considered to have the potential to leach BTEX, inorganics, metals, PAHS (acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, 2 methylnaphthalene) and phenols (phenol, 2,4 dimethylphenol, 2 methylphenol, 3&4 methylphenol) under the laboratory ASLP conditions.

4.2.2 Soil Vapour

AECOM (2010b and 2010c) soil vapour analysis reported some gasworks-derived impacts which exceeded the adopted ambient air guidelines (adjusted using an attenuation factor of 0.01) for naphthalene (converted ATSDR MRL 2005) at two locations within the Site and one location in the ORWN Area and two locations within the ORWS Area. Oxygen measurements taken from the 11 locations within the Barangaroo site from depths of 0.6 to 1.7 mbgs ranged from 4.2% to 17.6%. This suggests that there is sufficient oxygen movement through the upper soils present across the site beneath the current slab on grade foundation (which was observed to be of varying quality) to support biodegradation processes.

4.2.3 Groundwater

Previous reports found that dissolved-phase concentrations of contaminants at the Site were variably above the Site investigation criteria e.g. lead, cadmium, chromium (III+VI), cobalt, copper, mercury, nickel, zinc, benzene, naphthalene and phenol (AECOM, 2010b; Coffey, 2008).

The most significant groundwater contamination was identified in the immediate vicinity of the former gasworks infrastructure and contamination, including BTEX, naphthalene, PAHs and ammonia, was present in both dissolved and SPGWT (Coffey, 2008; ERM, 2008a; AECOM, 2010b). Concentrations of contaminants in excess of the assessment criteria were also identified in wells down-gradient of the gasworks footprint, indicating the westerly migration of contamination (AECOM, 2010b). The results of the AECOM (2010b) investigation indicated that the variable nature and distribution of fill materials at the Site caused localised variations in groundwater flow and associated contaminant migration, which is further complicated by tidal influences. The previous investigations indicate that there is contaminated groundwater migrating from the Site across the Site boundary. It is expected that the mass flux of the contaminants migrating across the Site boundary will change continually. However, it should be noted that the previous investigations have not calculated mass flux because the number of variables considered and the complexity of the system would necessitate simplification of a complex system that would have a large degree of uncertainty.

4.2.4 Considerations for Contaminant Mobility

Soil

The AECOM (2010b) investigation reported SPWGT and other fill materials contaminated with gasworks related chemicals in a number of locations within the former gasworks area, indicating these locations were source areas for contamination. Maximum concentrations of gasworks related chemicals were generally located within proximity to and to a lesser extent, down hydraulic gradient (west) of the former gasworks footprint, the results of which suggested that lateral migration has occurred. The results of the Blocks 1 to 3 DGI (AECOM, 2010a) and ORWN DGI (AECOM, 2010c) also confirmed gasworks associated chemicals and staining were present in soils immediately south and west of the Site, respectively.

Soil Leachability

The AECOM (2010b, 2010a) ASLP analysis on Site soils further indicated there is potential for mobility of key chemicals from soil sources, at levels which exceed the adopted groundwater screening criteria. The analysis confirmed that locations of elevated concentrations of contaminants in soil associated with the former gasworks site, notably BTEX, naphthalene and PAHs, included areas near the boundary of the Site.

Additional ASLP analyses undertaken by AECOM as part of the Supplementary VMP DGI (AECOM, 2012) provided further confirmation of whether or not a particular contaminant is leachable, particularly in cases where the groundwater screening criteria is at or near the laboratory standard LOR. The ASLP is considered to be representative of the potential of the material to leach at the Site as the ASLP was conducted under neutral leachate conditions which is the least aggressive of the available analytical leachate solutions. It is therefore considered to simulate the potential for *in-situ* soils to leach contaminants from surface water and rain water infiltration. These results are shown in **Table T8** in **Appendix A**. Sample locations are shown on **Figure F3** in **Appendix B**. The results confirm:

- that cyanide was not detected above the LOR in leachate;
- high molecular weight PAHs and some phenols exhibited very limited if any leachability;
- in 4 out of the 10 samples the laboratory was unable to achieve the ultra trace LOR. Matrix effects, possibly related to salinity effects and/or the presence of organic compounds, interfered with (raised) the achievable LOR; and
- overall, some metals, low molecular weight PAHs and some phenols exhibited potential mobility via leaching to groundwater.

Groundwater

Dissolved phase contamination associated with the former gasworks, was reported by AECOM (2010b) as being present across the Site as well as down hydraulic gradient of the site (AECOM, 2010c). Significant concentrations of arsenic, lead, cadmium, cobalt, copper, mercury, nickel, zinc, benzene, naphthalene and phenol were reported in groundwater underlying the former footprint of the gasworks infrastructure. Similarly, free phase tar was reported in eight wells located within the footprint of the former gasworks site (within Block 4 and Hickson

Road). As above, SPGWT was also identified at other locations, beyond the historic gasworks infrastructure, but within the Site, as shown on **Figure F8** in **Appendix B**.

Additional analyses were undertaken by AECOM, in consideration of contaminant mobility in groundwater, as part of the Supplementary VMP DGI (AECOM 2012). The additional analysis included:

- Standard (Limit of Reporting) PAH and phenol analysis of unfiltered groundwater samples (here on referred to as unfiltered results).
- Ultra-trace (low level) PAH and phenol analysis of twice laboratory filtered (using 0.45µm filter paper) groundwater samples (here on referred to as “Filtered” results). The Laboratory Limit of Reporting (LOR) for all ultra-trace analysis was less than the adopted MWQG outlined in **Section 8.4**.
- Analysis of the residue retained on laboratory filter papers (“Suspended Material”) from each Filtered sample for PAHs.

The additional analysis was undertaken on groundwater samples taken from 13 groundwater monitoring wells selected to include more significant contamination identified by the previous investigation works at the Site. The locations of the additional groundwater monitoring wells are presented in **Figure F2** in **Appendix B**.

It is noted that whilst contaminants sorbed onto colloids may be transported in the saturated zone, the inundation of seawater twice a day with the incoming tide will reduce the overall seaward movement of contamination. That is, the migration of groundwater from the conate zone, located up hydraulic gradient of the Tidal Prism, is slowed by each flooding tide. In consideration of this, and the lack of leachability of high molecular weight PAHs reported by the Supplementary VMP DGI, only contaminants which are present within the dissolved phase will be considered as CoPC for the purposes of assessing ecological risk. As such, AECOM has not considered that high molecular weight PAHs as CoPC, as they are not present within the dissolved phase groundwater at the Site and are more likely to be impeded from migration off-site by the fill soils.

The results as they pertain to the selection of CoPC for the assessment of ecological risk are discussed further in **Section 8.5.**

Separated Phase Gasworks Waste and Tar

AECOM (2010b) considered the migration of SPGWT (equivalent to NAPL) to occur both vertically and horizontally through the profile under the influence of gravity. The slope of the bedrock interface at the Site towards the west is also likely to be influencing SPGWT migration.

SPGWT within the Site is predominantly present in the eastern area of Block 4 and 5, and within or adjacent to the former gasworks infrastructure present beneath Hickson Road (i.e. the gas holder annulus and tar wells).

SPGWT has also been identified to the west of the Site, outside the Site boundary, and has generally been reported to be present at depth within the natural clays and within the clay/bedrock interface. Locations of SPGWT within and outside the Site are illustrated in **Figure F8** in **Appendix B**.

Although SPGWT was not formally identified by the Blocks 1 to 3 DGI (AECOM, 2010a), groundwater impacts likely associated with the former gasworks and infrastructure within the Site, were identified in Block 3.

Non Aqueous Phase Liquids (NAPLs)

AECOM notes that Section 3.5.1 of the NSW DEC (2007) Guidelines for the Assessment and Management of Groundwater Contamination requires that “*Where light NAPLs (LNAPLs) or dense NAPLs (DNAPLs) are present in the subsurface they must be removed or treated as much as practicable*”.

Consequently, in accordance with policy and guidelines made by the NSW EPA, all NAPL (referred to in this report as SPGWT) identified on the Site is required to be remediated to the extent practicable.

4.2.5 Consideration of Co-occurrence of Chemicals in Soil and Groundwater

There is potential for chemicals to be present in soil and groundwater at the same location at the Site. In particular, co-occurrence of CoPC with similar toxicological mechanisms for humans or the environment may be expected to exhibit additive or other effects. These effects are discussed in the relevant guidance documents adopted for this HHERA. The derivation of SSTCs for soil and groundwater at the Site is considered to be sufficiently conservative such that should a mixture of contaminants be present the potential in both soil and groundwater at any one location, human health should not be adversely impacted.

No terrestrial ecological receptors have been identified at the Site (refer to **Section 8.2.1**), therefore the ecological risk assessment is designed to identify potential risk to off-site receptors associated with migration of groundwater off-Site. Furthermore, the consideration of potential soil and groundwater co-occurrence is not warranted for ecological receptors.

4.3 Declaration Site Contaminants

Although previous site investigations have focussed on a range of potential contaminants associated with the historic land uses across the Barangaroo Stage 1 Development Precinct, the objective of this HHERA is to assess the current risk to on-site land users and to derive health based screening criteria (SSTC) for the purpose of remediation to remove the NSW EPA Declaration.

It has been agreed with the NSW EPA that to achieve this objective, the CoPC assessed by this HHERA can be limited to those defined within the NSW EPA Declaration. Therefore the CoPC considered further within this HHERA will include:

- Polycyclic Aromatic Hydrocarbons (PAHs): acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, and pyrene.
- Benzene, toluene, ethylbenzene and xylenes (BTEX).
- Total Petroleum Hydrocarbons (TPHs).
- Ammonia.
- Phenol.
- Cyanide.

The complete list of chemicals which have been identified in soil and groundwater at the Site by previous investigations at the Site have been considered separately within the HHERA Declaration Site (AECOM, 2011a).

5.0 Human Health Risk Assessment

The human health risk assessment component of this project comprised both:

- a forward risk assessment, which quantitatively assesses the risk associated with the CoPC defined within the NSW EPA Declaration; and
- derivation of SSTC for soil and groundwater based on allowable land uses under the current Site zoning.

Based on the current site use, the risk assessment considered two receptor groups who may be exposed to Site contaminants;

- Scenario 1 – Recreational Receptors, discussed further in **Section 5.3.5.**
- Scenario 2 – Intrusive Maintenance Workers, discussed further in **Section 5.3.6**

The human health risk assessment was undertaken in accordance with NEPC (1999a, 1999b) guidelines for risk assessment and derivation of health-based criteria in environmental media. The methodology included the following key steps:

- Refinement of the list of CoPC in environmental media (from that in the NSW EPA Declaration), based on comparison to relevant human health based 'Tier 1' screening criteria.
- Qualitative and quantitative assessment of the toxicity of each CoPC.
- Consideration of Conceptual Site Models (CSMs) for land use scenarios relevant to existing or currently permissible uses of the Site.
- Quantitative Exposure Assessment for each land use scenario, in order to estimate the extent to which human receptors may be exposed to CoPC at the Site and including vapour and dust migration modelling where relevant.
- Characterisation of the nature and potential incidence of adverse health effects to receptors based on comparison of estimated contaminant intake or exposures to relevant toxicity (dose-response) criteria.
- Comparison of risk estimates with risk acceptance criteria recommended and/or adopted by state and federal regulatory agencies.
- Where unacceptable risks were identified, chemicals were assessed in terms of their contribution to the total threshold and non-threshold risks reported. Where CoPC were defined to "significantly" contribute to reported risk totals, site specific target criteria (SSTC) were derived.
- SSTC for soil and groundwater were derived for those CoPC which were identified to "significantly" contribute to the total risk. Estimation of SSTC based on consideration of toxicity, exposure, contaminant migration modelling and acceptable risk levels.
- Comparison of SSTC for current landuse scenarios to chemical concentrations reported at the Site.
- Adoption of acceptable risk levels upon which to base derived SSTC.
- Derivation of media and chemical specific SSTC for each CoPC based on consideration of toxicity criteria, exposure parameters, contaminant transport modelling and acceptable risk levels.

The above steps are further described in the **Sections 5.1** to **5.4** and **Section 6.0** below.

The algorithms used for vapour modelling and for estimation risk and the derivation of of SSTC are detailed in **Error! Reference source not found.** and spreadsheets which demonstrate the calculations for each of the modelled receptors are provided in **Appendix D** (Scenario 1 - Paved Recreation) and **Appendix E** (Scenario 2 – Intrusive Maintenance).

5.1 Chemicals of Potential Concern

For the purposes of the human health risk assessment, those chemicals identified in the NSW EPA Declaration (**Section 4.3**) have been assessed for their potential to present a risk to human health.. In general, a chemical was selected as a CoPC if it was reported to be present in environmental media at the Site above relevant screening criteria for the protection of human health. The chemical screening process to identify CoPC was undertaken based on the dataset which relates to the Site (the NSW EPA Declaration Area) and which is currently available (i.e. based on available soil and groundwater analytical data for the Site). Where multiple monitoring events have been undertaken (e.g. groundwater sampling) all data has been included.

The screening selection process undertaken for the purpose of identification of CoPC for the human health risk assessment is further detailed in the following sections for soil and groundwater.

5.1.1 Chemicals of Potential Concern in Soil

CoPC in soil were selected based on comparison to screening criteria for the most sensitive potential land use scenario considered relevant to current or potential future use of the Site. The screening criteria adopted for CoPC selection in soil were the following (in order of preference):

- Health Investigation Levels (HIL's) published by NEPC (1999d), specifically:
  - National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) 'E' level for recreational use of land (note that these are more conservative than the NEPM 'F' levels for commercial land use);
- For those chemicals for which no NEPM HIL's have been published:
  - the United States Environment Protection Agency (USEPA) Regional Screening Levels (RSLs; USEPA, 2012) for residential soil (note that USEPA RSLs have not been derived for recreational land use, so the most conservative low density residential RSLs were adopted. Note also that within the derivation of the RSLs for inhalation exposures, there was no consideration of inhalation indoors, only outdoors);
- Where no screening value is presented in the above referenced guidelines (e.g. TPH fractions):
  - the laboratory limit of reporting has been adopted as a suitable screening value.

The CRC Care Health Screening Levels (CRC Care 2011) were considered as potential screening criteria; however they were not adopted because the guidelines state that the TPH criteria are not applicable non-petroleum sites, such as a gasworks.

Available historical soil analytical data across all soil depths are summarised and compared to the adopted soil screening criteria in **Table T1** in **Appendix A**.

For the purpose of this risk assessment, soil impacts in the unsaturated zone are considered to present a potential source for the identified current on-site receptors. Therefore, soil impacts identified between the ground surface and 2 mbgl have been considered for the purpose of identifying the CoPC to be used in the risk calculations and will be considered to represent potential exposure point concentrations (EPC) for each of the modelled receptors. Based on these considerations, CoPC which will be assessed further in the human health risk assessment will be limited to those chemicals identified in the NSW EPA Declaration (as detailed in **Section 4.3**) which:

- exceed the adopted soil screening criteria; and
- which are located in the unsaturated zone of the site (considered to be 0 to 2 m bgs).

Table T2 in **Appendix A** presents the screened soil analytical results collected from the NSW EPA Declaration Area (the Site), which exist at the site between 0 and 2 m bgs.

CoPC were retained or excluded from the risk assessment as follows:

- Chemicals which were volatile and reported above LORs were selected as CoPC even if they did not exceed the screening criteria. This is considered appropriate as the adopted screening criteria were not derived with consideration to vapour exposure pathways.
- Non-volatile chemicals for which the maximum reported concentration did not exceed the adopted screening criterion were excluded as CoPC.
- Chemicals which were reported in one or more samples above the adopted screening criterion were selected as CoPC and further considered in the quantitative risk assessment.
- Chemicals which were reported above laboratory detection limits, but for which no screening criterion was available, were further evaluated on a case by case basis to assess whether the frequency of detection and reported concentrations warranted further consideration.

The exposure pathway for Scenario 1 (Paved Recreation) is limited to the inhalation exposure pathway only as no direct exposure with soil or groundwater is considered possible (Refer to **Section 5.3.5.3**). Therefore, where a chemical is not considered to be sufficiently volatile (refer to **Section 5.1.4**) no consideration of this exposure pathway will be considered for the Scenario 1 (Paved Recreation) receptor.

Table 9 below demonstrates the above decision making process and the identified CoPC to be considered for Scenario 1 (Paved Recreation) and Scenario 2 (Intrusive Maintenance).

Where a chemical is identified as a CoPC, the maximum observed concentration has been adopted as the potential concentration which receptors may be exposed to, at the site for the purpose of the risk assessment. This approach results in a risk characterisation which assumes continuous exposure to the maximum CoPC soil concentration at one distinct location, which is considered appropriate for initial risk screening purposes.

For comparative purposes AECOM also undertook a statistical review of the reported CoPC soil concentrations to determine the 95% upper confidence limit (UCL) of the observed concentrations in soil across the Site. A discussion of this analysis is presented in **Section 5.4.2.2.**

This page has been left blank intentionally.

Table 9 Selection Process for Identifying Soil CoPC and EPC for Human Health Risk Assessment

Chemical	Screening Criteria (mg/kg)	Number of Results *	Number of Detects *	Max.Conc.(mg/kg) *	# Guideline Exceedances (Detects Only)	Chemical Exceeds Screening Criteria	Is the Chemical Volatile?	EPC Scenario 1 (mg/kg) (b)	EPC Scenario 2 (mg/kg) (b)	Location where maximum was observed *
PAHs										
PAHs (Sum of total)	40 (a) (c)	23	20	20 934	7	Yes (a)	-	×	×	BH204D (1.5)
Acenaphthene	(a)	123	29	273	0	(a)	Yes	270	270	AECOM_BH54 (1-1.4)
Acenaphthylene		123	60	1000	0		Yes	1000	1000	AECOM_BH54 (1-1.4)
Anthracene		123	64	1200	0		Yes	1200	1200	BH087 (1.5 -1.95
Benz(a)anthracene		123	82	912	72		No	×	910	AECOM_BH54 (1-1.4)
Benzo(a) pyrene		123	77	652	48		No	×	650	BH204D (1.5)
Benzo(b)&(k)fluoranthene		32	16	150	16		No	×	(f)	-
Benzo(b)fluoranthene		123	64	824	56		No	×	820	AECOM_BH54 (1-1.4)
Benzo(g,h,i)perylene		123	72	305	0		No	×	310	BH204D (1.5)
Benzo(k)fluoranthene		91	53	324	35		No	×	320	AECOM_BH54 (1-1.4)
Chrysene		123	75	631	23		No	×	630	BH204D (1.5)
Dibenz(a,h)anthracene		123	45	72.5	42		No	×	73	BH204D (1.5)
Fluoranthene		123	86	2130	0		Yes	2100	2100	AECOM_BH54 (1-1.4)
Fluorene		123	42	1290	0		Yes	1300	1300	AECOM_BH54 (1-1.4)
Indeno(1,2,3-c,d)pyrene		123	67	247	60		No	×	250	BH204D (1.5)
Naphthalene		123	51	8410	22		Yes	8400	8400	BH204D (1.5)
Phenanthrene		123	79	3130	0		Yes	3100	3100	AECOM_BH54 (1-1.4)
Pyrene		123	89	1670	0		Yes	1700	1700	AECOM_BH54 (1-1.4)
BTEX										
Benzene	1.1 (d)	121	19	61	6	Yes	Yes	61	61	BH204D (1.5)
Ethylbenzene	5.4 (d)	121	8	8	2	Yes	Yes	8	8	AECOM_BH54 (1-1.4)
Toluene	5000 (d)	121	15	69.2	0	No	Yes	69	69	BH204D (1.5)
Xylene (m & p)	590 (d)	118	15	67.2	0	No	Yes	×	×	-
Xylene (o)	690 (d)	118	8	26.9	0	No	Yes	×	×	-
Total Xylene (ESDAT)	630 (d)	121	15	94.1	0	No	Yes	94	94	BH204D (1.5)
TPH										
TPH C6 - C9	10 (e)	123	16	226	10	Yes	Yes	230	230	BH204D (1.5)
TPH C10 - C14	50 (e)	122	22	54 200	22	Yes	Yes	54 000	54 000	BH204D (1.5)
TPH C15-C28	100 (e)	122	62	72 400	62	Yes	No	×	72 000	BH204D (1.5)
TPH C29-C36	100 (e)	122	60	20 600	60	Yes	No	×	21 000	BH204D (1.5)
Phenol										
Phenol	17 000(c)	49	11	1720	0	No	No	×	×	-
Cyanide										
Cyanide Weak Acid Dissociable (WAD)	1000 (c)	9	1	8	0	No	Yes	×	×	-
Cyanide (Free)		3	0	<1	0	No	Yes	×	×	-

Chemical	Screening Criteria (mg/kg)	Number of Results *	Number of Detects *	Max.Conc.(mg/kg) *	# Guideline Exceedances (Detects Only)	Chemical Exceeds Screening Criteria	Is the Chemical Volatile?	EPC Scenario 1 (mg/kg) (b)	EPC Scenario 2 (mg/kg) (b)	Location where maximum was observed *
Cyanide Total		51	24	575	0	No	Yes	×	×	-

Notes:

*Only soil samples collected between 0 and 2m bgl were considered to be representative of potential exposure concentrations. See discussion above in **Section 5.1.1**.

× indicates that the chemical was not assessed further within the risk assessment.

(a) As the sum of Total PAHs was observed to exceed the adopted screening criteria, individual PAHs have been assessed separately.

(b) EPC (mg/kg) is the maximum observed concentration in vadose zone soils (0-2 m bgl) rounded to two significant figures (for initial risk screening).

(c) NEPC (1999)

(d) RSLs; USEPA (2012)

(e) Laboratory LOR

(f) Benzo(b&k)fluoranthene is modelled separately as benzo(b)fluoranthene and benzo(k)fluoranthene

5.1.2 Chemicals of Potential Concern in Groundwater

Beneficial uses of groundwater for which screening or investigation levels have been published by Australian regulatory agencies (e.g. potable use, irrigation, stock watering, etc) are not considered relevant to the Site because current and future extractive uses of groundwater are precluded by high salinity. However, current and/or future Site users may be exposed to groundwater via the vapour migration pathway or via direct contact during intrusive maintenance or construction activities.

AECOM has adopted a conservative approach, whereby drinking water guidelines (i.e. the lowest of available human health based guideline values) have been compared to reported Site chemical concentration for Tier 1 screening of CoPC in groundwater.

The adoption of guidelines which have been derived to be protective of exposure via ingestion routes is considered conservative when used for the screening of inhalation exposures (e.g. Scenario 1 (Paved Recreation). Guidelines derived to be protective of ingestion pathways are based on a percentage of the allowable intake for a specific chemical with consideration of potential exposures from other routes (i.e. dermal and inhalation). As it is considered most likely that Scenario 1 (Paved Recreation) and Scenario 2 (Intrusive Maintenance) receptors will predominantly be exposed via the inhalation route, this screening is appropriate for the purposes of identifying potential CoPC at the Site as they are protective of multiple direct contact exposure pathways.

Specifically, the following health-based guidelines or screening levels have been adopted (in order of preference):

- National Health and Medical Research Council (NHMRC, 2011), *Australian Drinking Water Guidelines (ADWG, 2011)*;
- For chemicals for which no ADWG value has been published:
  - USEPA (2012), *Regional Screening Levels* (for Tap Water);
- Where no screening value is presented in the above referenced guidelines (e.g. TPH fractions):
  - the laboratory limit of reporting has been adopted as a suitable screening value.

Available historical groundwater analytical data are summarised and compared to the adopted groundwater screening criteria in **Table T3** in **Appendix A**.

CoPC in groundwater were retained or excluded from the risk assessment as follows:

- Chemicals which were not reported above laboratory detection limits in any samples were excluded as CoPC;
- Chemicals for which the maximum reported concentration did not exceed the adopted screening criteria were excluded as CoPC;
- Chemicals which were reported in one or more samples above the adopted screening criteria were selected as CoPC and further considered in the quantitative risk assessment;
- Chemicals which were reported above laboratory detection limits, but for which no screening criteria was available were further evaluated on a case by case basis to assess whether the nature of the compound, frequency of detection and/or reported concentrations warranted further consideration in the risk assessment.

Table 10 below demonstrates the above decision making process which identifies and the identified CoPC to be considered for Scenario 1 (Paved Recreation) and Scenario 2 (Intrusive Maintenance).

Where a chemical is identified as a CoPC, the maximum observed concentration has been adopted as the potential concentration which receptors may be exposed to, at the Site for the purpose of the risk assessment. This approach results in a risk characterisation which assumes continuous exposure to the maximum CoPC groundwater concentration at one distinct location, which is considered appropriate for initial risk screening purposes.

For comparative purposes AECOM also undertook a statistical review of the reported CoPC on-site groundwater concentrations to determine the 95% upper confidence limit (UCL) of the observed concentrations in groundwater across the site. A discussion of this analysis is presented in **Section 5.4.2.2.**

This page has been left blank intentionally.

Table 10 Selection Process for Identifying Groundwater CoPC and EPC for Human Health Risk Assessment

Chemical	Units	Screening Criteria	Number of Results	Number of Detects	Maximum Detect	Number of Guideline Exceedances (Detects Only)	Volatile (Yes or No)	EPC Scenario 1 (b)	EPC Scenario 2 (b)	Location where maximum was observed
PAHs										
PAHs (Sum of total)	µg/L	-	69	63	530 568	-	NO (a)	×	×	-
Acenaphthene	µg/L	400 (e)	68	39	4480	3	YES	4500	4500	MW205
Acenaphthylene	µg/L	400 (e)	68	50	43 200	8	YES	43 000	43 000	MW205
Anthracene	µg/L	1300 (e)	68	30	15 400	4	YES	15 000	15 000	MW205
Benz(a)anthracene	µg/L	0.029 (e)	68	24	12 600	24	NO	×	13 000	MW205
Benzo(a)pyrene	µg/L	0.01 (d)	68	23	9260	23	NO	×	9300	MW205
Benzo(b)&(k)fluoranthene	µg/L	0.029 (e)	26	5	9860	5	NO	×	(c)	-
Benzo(b)fluoranthene	µg/L	0.029 (e)	42	15	8330	15	NO	×	8300	MW15
Benzo(g,h,i)perylene	µg/L	87 (e)	68	17	4220	6	NO	×	4200	MW15
Benzo(k)fluoranthene	µg/L	0.29 (e)	42	13	3670	13	NO	×	3700	MW10
Chrysene	µg/L	2.9 (e)	68	21	9780	18	NO	×	9800	MW205
Dibenz(a,h)anthracene	µg/L	0.0029 (e)	68	10	822	10	NO	×	820	MW15
Fluoranthene	µg/L	630 (e)	68	34	25 900	7	NO	×	26 000	MW15
Fluorene	µg/L	220 (e)	68	38	21 400	9	YES	21,000	21 000	MW10
Indeno(1,2,3-c,d)pyrene	µg/L	0.029(e (e)	68	17	3050	17	NO	×	3100	MW15
Naphthalene	µg/L	0.14 (e)	69	55	283 000	55	YES	280,000	280 000	MW205
Phenanthrene	µg/L	1300 (e)	68	39	74 100	7	YES	74,000	74 000	MW205
Pyrene	µg/L	87 (e)	68	37	27 900	12	YES	28,000	28 000	MW205
BTEX										
Benzene	µg/L	1 (d)	57	39	41 000	39	YES	41 000	41 000	MW10
Ethylbenzene	µg/L	300 (d)	57	37	3020	14	YES	3000	3000	MW015
Toluene	µg/L	800 (d)	57	35	17 600	21	YES	18 000	18 000	MW205
Xylene (m & p)	µg/L	190 (e)	56	37	4490	26	YES	(g)	(g)	-
Xylene (o)	µg/L	190 (e)	56	37	2240	25	YES	(g)	(g)	-
Total Xylene (ESDAT)	µg/L	600 (d)	57	38	6700	26	YES	6700	6700	MW015
TPH										
TPH C6 - C9	µg/L	20 (f)	55	35	73 600	35	YES	74 000	74000	MW205
TPH C10 - C14	µg/L	50 (f)	56	41	1 730 000	41	YES	1 700 000	1 700 000	MW205
TPH C15 - C28	µg/L	100 (f)	56	44	1 520 000	44	NO	×	1 500 000	MW205
TPH C29 - C36	µg/L	50 (f)	56	33	332 000	33	NO	×	330 000	MW205
Phenol										
Phenol	µg/L	4500 (e)	65	35	392 000	7	YES	390 000	390 000	MW10
Ammonia										
Ammonia	mg/L	0.5 (d)	3	3	130	3	YES	350	350	MW10

Chemical	Units	Screening Criteria	Number of Results	Number of Detects	Maximum Detect	Number of Guideline Exceedances (Detects Only)	Volatile (Yes or No)	EPC Scenario 1 (b)	EPC Scenario 2 (b)	Location where maximum was observed
Ammonia as N	mg/L	0.5 (d)	38	34	348	33				
Cyanide										
Cyanide (WAD)	mg/L	0.08	29	7	0.02	0	YES	×	×	-
Cyanide (Free)	mg/L	0.08	34	5	0.013	0	YES	×	×	-
Cyanide Total	mg/L	0.08	14	11	19	10	YES	(h)	(h)	-

Notes:

× indicates the chemical was not assessed further within the risk assessment.

(a) As the sum of Total PAHs was observed to exceed the adopted screening criteria, individual PAHs have been assessed separately.

(b) EPC (mg/kg) are based on the maximum observed concentration rounded to two significant figures.

(c) Benzo(b&k)fluoranthene is modelled separately as benzo(b)fluoranthene and benzo(k)fluoranthene.

(d) ADWG (2011)

(e) RSLs; Tapwater, USEPA (2012)

(f) Laboratory LOR

(g) Xylene (m & p) and Xylene (o) are assessed further as Total Xylene.

(h) Cyanide is not considered to be bioavailable at the site. Refer to discussion below.

5.1.3 Total Cyanide Exclusion as CoPC

Although Total Cyanide was reported above guideline values, it is noted that free cyanide concentrations did not exceed health-based guidelines and the maximum reported weak acid dissociable (WAD) cyanide concentration only marginally exceeded the drinking water guideline. The presence of significant concentrations of iron in groundwater at the Site indicates that it is highly unlikely that free cyanide would be present at the Site. Cyanide forms tight bonds with iron which produces less toxic cyanide complexes that, under the conditions observed at the Site, are difficult to break. A number of studies have also shown that free cyanide is not generally present at gasworks sites (CCME, 1999a; Ghosh, 1999; Ghosh, 2004; Kjeldsen, 1999; Meeussen, 1994; Meeussen, 1995; Shifrin, 1996). It is therefore considered unlikely that the bioavailable fraction of cyanide exceeds the relevant investigation criteria. Cyanide has therefore not been further assessed as a CoPC in the current HHERA.

5.1.4 Approach to the assessment of volatile chemicals

It is noted in **Section 5.3** that the dominant exposure pathway to future and existing human receptors identified is the inhalation of volatile contaminants within the outdoor air environment. Consideration of which CoPC were sufficiently volatile to migrate into outdoor air was made and CoPC that were not sufficiently volatile were not included in inhalation exposure pathways.

A CoPC was considered to be sufficiently volatile if its Henry's law constant is 1 x 10^{-5} atm-m^3/mole or greater (USEPA, 2004).

It is assumed that TPH C_{15+} are not sufficiently volatile based on Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) (1997) which states that TPH fractions greater than TPH C_{15} are not considered to be volatile and inhalation was not considered to be a relevant exposure pathway.

Volatile compounds are usually classified as chemicals which have a boiling point range less than 250 degrees celsius (Health Canada 1995). Volatile chemicals are also considered to readily volatilise or partition into air under normal temperatures. Further international guidance exists which suggests that compounds with a molecular weight greater than 200 g/mol are not volatile enough to be a vapour intrusion issue (HKEPD 2007).

Therefore, with the exception of Scenario 2 (where direct contact pathways with soil and groundwater have also been considered) the following CoPC have been selected for assessment of risk associated with vapour intrusion as they are considered to be sufficiently volatile for intrusion into outdoor air:

- Acenaphthene;
- Acenaphthylene;
- Ammonia;
- Anthracene;
- Benzene;
- Ethylbenzene;
- Fluorene;
- Naphthalene;
- Phenanthrene;
- Pyrene;
- Toluene;
- TPH C_6-C_9 (aliphatic);
- TPH C_{10}-C_{14} (aromatic and aliphatic); and
- Xylenes.

5.2 Toxicity Assessment

5.2.1 Introduction

The toxicity assessment stage of a risk assessment is separated into two components, hazard identification and dose-response assessment. The hazard identification stage is a qualitative description of the capacity of a contaminant or agent to cause harm. The dose-response assessment includes the selection of appropriate toxicity criteria from a hierarchy of sources, in accordance with NEPC (1999a) and enHealth (2004) guidance.

5.2.2 Hazard Identification

The hazard identification process requires a review of existing toxicological information from a variety of appropriate sources to describe the capacity of a specific agent to produce adverse health effects.

Toxicological profiles for the chemicals other than TPH (detailed in **Table 9** and **Table 10**) are provided in **Appendix F**.

The toxicity of individual components which may be present in TPH mixtures has been described by TPHCWG (1997a). The methodology recommended by TPHCWG (1997a) for assessment of risk associated with TPH mixtures is an indicator/surrogate approach, whereby indicator compounds within petroleum which are known to be carcinogens or can be evaluated individually (primarily BTEX and PAHs) are considered separately and potential hazards associated with the remaining mixture (i.e. the mass of petroleum remaining after evaluation of the indicators) are assessed using a surrogate approach (i.e. based on the toxicity of compounds known or expected to be present within TPH fractions for which analytical data are available). This approach and the recommended surrogate toxicity criteria used in this assessment are further detailed by TPHCWG (1997a).

It is noted that in the assessment of TPH, consideration of the aliphatic and aromatic content of each hydrocarbon fraction was undertaken with regards to derivation of SSTC for soil and groundwater. The proposed SSTC for soil and groundwater was therefore the sum of the individual criteria derived for the aliphatic and aromatic fractions. Should exceedances of the proposed SSTC for TPH be observed, consideration should be given to whether additional analysis is required to determine the composition and nature of the TPH.

5.2.3 Dose Response Assessment

The objective of the dose response assessment is to identify the toxicity values for each CoPC to be used for the quantification of human health risk. The numerical values derived from toxicity dose-response studies are referred to collectively as toxicity values. The toxicity values derived are based on two different approaches to the characterisation of dose-response (NHMRC, 1999 and USEPA, 2005):

- For chemicals that have the potential to result in carcinogenic effects that are associated with a genotoxic mechanism, any level of exposure is assumed to result in some incremental lifetime risk of cancer. These chemicals are assessed on the basis of a non-threshold dose-response relationship;
- For other chemicals that may be associated with non-carcinogenic effects, or with other carcinogenic effects that are not genotoxic, a threshold criterion is considered relevant. The threshold level is considered to be a level below which adverse health effects are not expected to occur. Exceedance of the threshold level does not imply that adverse effects will occur, as there are a number of uncertainties and safety factors incorporated into the threshold value adopted, rather that exposure needs to be further evaluated.

The toxicity values adopted for the CoPC in this risk assessment are discussed in toxicological profiles provided in **Appendix F** and summarised in **Table T4** in **Appendix A**. Values have been obtained (where available) from the following information sources (listed in order of preference, as per NEPC, 1999a and enHealth, 2004 guidance):

- National Health & Medical Research Council (NHMRC) publications and documents from other joint Commonwealth, State and Territory health organisations;
- World Health Organisation (WHO) publications;
- Agency for Toxic Substances and Disease Registry toxicological profiles;
- Criteria published by USEPA sources, including those published by the USEPA Integrated Risk Information System (IRIS) and those adopted by USEPA regional offices in the derivation of Regional Screening Levels (RSLs).

Toxicity values for TPH were not available from the above listed sources and have been based on values recommended by the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG, 1997a).

5.2.4 Non-threshold Toxicity Criteria

The assessment of potential effects associated with genotoxic carcinogens requires the use of a non-threshold toxicity value. The values available are essentially the slope of the cancer dose-response curve for the chemical (based on relevant studies and approaches to extrapolate effects from high doses to low doses) and are termed either a cancer slope factor (CSF) or an inhalation unit risk (IUR). The CSF (expressed as $(mg/kg/day)^{-1}$), or IUR (expressed as $(ug/m^3)^{-1}$) is used to estimate the probability of an individual developing cancer at some point in a lifetime as a result of a specific exposure.

As described in **Appendix F**, of the CoPC identified at the Site, benzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h) anthracene and indeno (1,2,3-cd)pyrene are considered to be genotoxic carcinogens and have published IURs and/or CSFs. These compounds have therefore been assessed based on non-threshold toxicity criteria where available.

While CSFs or IURs have not been published for carcinogenic PAHs (cPAHs) other than benzo(a)pyrene, the potential carcinogenic effects of these compounds (benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene) are considered to act as genotoxic carcinogens by ATSDR (1995). In order to account for the potential presence of mixtures of cPAHs, cPAHs have been assessed as BaP equivalents and summed for comparison to the BaP CSF as a single total cPAH value.

Adopted non-threshold toxicity criteria and the source of the adopted values are summarised in **Table T4** in **Appendix A.**

5.2.5 Threshold Toxicity Criteria

Potential health effects that are assessed on the basis of a threshold dose response utilise a threshold value which is typically termed an acceptable or tolerable daily intake (ADI or TDI) or reference dose (RfD). For the purpose of this assessment, the threshold value adopted has been termed an ADI. An ADI is a chemical intake below which it is considered unlikely that adverse effects would occur in human populations, including sensitive sub-groups (e.g. the very young or elderly). Hence the ADI relates to intakes from all sources, the Site related impacts as well as background intakes (where relevant).

Where relevant to inhalation exposures the threshold value is typically termed a tolerable concentration in air (TC) or reference concentration (RfC), which is an estimate of a continuous inhalation exposure concentration to people (including sensitive subgroups) that is likely to be without risk of deleterious effects during a lifetime.

In order to account for potential cumulative exposures to multiple chemicals deriving from either soil, groundwater or both, AECOM has adopted the following approach to allocate proportional risks to chemicals present on Site:

1) Benzene, toluene, ethylbenzene and xylene were assigned a hazard index of 0.25 each.

2) TPH fractions C_6-C_9, C_{10}-C_{14}, C_{15}-C_{28}, C_{29}-C_{36}) were assigned a hazard index of 0.25 each (0.125 for aliphatic and 0.125 for aromatic).

3) All non carcinogenic PAHs were assigned a hazard index of 0.2.

4) All other threshold chemicals were assigned a hazard index of 1.0.

Adopted threshold toxicity criteria and the source of the adopted values, are shown in **Table T4**.

5.2.6 Dermal Toxicity of PAHs

The assessment of dermal toxicity associated with carcinogenic PAHs has been assessed based on available oral toxicity (dose-response) criteria, in light of the fact that only oral and inhalation cancer potency estimates for benzo (a) pyrene have been published. This approach is consistent with that typically adopted for human health risk assessment in Australia given that dermal dose-response factors are generally not published by regulatory agencies endorsed by NEPM and enHealth health risk assessment guidance. In accordance with USEPA (2004b) guidance, dermal dose-response criteria toxicity criteria are therefore derived from oral dose-response criteria, with correction for chemical-specific gastrointestinal absorption where possible (this converts the oral dose-response criterion, which is based on applied dose, to an absorbed dose equivalent for comparison to dermally absorbed exposure estimates).

While the adopted approach is consistent with relevant Australian and international health risk assessment guidance, a study by Knafla et al. (2006) has indicated that the cancer potency of carcinogenic PAHs via the dermal pathway may be higher than that via the oral pathway, based on review of dermal carcinogenesis studies in mice. The dermal slope factor derived by Knafla et al. (2006) for benzo(a)pyrene was 25 $(mg/kg/day)^{-1}$, which is 50 times higher than the adopted oral slope factor (from NHMRC, 2004) for benzo(a)pyrene of 0.43 $(mg/kg/day)^{-1}$. While there are some key uncertainties associated with the application of this dermal slope factor to human health risk assessment, particularly given that the value was derived from mouse studies and has not been scaled to account for interspecies differences in body weight and/or skin surface area which may affect skin metabolic capacities, AECOM has conservatively adopted the Knafla dermal slope factor value for the assessment of exposure to soils. It is considered that the slope factor should not be applied to the groundwater SSTC derivation as discussed in **Section 9.1.4.1**.

5.3 Conceptual Site Models and Quantitative Exposure Assessments for Current Land Use Areas

5.3.1 Description of Current Site Uses

Access to the Site (excluding Hickson Road) is limited by the presence of a cyclone wire fence on the eastern side. Three gatehouses are present along the fenced area to permit access to Barangaroo, which is controlled by a 24 hour security presence. A harbour walk controlled by the presence of temporary fencing has been opened to the public.

A two storey amenities building was previously present on the eastern portion of the Site and has now been demolished. The northern portion of the former maintenance building was located within the Site, adjacent to Hickson Road, and was reportedly historically used by Sydney Ports personnel for maintenance. The Site is currently vacant and the current use is limited to public recreational uses (specifically the harbour walk on a small portion of the Site and Hickson Road) and intrusive maintenance personnel associated with road repair or Site infrastructure development. Therefore there has been no assessment of potential commercial land use on the Site.

A temporary cruise ship terminal is located directly to the northwest of the Site, adjacent Darling Harbour. Passengers and crew embarking and disembarking from cruise ships may also utilise the harbour walk on and/or in close proximity to the Site.

5.3.2 Vapour Transport Modelling

In order to estimate the concentration of vapour phase contaminants in indoor air (slab on grade) or outdoor air (i.e. at the point of potentially significant human exposure) that results from given chemical concentration in soil, soil vapour or groundwater, vapour transport modelling was undertaken using methods based on the Johnson and Ettinger (1991) model, as described in the following documents:

1) ASTM International, 2002. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. E1739 – 95 (reapproved 2002); and

2) USEPA, 2004a. *User's Guide for Evaluating Subsurface Vapour Intrusion into Buildings.* Office of Emergency and Remedial Response. Revised February 22, 2004.

The above documents were also used as reference sources for vapour transport modelling.

The methodology and algorithms used for vapour modelling are described in more detail in **Error! Reference source not found.** and the vapour modelling calculations for each scenario are included in **Appendix D** and **Appendix E.**

The vapour model methodology predicts the concentration of vapour phase chemical in indoor or outdoor air that may result from a reported concentration in soil or groundwater by estimation of a chemical- and scenario-specific volatilisation factor (VF). The VF incorporates transport and attenuation processes occurring between the soil or groundwater source and the enclosed space or ambient air. The calculation of the VF is dependent on a number of chemical and scenario specific factors such as:

1) the volatility of the chemicals;

2) the depth to subsurface soil or groundwater contamination;

3) the effective porosity of the overlying unsaturated soil zone;

4) the presence of surface barriers (e.g. concrete slabs); and

5) the extent of dilution and mixing at the surface, based primarily on:

    a) building volume and air exchange rates (for indoor air); or

b) wind speed (for outdoor air).

It should be noted that the Johnson and Ettinger (1991) model was designed to be used as a conservative first tier screening model (i.e. to assess whether vapour intrusion risks are possible and therefore whether further investigation or mitigation may be warranted). The model incorporates a number of conservative assumptions, including:

1) that chemical concentrations in the subsurface source (soil or groundwater) remain constant over the duration of exposure (i.e. a non-depleting source not subject to degradation processes);
2) equilibrium partitioning between chemicals in soil and groundwater and chemical vapours in the source zone;
3) steady-state vapour and liquid-phase diffusion through the vadose zone;
4) no biodegradation or loss of chemical as it diffuses towards the ground surface;
5) that all chemical vapours beneath a structure will enter the structure (i.e. vapours will not migrate laterally around a structure); and
6) steady, well mixed dispersion of emanating vapours within the enclosed or ambient mixing space.

According to USEPA (2004a), only chemicals with a Henry's Law constant of 1×10^{-5} atm-m^3/mol or greater are considered sufficiently volatile to warrant consideration with respect to vapour intrusion (**Section 5.1.4**).

5.3.3 Soil Vapour Partitioning

Soil partition modelling is known to be overly conservative and theoretical concentrations can be between 10 and 1000 times actual measured values (CCME, 2008a; CRC, 2010; USEPA, 1993; Hartman, 2002; Villeneuve and Fontana (undated) and Shih and Wu, 2005). A number of factors are thought to influence the discrepancy between theoretically modelled soil to air concentrations and actual results such as contaminant soil adsorption, organic carbon, adsorption at the air/ water interface, soil heterogeneity and biodegradation processes.

The UK Environment Agency (2009) has an adopted value of 10 for volatile soil investigation levels to account for this potential discrepancy. The Canadian Council of Ministers of the Environment (CCME) (CCME, 2008a) has also adopted a value of 10 in the calculation of soil investigation levels in petroleum hydrocarbons (PHC) to account for overestimation in the soil partitioning modelling. The CRC health screening levels for petroleum hydrocarbons (Friebel and Nadebaum, 2011) has also accounted for this partitioning uncertainty and a 10 fold factor has also been adopted. These documents have focussed on petroleum hydrocarbons, which may not be the only compounds for which the overestimation is applicable but are the compounds in which the most research has been conducted.

Therefore, to account for this partitioning uncertainty in soil, AECOM has applied a 10 fold partitioning factor in the modelling of human health risks (but not odour) to petroleum related compounds which are sufficiently volatile for vapour intrusion, these include TPH (C_6-C_9 and C_{10}-C_{14}) and BTEX. No vapour partitioning factor has been applied to other chemicals (e.g. PAHs).

5.3.3.1 Exposure Point Concentrations

To quantitatively assess risk to human health from in-situ CoPC in soil and groundwater, a representative EPC has been determined as an input parameter for the risk calculations. For the purpose of this risk assessment where;

- a CoPC is identified (refer to **Table 9** and **Table 10**) , and
- where there is a potential for a complete exposure pathway to exist (for the modelled receptors) (refer to **Section 5.3.5.3** for Scenario 1 exposure pathways and **Section 5.3.6.3** for Scenario 2 exposure pathways).

The maximum concentration of that chemical observed at the Site in soil (0-2m bgs) and groundwater (all depths) has been adopted as the EPC for the risk calculations.

It is noted that shallow groundwater impacts would be considered most relevant to the potential vapour source (Scenario 1 and Scenario 2) and for direct contact (Scenario 2). However the available dataset does not provide sufficient detail with respect to the shallow groundwater impacts alone. Therefore, all groundwater well monitoring data has been included.

Adoption of the maximum concentration of the identified CoPC across the Site within the risk calculations results in a characterisation of risk which assumes all maximum concentrations are observed at one location (the point of exposure). As demonstrated in **Table 9** and **Table 10** the maximum observed concentrations have been identified at the following sampling locations:

- Soil:
  - BH204 (1.5),
  - AECOM_BH52 (1-1.4),
  - AECOM_BH54 (1-1.4) and
  - BH087 (1.5-1.95).
- Groundwater:
  - MW15
  - MW10
  - MW205 and
  - MW015 (BH087)

As shown on **Figure F3** in **Appendix B**, these locations are all in close proximity to each other and correlate to the area of the former gas works infrastructure. The use of maximum concentrations as the EPC allows for the possibility that a receptor may spend the majority of their assumed exposure period in the vicinity of the above locations. This is considered to be possible (albeit unlikely), particularly for Scenario 2 receptors (intrusive workers), as the need to undertake ongoing maintenance in a single location cannot be ruled out.

Where an unacceptable risk is identified for a potential exposure scenario based on the application of the maximum CoPC concentrations as EPC, further assessment will be made to the EPC. This consideration has included the application of 95% UCL soil and groundwater concentrations as EPC as discussed in **Section 5.4.2.2.**

5.3.4 Summary of Land Use Scenarios and Associated Conceptual Site Models Considered in the Human Health Risk Assessment

Based on current Site uses, applicable land use scenarios are summarised below in **Table 11**and are further described in **Sections 5.3.5** to **5.3.6**. Recreational use and intrusive maintenance work for road repair or Site infrastructure development or maintenance may be expected to occur at the Site without a requirement for development approval.

Table 11 Summary of Land Use Scenarios Considered in HHERA

Scenario Number	Name and Description	Most Sensitive Human Receptor	General Assumptions
1	Paved Recreation The entire Site is currently covered with concrete/hardstand paving. This scenario has assumed that contaminated soil may be present directly underlying concrete surface cover.	Recreational Users Assumed to be exposed 2 hrs/day, 365 days/year, for 70 years.	Open Space with Concrete surface covering. Assume that there is significant oxygen movement through the top 2m of the soil based on the oxygen measurements collected during the soil gas sampling (see **Section 4.2.2).** Concrete assumed to be minimum 10 cm thick and to have crack fraction of 0.01 (to account for higher cracking possible in surface covering).
2	Intrusive Maintenance Short term intrusive maintenance scenario, e.g. for maintenance of utility services.	Adult worker 8 hrs/day, 15 days/year for 1 year. Direct contact with groundwater may occur due to shallow water – no more than 1 hour per day. Vapour may be derived from pooled groundwater or from exposed soils in trench.	Short term maintenance work or Site investigations may be required. Assumed not to exceed 3 working weeks per year by same worker. While maintenance work may be expected to be predominantly within existing infrastructure easements and structures, ground-intrusive work may conceivably be planned.

5.3.5 Scenario 1 (Paved Recreation)

The paved recreation scenario is assumed to represent areas of the Site which, under current Site use, are used for public open space and which have a hardstand concrete surface covering. No unpaved areas currently exist across the Site. The scenario is depicted in **Figure F4** in **Appendix B.**

5.3.5.1 Contaminant Migration Pathways

Contaminant migration pathways relevant to potential human exposure to contaminants within paved recreation/open space areas are summarised in **Table 12.**

Table 12 Contaminant Migration Pathways - Scenario 1 (Paved Recreation)

Contaminant Migration Pathways	Relevant to Scenario?	Comments
Volatilisation from soil and vapour migration to outdoor air	Yes	While significant accumulation of vapours in outdoor air is considered unlikely, it is possible that soil or groundwater derived vapours may be dispersed in outdoor air within public open space/recreation areas at the Site.
Volatilisation from groundwater and vapour migration to outdoor air	Yes	
Migration of outdoor air/vapours to indoor airspaces	Potentially	Significant levels of soil or groundwater derived contaminants in outdoor air are not expected to reach indoor air spaces due to significant mixing and degradation processes which would occur.

5.3.5.2 Human Receptors

Regular users of public open space at the Site (e.g. individuals crossing the Site to access the Harbour Walk or pedestrians using Hickson Road) have been considered as the most sensitive receptors for the Paved Recreation Scenario.

5.3.5.3 Exposure Pathways

Potential pathways via which the above receptors may be exposed to Site-derived contamination are summarised in **Table 13** below.

Table 13 Exposure Pathway Analysis - Scenario 1 (Paved Recreation)

Exposure Pathway	Complete?	Notes
Adult or Child Recreational Users		
Incidental ingestion of chemicals in soil	×	The Site is covered with concrete which precludes direct contact and/or generation of dust from contaminated soil.
Dermal absorption of chemicals from soil	×	
Inhalation of chemicals in soil-derived airborne particulates	×	
Inhalation of soil-derived vapours	✓	Potentially complete and significant pathway.
Incidental ingestion of chemicals in groundwater (incidental contact)	×	Groundwater present at average 2 mbgs and assumed not to be contacted by recreational users as these receptors will not undertake intrusive works.
Dermal absorption of chemicals in groundwater (incidental contact)	×	
Inhalation of groundwater derived vapours	✓	Potentially complete and significant pathway.

5.3.5.4 Exposure Parameters

Human exposure parameters adopted for Scenario 1 are summarised in **Table 14** below.

Table 14 Exposure Parameters - Scenario 1 (Paved Recreation)

Parameter (units)	Adopted Value	Source/Reference
Exposure Time (hours/day)	2	NEPC (1999) default for recreational receptors. This is conservative as it is noted that the Harbour Foreshore walk is only accessible on non-boat days (i.e. when no ship is present at the temporary ferry terminal).
Exposure Frequency (days/year)	365	Conservative Assumption (for reasons noted above).
Exposure Duration (years)	6 (child) 64 (adult)	NEPC (1999a) and enHealth (2004). Conservatively assumes recreational receptors may frequent the Site for their entire lifetime, assumed to be 70 years.

5.3.5.5 Vapour Transport Modelling

Soil and groundwater vapour transport modelling was undertaken using the Johnson and Ettinger (1991) vapour transport models summarised in **Section 5.3.2** and described in more detail in **Error! Reference source not found.**. The vapour modelling calculations for Scenario 1 are included in **Appendix D.**

The CRC health screening levels for petroleum hydrocarbons (Friebel and Nadebaum, 2011) have also accounted for biodegradation and adjustments between 10 and 100 fold are applicable to derived criteria when evidence of oxygen >5% and or certain Site conditions are met. CCME (2008a) has also reported that not accounting for biodegradation could result in the risks being overestimated 10 to 1000 times.

Polycyclic aromatic hydrocarbons such as acenaphthene, acenaphthylene, phenanthrene and pyrene and compounds such as dibenzofuran are known to have half lives in soil and groundwater which range from 4 weeks to 5 years (Howard et al, 1991)[1] and relatively shorter half lives in air ranging from 1 hour to 24 hours. The relatively rapid half-life in air is predominantly due to biodegradation and hydrolysis.

AECOM has measured oxygen from a range of depths (1.6-2.5 mbgs) from beneath the Site at between 5% and 20%; indicating that the current conditions for paved areas of the Site are influenced by the presence of oxygen.

The presence of oxygen beneath the Site and within the soil indicates that the conditions are favourable for biodegradation processes.

It is noted that the soil vapour present beneath the existing slab at the Site in open space areas will also undergo significant biodegradation processes when the contaminants migrate to the surface into the ambient air environment. It is considered that this applies to paved recreational areas only at the Site (Scenario 1 only). It is considered that there is insufficient information and mixing zones to apply this to intrusive maintenance worker scenarios.

It is considered appropriate that a 10 fold factor is applied to the modelled soil concentrations at the Barangaroo site to account for biodegradation processes, as measured oxygen within the sub-surface at the site was greater than 5%. This factor is presented as the "biodegradation adjustment factor" presented in **Table 15** below.

The geologic, hydrogeologic and building parameters adopted for vapour intrusion modelling for Scenario 1 are summarised in **Table 15** below.

Table 15 Vapour Modelling Assumptions - Scenario 1 (Paved Recreation)

Parameter (units)	Adopted Value	Source/Justification
Vadose Zone and Hydrogeological Parameters – Soil to Outdoor Air		
Depth to soil contamination (cm)	0.01	Negligible value; assumes soil contamination may be present directly beneath concrete/hardstand at Site.
Fraction of organic carbon in soil source (unitless)	0.002	USEPA (2004a) defaults for coarse sand/gravel. Conservative assumption for coarse sand/ gravel
Soil bulk density (g/cm^3)	1.66	
Total porosity in soil source zone (for soil model) (unitless)	0.375	
Air filled porosity in soil source zone (unitless)	0.321	
Water filled porosity in soil source zone (unitless)	0.054	
Vapour phase source partitioning adjustment (unitless)	10	A factor of 10 has been applied to soil-to-vapour partitioning equation associated with BTEX, TPH C_6-C_9, C_{10}-C_{14}, to reflect the differences observed between theoretical estimates of partitioning and field measurements (see CCME, 2008a and Friebel and Nadebaum, 2011).
Biodegradation adjustment factor (unitless)	10	Adjustment for assumed presence of oxygen (and associated biodegradation of vapours) in paved areas. Factor of 10 is considered conservative as it is at lower end of ranges suggested by Davis et al. (2009) and CCME (2008a).
Vadose Zone and Hydrogeological Parameters – Groundwater to Outdoor Air		
Depth to groundwater contamination (cm)	200	Based on reported average depth to groundwater of 2 m, allowing for USEPA (2004a) default capillary zone thickness for sand aquifer and for concrete surface covering.
Vadose zone thickness (cm)	173	

[1] Handbook of Environmental Degradation Rates, Philip H Howard, Robert S Boethling, William F Jarvis, William M Meylan, Edward M Michalenko, Lewis Publishers, 1991, CRC Press LLC.

Parameter (units)	Adopted Value	Source/Justification
Vadose Zone and Hydrogeological Parameters – Soil to Outdoor Air		
Thickness of capillary zone (cm)	17	Vadose zone thickness calculated as depth to water less capillary zone thickness less concrete thickness. The default capillary zone thickness for sand (USEPA, 2004a) has been adopted after review of borelogs for bores drilled in locations where this scenario is likely to be applied. It was determined that the predominant soil type in these areas was sand, silty sand, clayey sand and gravelly sand. As the presence of other soil types with sand is likely to increase the capillary zone thickness is was considered conservative to assume the capillary zone thickness of sand as this soil type displays the lowest capillary thickness.
Total porosity in vadose zone (unitless)	0.375	USEPA (2004a) defaults for sand (residual impacted soil and imported fill conservatively assumed to be sandy)
Air filled porosity in vadose zone (unitless)	0.321	
Water filled porosity in vadose zone (unitless)	0.054	
Total porosity in capillary zone (unitless)	0.375	USEPA (2004a) default for sand (considered conservative for mixed soil/fill types reported at Site).
Air filled porosity in capillary zone (unitless)	0.122	
Water filled porosity in capillary zone (unitless)	0.253	
Concrete Surface Cover Characteristics		
Concrete thickness (cm)	10	Conservative assumption. Concrete thickness considered likely to be greater than 10 cm.
Areal crack fraction (unitless)	0.01	Conservative assumption to account for potential cracks in concrete cover. Note that 0.01 (1%) cracks is equivalent to the presence of a one metre long 1 cm crack within every square meter of concrete.
Total porosity in concrete cracks	0.375	Assumes cracks in concrete surface cover are filled with sand (values are USEPA, 2004a defaults for coarse sand).
Air filled porosity in concrete cracks	0.321	
Water filled porosity in concrete cracks	0.054	
Outdoor/Ambient Air Characteristics		
Wind speed (cm/s)	378	Average annual 9 am and 3 pm windspeeds measured at observatory point in Sydney (BOM, 2010).
Width of source area parallel to wind (cm)	4500	Conservative default – assumed receptor is downwind of 45 m source zone for entire exposure time and that all vapours from that zone reach receptor.
Ambient air mixing zone height	200	Conservative default – assumes all emitted vapours are mixed within two metres of ground surface.

5.3.6 Scenario 2 (Intrusive Maintenance)

The intrusive maintenance scenario has been considered to account for potential intrusive maintenance activities which may be undertaken at the Site. It should be noted that modelling of exposure and risks to intrusive receptors is associated with a high degree of uncertainty, as it is not possible to accurately predict the nature and extent of intrusive works which may occur at the Site in the future. The intrusive worker considered in this assessment was assumed to only occasionally and/or intermittently conduct intrusive works at the Site (e.g. as required to maintain underground services), but is not assumed to undertake longer term intrusive works, such as construction or redevelopment of the Site. Potential risks to a worker involved in extended periods of intrusive works at the Site would need to be considered and managed in the future should such activities occur.

It is also noted that risks to construction and/or remediation workers during proposed future remediation of the Site will be considered in a separate study reported under separate cover. The scenario is depicted in **Figure F5** in **Appendix B.**

5.3.6.1 Contaminant Migration Pathways

Contaminant migration pathways relevant to potential human exposure to contaminants by intrusive maintenance workers are summarised in **Table 16** below.

Table 16 Contaminant Migration Pathways – Scenario 2 (Intrusive Maintenance)

Contaminant Migration Pathways	Relevant to Scenario?	Comments
Volatilisation from soil and vapour migration to within trenches/excavations	Yes	It is possible that soil or groundwater derived vapours may accumulate within trench airspaces overlying contaminated soil or groundwater.
Seepage of groundwater to within trenches or excavations	Yes	Due to the shallow nature of and tidal influence on groundwater levels at the Site, groundwater may seep into maintenance trenches or other excavations.
Volatilisation from groundwater (within trench) to trench air	Yes	Vapours derived from groundwater which has seeped into a trench may volatilise to outdoor/trench air.
Volatilisation from subsurface groundwater and vapour migration to within trenches/excavations	No	While this contaminant migration pathway may be relevant for a shallow trench scenario (less than 1 mbgs), the more conservative scenario where groundwater is assumed to enter the trench has been modelled for this scenario.

5.3.6.2 Human Receptors

The most highly exposed receptor for the intrusive maintenance scenario is a short term worker involved in maintenance/excavation activities. Consideration of this receptor is also considered to be protective of a casual observer, or banksman, above the excavation.

5.3.6.3 Exposure Pathways

Potential pathways via which the above receptors may be exposed to Site-derived contamination are summarised in **Table 17** below.

Table 17 Exposure Pathway Analysis - Scenario 2 (Intrusive Maintenance)

Exposure Pathway	Complete?	Notes
Adult Intrusive Worker		
Incidental ingestion of chemicals in soil	✓	Workers may come into contact with soil exposed as a result of excavation activities.
Dermal absorption of chemicals from soil	✓	
Inhalation of chemicals in soil-derived airborne particulates (within trench)	✓	Airborne dust may be generated from exposed soils within trench.
Inhalation of soil-derived vapours	✓	Chemicals may volatilise from exposed soils within trench and accumulate within the trench airspace.
Incidental ingestion of chemicals in groundwater (incidental contact)	✓	Workers may come into contact with shallow groundwater which has seeped into trench extending below the water table.
Dermal absorption of chemicals in groundwater (incidental contact)	✓	

Exposure Pathway	Complete?	Notes
Adult Intrusive Worker		
Inhalation of groundwater derived vapours	✓	Groundwater derived vapours are assumed to volatilise from groundwater which has seeped into trench.

5.3.6.4 Exposure Parameters

Human exposure parameters adopted for Scenario 2 are summarised in **Table 18** below.

Table 18 Exposure Parameters - Scenario 2 (Intrusive Maintenance)

Parameter (units)	Adopted Value	Source/Reference
Body weight (kg)	70	USEPA (1989). Note that the value of 64 kg recommended by enHealth (2004) and NEPC (1999a) has not been adopted as it is based on reported body weights in developing countries and is not considered representative of body weights for the Australian population.
Exposure Frequency (days/year)	15	Professional judgement – allows for up to 3 working weeks of maintenance at the Site to be undertaken by the same maintenance worker.
Exposure Duration (years)	1	Assumes maintenance work at the Site will be undertaken by different workers from year to year (i.e. it is not considered likely that the same worker would return to undertake maintenance work over consecutive years, based on the intermittent and random nature of maintenance work that would be expected at the Site).
Exposure Time for Inhalation (hours/day)	8	Conservatively assumes worker may be present within or directly adjacent the trench for entire workday (8 hours/day).
Incidental Soil Ingestion Rate (mg/day)	330	USEPA (2002) recommended value for construction workers.
Exposed Skin Surface Area for Soil Contact (cm^2/day)	3600	Assumes that workers will wear long pants and that head, forearms and hands may be in contact with soil. Based on 50th percentile skin surface area for males (from Table 6-2 within USEPA, 1997).
Soil to Skin Adherence Factor (mg/cm^2)	1.5	As presented in Exhibit 6-15 of *Risk Assessment Guidance for Superfund* (USEPA,1989).
Exposed Skin Surface Area for Groundwater Contact (cm^2)	3900	Assumes that lower legs and feet may be wetted while workers stand in pooled water within trench. Based on 50th percentile skin surface area for males (from Table 6-2 within USEPA, 1997).
Exposure Time for Water Contact (hours/day)	1	Professional judgement; assumes that worker would not be wading/standing in water for more than one hour per day (on average) during maintenance works.
Incidental Water Ingestion Rate (L/day)	0.005	Professional judgement. Value is five times higher than that recommended by EPHC (2006) for indirect/incidental ingestion via contact with plants and lawns during irrigation and 50 times higher than that specified for incidental ingestion due to exposure to sprays during irrigation.

5.3.6.5 Chemical-Specific Factors for Dermal Exposure Assessment

Dermal absorption factors (DAF; for estimation of chemical absorption from soil during dermal contact) and dermal permeability constants (K_p; for estimation of chemical absorption from water during dermal contact) were obtained, where available from Risk Assessment Information System (RAIS) (University of Tennessee, 2010). Where DAFs were not published by RAIS, default values for chemical groups were adopted based on USEPA (2004b) and/or USEPA (1995) recommendations (i.e. 10% for semi-volatile chemicals, 1% for metals/inorganics and insignificant for volatiles).

K_p values for TPH fractions were estimated from log octanol water partition coefficient (K_{ow}) values reported by TPHCWG (1997b) for specific compounds within each TPH fraction (see Table 3 within TPHCWG, 1997b). The geometric mean of log K_{ow} values for compounds relevant to each TPH fraction was first calculated and the K_p for that fraction was estimated using the following empirical predictive correlation recommended by USEPA (2004b):

$$\log K_p = -2.80 + 0.66 * \log K_{ow} - 0.0056 * MW$$

Where:

K_p = Dermal permeability coefficient (cm/hr)

K_{ow} = Octanol/water partition coefficient (unitless)

MW = Molecular weight (g/mole).

The log K_{ow} values reported by TPHCWG (1997b) for specific chemicals within TPH mixtures were estimated using the commercially available software program ClogP, rather than being empirically derived, and TPHCWG (1997b) noted that estimates of log K_{ow} greater than 6 are likely to be overestimated. The log K values used for estimation of K_p in this assessment were therefore capped at a value of 6 (i.e. the log K_{ow} of fractions for which the geometric mean was greater than 6 were assumed to be 6).

Molecular weights for TPH mixtures used to estimate K_p values were fraction weighted averages of values recommended by TPHCWG (1997b) for differently grouped TPH fractions.

The DAF and K_p values adopted for this assessment are included in **Appendix E.**

5.3.6.6 Vapour Transport Modelling

Volatilisation factors for vapour migration from surface soil to trench air were estimated based on the Jury et al (1983) method, as recommended by ASTM (2002). The vapour modelling calculations for Scenario 2 are included in **Appendix E**.

Volatilisation factors for vapour migration from groundwater present within an excavation to trench air were conservatively modelled as mass limited, based on the following equation:

$$VF_{w,exc} = \frac{Q_{water}}{U_{air} W \delta_{air}}$$

Where:

$VF_{w.exc}$ = Volatilisation factor from water pooled within a trench to trench air (mg/m^3 per mg/L)

Q_{water} = flow rate of water into trench (cm^3/s)

U_{air} = ambient air velocity within the trench (cm/s)

W = width of source zone area (cm)

δ_{air} = air mixing zone height (cm)

Q_{water} was calculated using the following equation:

$$Q_{water} = V_{gw} D_{gw} W_{trench}$$

Where:

V_{gw} = groundwater seepage velocity (cm/sec)

D_{gw} = depth of groundwater in trench (cm)

W_{trench} = width of trench (cm)

The parameters required for the intrusive maintenance scenario vapour modelling for Scenario 2 are summarised in **Table 19** below.

Table 19 Vapour Modelling Assumptions - Scenario 2 (Intrusive Maintenance)

Parameter (units)	Adopted Value	Source/Justification
Vadose Zone/Soil Parameters – Soil to Trench Air		
Fraction of organic carbon in soil source (unitless)	0.002	USEPA (2004a) defaults for coarse sand/gravel
Soil bulk density (g/cm^3)	1.66	
Total porosity in soil source zone (for soil model) (unitless)	0.375	
Air filled porosity in soil source zone (unitless)	0.321	
Water filled porosity in soil source zone (unitless)	0.054	
Vapour phase source partitioning adjustment (unitless)	10	Default factor applied to soil-to-vapour partitioning equation to reflect the differences observed between theoretical estimates of partitioning and field measurements (see CCME, 2008a and Friebel and Nadebaum, 2011).
Groundwater Parameters – Groundwater to Trench Air		
Groundwater seepage velocity into trench (cm/sec)	1.5 x 10^{-2}	Conservative estimate of maximum expected velocity for a sandy or gravelly aquifer (50 ft/day = 13 m/day)
Depth of groundwater in trench (cm)	50	For surface excavation, assumes trench may extend to 2 mbgs and that average groundwater level over the excavation period is 1.5 mbgs. This is considered conservative given that average depth to groundwater over tidal cycle is reported be approximately 2 mbgs.
Dimension of trench perpendicular to groundwater flow (cm)	200	The width of the source parallel to the wind is the dimensions of the length of the source in the direction of windflow. As the trench is assumed to be affected by tidal inflow and may theoretically be wet along all walls and the floor of the trench, the source area parallel to the wind has been conservatively assumed to include 200 cm along two walls and the floor of the trench (200 x 300 cm). This is defined separately from the dimension of the trench perpendicular to groundwater flow which has been set at 200 cm. It should be noted that due to the extensive development works (basement carparks and retention walls) intrusive maintenance workers would only be anticipated to come into contact with groundwater in the area of Hickson Road.
Outdoor/Ambient Air Characteristics		
Wind speed (cm/s)	37.8	Average annual 9 am and 3 pm windspeeds measured at observatory point in Sydney (BOM, 2010), reduced by factor of 10 to account for reduced wind circulation within a trench.
Width of source area parallel to wind (cm)	600	Assumes trench is up to 2 m long and up to 2 m deep.
Ambient air mixing zone height	200	Conservative default – assumes all emitted vapours are mixed within two metre deep trench.

5.3.6.7 Particulate Emission Factors

The respirable dust (PM_{10}) concentrations in trench air were estimated assuming a particulate emission factor (PEF) of 3.6 x 10^7 m^3/kg. This PEF is the USEPA (2002) default for construction (dozing and grading) activities. It is noted that this PEF is applicable to large scale construction projects and is therefore considered to be conservative for assessment of smaller scale short term maintenance/trench scenarios.

5.3.7 Estimation of Chemical Intakes

Estimated chemical intake calculations for exposure to CoPC by relevant receptors and pathways are detailed in **Appendix D** and **Appendix E**and were generated using the following equations, which are primarily based on USEPA, 1989 algorithms.

Inhalation of Particulates or Vapours (Scenario 1 and Scenario 2)

The following equation has been adopted to estimate intakes associated with inhalation of chemicals in air (particulate or vapours). Inhalation exposures have been estimated using the revised methodology published by the USEPA (USEPA, 2009), which recommends adjustment of the measured or estimated contaminant concentration in air to account for site-specific exposure considerations, rather than estimation of a chronic daily intake of contaminant via the inhalation pathway.

For particulates, it is assumed that all particulates inhaled are small enough to penetrate deep into the lungs (i.e., are inspirable), and that the particulate air EPCs have been estimated as inspirable (PM_{10}) dust concentrations.

$$EC_{inh} = \frac{C_a * ET * EF * ED}{AT * 365 \frac{days}{year} * 24 \frac{hours}{day}}$$

Where:

EC_{inh}	=	Exposure Adjusted Air Concentration (mg/m^3)
C_a	=	Chemical Concentration in Air (mg/m^3)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
AT	=	Averaging Time (years)
	=	70 years for non-threshold carcinogens
	=	ED for chemicals assessed based on threshold effects

Note that when assessing inhalation of particulates derived from soil, the chemical concentration in airborne particulates ($C_{a,part}$) is calculated as:

$$C_{a,part} = \frac{C_s}{PEF}$$

Where:

PEF is the particulate emission factor in units of m^3/kg.

When assessing inhalation of vapours derived from soil or groundwater, the vapour concentration in air ($C_{a,vap}$) is calculated as:

$$C_{a,vap,s} = C_s * VF_s$$

Where:

$C_{a,vap,s}$ = Vapour concentration in air deriving from soil (mg/m^3)

VF_s = Volatilisation Factor from soil to air (mg/m^3 / mg/kg)

OR

$$C_{a,vap,gw} = C_{gw} * VF_{gw}$$

Where:

$C_{a,vap,gw}$ = Vapour concentration in air deriving from groundwater (mg/m^3)

VF_{gw} = Volatilisation Factor from groundwater to air (mg/m^3 / mg/L)

Incidental Ingestion of Soil (Scenario 2 only)

$$CDI_{ing,s} = \frac{C_s * IngR_s * EF * ED * CF}{365 \frac{days}{year} * AT * BW}$$

Where:

$CDI_{ing,s}$ = Chronic Daily Intake for Soil Ingestion (mg/kg/day)

C_s = Chemical Concentration in Soil (mg/kg)

$IngR_s$ = Soil Ingestion Rate (mg/day)

CF = Unit conversion factor (kg/10^6 mg)

BW = Body weight (kg)

and other factors that are as defined earlier.

Dermal Contact with Soil (Scenario 2 Only)

$$CDI_{der,s} = \frac{C_s * AH * SA * AF * EF * ED * CF}{365 \frac{days}{year} * AT * BW}$$

Where:

$CDI_{der,s}$ = Chronic Daily Intake for Dermal Contact with Soil (mg/kg/day)

AH = Soil Adherence Factor (mg/cm^2/day)

SA = Skin Surface Avalable for Contact (cm^2)

AF = Dermal Absorption Factor (chemical-specific; unitless)

and other factors are as defined earlier.

Ingestion of Water (Incidental or Potable) (Scenario 2 Only)

$$CDI_{ing,w} = \frac{C_w * IngR_w * EF * ED}{365 \frac{days}{year} * AT * BW}$$

Where:

$CDI_{ing,w}$ = Chronic Daily Intake for Water Ingestion (mg/kg/day)

C_w = Chemical Concentration in Water (mg/L)

$IngR_w$ = Water Ingestion Rate (L/day)

and other factors are as defined earlier.

Dermal Contact with Water (Scenario 2 Only)

$$CDI_{der,w} = \frac{C_w * k_p * SA * ET * EF * ED * CF_w}{365 \frac{days}{year} * AT * BW}$$

Where:

$CDI_{der,w}$ = Chronic Daily Intake (dermal water contact) (mg/kg/day)

C_w = Chemical concentration in water (mg/L)

K_p = Dermal permeability constant for water (cm/hour)

CF_w = Conversion factor (10^{-3} L/cm^3)

5.4 Risk Estimates and Characterisation

Risk characterisation is the initial step in the quantitative risk assessment process. In this step, information gathered and derived from the toxicity assessment and exposure assessment is used to derive quantitative estimates of risk to human health. The risk calculations undertaken in the HHERA are detailed in **Appendix D** (Scenario 1 – Paved Recreation) and **Appendix E** (Scenario 2 – Intrusive Maintenance) and are summarised in the following sections.

5.4.1 Methodology

The methodology used to estimate risks and the risk acceptability criteria adopted in the assessment are presented in the following sections.

5.4.1.1 Non-Threshold (Carcinogenic) Risk Estimates

Risks to human health for CoPCs considered to be genotoxic carcinogens were estimated as the incremental probability of an individual developing cancer over a lifetime as a result of chemical exposure. The numerical estimate of incremental lifetime carcinogenic risk was calculated using the following relationship:

$$ILCR = CDI_{nt} * SF$$

or

$$ILCR = EC_{inh} * IUR * 10^3 \frac{\mu g}{mg}$$

Where:

ILCR = Incremental Lifetime Cancer Risk (unitless)

CDI_{nt} = Chronic Daily Intake (calculated based on non-threshold averaging time) (mg/kg/day)

SF = Cancer Slope Factor (mg/kg/day)$^{-1}$

EC_{inh} = Exposure adjusted air concentration (mg/m^3)

IUR = Inhalation Unit Risk (µg/m^3)$^{-1}$

To assess the overall potential for effects posed by simultaneous exposure to more than one chemical that is associated with non-threshold carcinogenic effects, the risk for each chemical and pathway relevant to a receptor, and for adults and children (as relevant), were summed. The resulting sum is referred to as the cumulative incremental lifetime carcinogenic risk and is estimated as follows:

$$ILCR_{cum} = \sum_{i=1,j=1}^{n} ILCR_{i,j}$$

Where

$ILCR_{cum}$ = Cumulative ILCR for a given receptor (unitless)

$ILCR_{i,j}$ = ILCR for chemical i and pathway j

n = Number of chemicals and/or pathways relevant to land use scenario.

This approach assumes that exposure to multiple carcinogens over a lifetime results in a cumulative effect, and therefore, exposures are summed over all intake routes.

Acceptable Incremental Lifetime Carcinogenic Risks

The incremental lifetime cancer risk estimates for each receptor have been compared to an adopted acceptable carcinogenic risk level of 1 in 100 000 (1×10^{-5}). It should be noted that a national or state guideline has not been formally published with respect to the level of acceptable carcinogenic risk. The adopted acceptable risk level of 1×10^{-5} has been adopted based on the following considerations:

- The Victorian State Environment Protection Policy (Air Quality Management) (VGG, 2001) adopts an incremental lifetime cancer risk of 1×10^{-5} for screening individual chemicals in air.
- EPA Victoria (EPAV) has advised auditors that where more than one carcinogenic chemical is present at a site, the cumulative cancer risks for all chemicals should not exceed 1×10^{-5}.
- NHMRC (2011) Australian Drinking Water Guidelines nominate a negligible level of risk as 1 in 1,000,000 (1×10^{-6}) for development of drinking water guideline values.
- WHO, 2011 Guidelines for Drinking Water Quality adopt a target cancer risk of 1×10^{-5} for development of drinking water guidelines.
- USEPA adopts an incremental lifetime cancer risk of 1×10^{-6} for development of Regional Screening Levels USEPA (2009) for individual chemicals and advises that the cumulative risk (including all chemicals) should not exceed 1 in 10,000 (1×10^{-4}).

Where the estimated cumulative cancer risk is greater than 1×10^{-5}, a more detailed and critical evaluation of the risk may be conducted, or appropriate risk management measures may be recommended.

5.4.1.2 Threshold Risk Estimates

Risks to human health for CoPC assessed on the basis of a threshold approach were estimated by comparison of the daily chemical intake or exposure adjusted air concentration of each CoPC with its respective TDI or Reference Concentration allowable from the Site (i.e., the TDI minus background intakes). The resulting ratio, referred to as the hazard quotient, is derived in the following manner:

$$HQ = \frac{CDI_t}{TDI - background}$$

or

$$HQ = \frac{EC_{inh}}{RfC - background}$$

Where:

HQ = Hazard Quotient (unitless)

CDI_t = Chronic Daily Intake (calculated based on threshold averaging time) (mg/kg/day)

TDI = Tolerable Daily Intake (mg/kg/day) – adjusted for background intake

EC_{inh} = Exposure adjusted air concentration (mg/m^3)

RfC = Tolerable Concentration in air (mg/m^3) – adjusted for background intake

A potentially unacceptable chemical intake/exposure is indicated if the exposure level exceeds the TDI or TC (i.e. if the hazard quotient is greater than 1).

To assess the overall potential for adverse health effects posed by exposure to multiple chemicals, the hazard quotients for each chemical and exposure pathway relevant to a receptor are summed. The resulting sum is referred to as the hazard index (HI), and is calculated using the following equation.

$$HI = \sum_{i=1,j=1}^{n} HQ_{i,j}$$

Where:

HI = Hazard Index (unitless)

$HQ_{i,j}$ = Hazard Quotient for pathway *i* and chemical *j* (unitless)

n = Number of chemicals and/or pathways relevant to land use scenario

If the HI is less than one, then cumulative exposure to the CoPC is considered unlikely to result in an adverse effect. If the sum is greater than one, a more detailed and critical evaluation of the hazards may be required, or appropriate risk management measures at the Site may need to be implemented.

5.4.2 Summary of Risk Estimates

Risk calculations for the on-Site receptors are provided in **Appendix D** (Scenario 1 - Paved Recreation) and **Appendix E** (Scenario 2 - Intrusive Maintenance).

5.4.2.1 Risk Estimates – Scenario 1 (Recreational Receptor)

A summary of the calculated reasonable maximum non-threshold risks (incremental lifetime excess cancer risks) and threshold risks (hazard indices) for Scenario 1 (Recreational Receptors) are presented in **Table 20** below.

Table 20 Risk Estimates – Scenario 1 - Recreational Receptor

Exposure Pathway	Non-Threshold (ILCR)	Threshold Risk (Hazard Index)	
		Adult	Child
Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air	3.5×10^{-8}	0.00082	0.00082
Inhalation of Groundwater-Derived Vapours in Outdoor Air	7.7×10^{-8}	0.0016	0.0016
a) **Total**	b) **1.1×10^{-7}**	c) **0.0025**	d) **0.0025**

Based on the adopted carcinogenic risk level of 1 in 100 000 (1×10^{-5}) for non-threshold chemicals and a hazard index (HI) of 1 for threshold chemicals, the risk to human health for on-Site recreational receptors has been identified to be acceptable for both threshold and non-threshold chemicals.

No further consideration of the CoPC in relation to the modelled Scenario 1 (Paved Recreation) exposure scenario will be undertaken. Development of SSTCs protective of this receptor group is not considered necessary as the risk presented by the maximum concentrations of CoPC (EPC) has been determined to be acceptable.

5.4.2.2 Risk Estimates – Scenario 2 (Intrusive Maintenance Receptor)

A summary of the calculated reasonable maximum non-threshold risks (incremental lifetime excess cancer risks) and threshold risks (hazard indices) for Scenario 2 (Intrusive Maintenance Receptors) are presented in **Table 21** below.

Table 21 Risk Estimates – Scenario 2 – Intrusive Maintenance Receptor

Exposure Pathway	Non-Threshold (ILCR)	Threshold Risk (Hazard Index)	
		Adult	Child
Incidental Ingestion of Soil	1.2×10^{-6}	1.1	-
Dermal Contact with Soil	9.6×10^{-5}	1.3	-
Inhalation of Surface Soil-Derived Dust in Outdoor Air	4.6×10^{-7}	0.0016	-
Inhalation of Surface Soil-Derived Vapours in Outdoor Air	1.4×10^{-8}	0.086	-
Inhalation of Groundwater Vapours (Where groundwater Enters Trench)	1.6×10^{-6}	9.0	-
Incidental Ingestion of Groundwater (Bathing or Excavation)	3.0×10^{-7}	0.66	-
Dermal Contact with Groundwater (Bathing or Excavation)	1.3×10^{-4}	130	-
e) **Total**	f) **2.3×10^{-4}**	g) **140**	h) **-**

Based on the adopted carcinogenic risk level of 1 in 100 000 (1×10^{-5}) for non-threshold chemicals and a hazard index (HI) of 1 for threshold chemicals, the risk to human health for on-Site intrusive maintenance workers is unacceptable. These risk estimates indicate that cumulative exposure to the CoPC may result in adverse health risks. The principal drivers for both threshold risk and non-threshold risk estimates are:

- dermal contact with groundwater;
- groundwater vapour inhalation within a trench;
- dermal contact with soil; and
- incidental soil ingestion..

The above risk estimates indicate that unacceptable risks are possible if maintenance work is conducted in the most impacted area(s) of the Site for the entire assumed exposure period. However, if maintenance work is conducted in a less impacted area of the Site, the resultant risk will be less.

For comparative purposes, AECOM calculated the 95% upper confidence limit (UCL) of the observed chemical concentrations in soil and groundwater across the site. Substitution of the maximum site concentrations with the 95% UCL as the EPC for soil and groundwater within the Scenario 2 risk assessment (Intrusive Maintenance) resulted in:

- risk estimates that were approximately one order of magnitude lower than the risks estimated based on maximum site concentrations as EPC; and
- unacceptable threshold and non-threshold risks.

5.4.3 CoPC requiring Remediation

For the purpose of identifying the CoPC which require remediation to reduce the risk to the Scenario 2 (Intrusive Maintenance) receptor (that is CoPC for which a SSTC will be derived), an analysis of the contribution each chemical makes to the threshold and non-threshold risk totals has been undertaken.

SSTC will be presented for CoPC identified in soil and groundwater which significantly contribute to the overall risk. AECOM considers those CoPC which contribute more than 20% to the combined cumulative risk (from all exposure pathways) significantly contribute to the risk presented to the Scenario 2 (Intrusive Maintenance) receptor. Therefore, SSTC will be presented for CoPC where;

a) The cumulative (soil and groundwater) threshold risk (hazard index) of a chemical is greater than 0.2; or

b) The cumulative (soil and groundwater) non-threshold risk (incremental lifetime cancer risk) of a chemical is greater than 2×10^{-6}.

The results of this analysis are presented in **Appendix C**. Using this approach, CoPC for which SSTC are not derived are not considered to contribute significantly to the total risk at the Site, even if their concentrations are not reduced during remediation works.

AECOM notes that the hazard index adopted in the risk characterisation and in the derivation of SSTC has taken into consideration the potential for cumulative exposures to multiple chemicals deriving from either soil, groundwater, or both as discussed in **Section 5.2.5**.

CoPC which are considered to significantly contribute to the unacceptable risk at the Site, and therefore for which SSTC in soil and groundwater will be derived include the following;

- Acenaphthylene;
- Ammonia;
- Fluoranthene;
- Naphthalene;
- Phenanthrene;
- Pyrene;
- cPAH;
- Benzene;
- TPH C_{10} – C_{14} (aliphatic and aromatic);
- TPH C_{15} – C_{28} (aliphatic and aromatic); and
- TPH C_{29} – C_{36} (aromatic).

The derivation of the SSTCs for soil and groundwater are presented in **Section 6.2.**

5.4.4 Potential Risks to Occupants of Adjacent Buildings

With respect to potential health risks to residents or other occupants of buildings adjacent the Site (e.g. on the east side of Hickson Road) associated with existing groundwater contamination, AECOM understands that:

- a human health risk assessment has previously been undertaken to assess potential risks to occupants of the residential building directly adjacent the Site;
- the potential health risks to building occupants due to Site-derived CoPC are currently being effectively managed (as referenced by the NSW EPA Declaration 21122); and
- the health risk assessment was reviewed and endorsed by a NSW EPA accredited Independent Site Auditor.

It is also expected that remediation of Hickson Road, as will be required to address the NSW EPA Declaration, and which is likely to include large scale contaminant source reduction will further reduce the potential for risk to occupants of adjacent buildings.

5.4.5 Potential Risks Associated with off Site Contamination

Assessment of potential risks to human health (including maintenance workers) and the environment from soil and groundwater contamination identified to the west of the Site will be the subject to a separate risk assessment (specifically the ORWN HHERA).

Potential risks to human health and the environment from soil and groundwater contamination identified to the south of the Site have been previously assessed by the separate ORWS HHERA Addendum (AECOM, 2011b). An assessment of risks to people engaged in Construction Works associated with basement construction in the ORWS Area will be considered by a separate Construction Worker Health Risk Assessment.

6.0 Estimation of Site-Specific Target Criteria

SSTC have been derived, for the purpose of remediation to reduce the unacceptable risk to the Scenario 2 (Intrusive Maintenance) receptor. SSTC were estimated for specific environmental media (e.g. soil or groundwater) and receptors, based on consideration of each pathway relevant to the given receptor and medium. The complete exposure pathways considered for the Scenario 2 (Intrusive Maintenance) are presented in the exposure pathway analysis and summarised in **Table 17.**

In order to estimate SSTC, a chemical-specific factor which incorporates all exposure and toxicity parameters other than the soil or groundwater concentration is first calculated. For simplicity, these factors are referred to as intake-toxicity factors (ITF). The ITFs are based on equations used for forward estimation of exposure and risk (equations as per USEPA, 1989, 2004b and 2009b guidance) (as presented in **Section 5.3.7**), but have been algebraically rearranged to express a numerical value which, if multiplied by the chemical concentration relevant to the pathway, would result in a risk estimate.

6.1 Derivation of SSTCs

The complete exposure pathways and corresponding ITF equations are presented in **Table 22** below and the complete equations are provided in **Section 6.1.1.**

Table 22 Complete Exposure Pathways and corresponding ITF Equations

Complete Exposure Pathway	Notes	ITF Equation
Incidental ingestion of chemicals in soil.	Workers may come into contact with soil exposed as a result of excavation activities.	Incidental ingestion of soil.
Dermal absorption of chemicals from soil.		Dermal contact with soil.
Inhalation of chemicals in soil-derived airborne particulates (within trench)	Airborne dust may be generated from exposed soils within trench.	Inhalation of soil-derived particulates
Inhalation of soil-derived vapours.	Chemicals may volatilise from exposed soils within trench and accumulate within the trench airspace.	Inhalation of soil-derived vapours
Incidental ingestion of chemicals in groundwater (incidental contact).	Workers may come into contact with shallow groundwater which has seeped into trench extending below the water table.	Incidental ingestion of water
Dermal absorption of chemicals in groundwater (incidental contact).		Dermal contact with groundwater.
Inhalation of groundwater derived vapours.	Groundwater derived vapours are assumed to volatilise from groundwater which has seeped into trench.	Inhalation of groundwater-derived vapours.

No SSTC were derived for the Scenario 1 (Paved Recreation) receptor as the total threshold and non-threshold risks were identified to be acceptable (**Section 5.4.2.1**).

6.1.1 SSTCs based on Threshold Risks

For chemicals assessed on the basis of threshold effects, ITFs are estimated as follows:

Incidental Ingestion of Soil

$$ITF_{ing,s} = \frac{IngR_s * EF * ED * CF}{365\frac{days}{year} * AT * BW} * \frac{1}{RfD}$$

Where:

$ITF_{ing,s}$ = Intake-Toxicity Factor for Soil Ingestion (kg/mg)

$IngR_s$ = Soil Ingestion Rate (mg/day)

EF = Exposure Frequency (days/year

ED = Exposure Duration (years)

CF = Unit conversion factor (kg/10^6 mg)

AT = Averaging Time (years)

= 70 years for non-threshold carcinogens

= ED for chemicals assessed based on threshold effects

BW = Body weight (kg)

RfD = Oral Reference Dose (mg/kg/day)

Dermal Contact with Soil

$$ITF_{der,ss} = \frac{AH * SA * AF * EF * ED * CF}{365\frac{days}{year} * AT * BW} * \frac{1}{RfD}$$

Where:

$ITF_{der,s}$ = Intake-Toxicity Factor for Dermal Contact with Soil (kg/mg)

AH = Soil Adherence Factor (mg/cm^2/day)

SA = Skin Surface Avalable for Contact (cm^2)

AF = Dermal Absorption Factor (chemical-specific; unitless)

and other parameters are as defined earlier.

Inhalation of Soil-Derived Particulates

$$ITF_{inh,part} = \frac{ET * EF * ED}{PEF * AT * 365\frac{days}{year} * 24\frac{hours}{day}} * \frac{1}{RfC}$$

Where:

$ITF_{inh,part}$ = Intake-Toxicity Factor for Particulate Inhalation (kg/mg)

ET = Exposure Time (hours/day)

RfC = Reference or Tolerable Concentration in Air (mg/m^3)

PEF = Particulate Emission Factor (m^3/kg)

and other parameters are as defined earlier.

Inhalation of Soil-Derived Vapours

$$ITF_{inh,vap,s} = \frac{VF_s * ET * EF * ED}{AT * 365\frac{days}{year} * 24\frac{hours}{day}} * \frac{1}{RfC}$$

Where:

$ITF_{inh,vap,s}$ = Intake-Toxicity Factor for Inhalation of Soil-Derived Vapours (kg/mg)

VF_s = Volatilisation Factor for Soil to Air (mg/m^3 per mg/kg)

and other parameters are as defined earlier.

Incidental Ingestion of Water

$$ITF_{ing,w} = \frac{IngR_w * EF * ED}{365\frac{days}{year} * AT * BW} * \frac{1}{RfD}$$

Where:

$ITF_{ing,w}$= Intake-Toxicity Factor for Water Ingestion (L/mg)

$IngR_s$ = Water Ingestion Rate (L/day)

and other parameters are as defined earlier.

Dermal Contact with Water

$$ITF_{der,w} = \frac{k_p * SA * ET * EF * ED * CF_w}{365\frac{days}{year} * AT * BW} * \frac{1}{RfD}$$

Where:

$ITF_{der,w}$ = Intake-Toxicity Factor for Dermal Water Contact (L/mg)

k_p = Dermal Permeability Constant for Water Contact (cm/hr)

CF_w = Unit Conversion Factor (L/10^3 cm^3)

and other parameters are as defined earlier.

Inhalation of Groundwater-Derived Vapours

$$ITF_{inh,vap,gw} = \frac{VF_{gw} * ET * EF * ED}{AT * 365\frac{days}{year} * 24\frac{hours}{day}} * \frac{1}{RfC}$$

Where:

$ITF_{inh,vap,gw}$ = Intake-Toxicity Factor for Inhalation of Groundwater-Derived Vapours (L/mg)

VF_{gw} = Volatilisation Factor for Groundwater to Air (mg/m^3 per mg/L)

and other parameters are as defined earlier.

6.1.2 SSTC based on Non-Threshold Risks

For genotoxic carcinogens assessed on the basis of non-threshold effects, the 1/RfD term in the above equations is replaced with the Cancer Slope Factor (for dermal and ingestion pathways), or the 1/RfC term is replaced by the Inhalation Unit Risk (IUR) multiplied by a conversion factor of 1000 µg/mg.

SSTC were then estimated as:

$$SSTC = \frac{THQ}{\sum_{i=1}^{n} ITF_i}$$

or for genotoxic carcinogens:

$$SSTC = \frac{TCR}{\sum_{i=1}^{n} ITF_i}$$

Where:

THQ	=	Target Hazard Quotient (applied on a chemical by chemical basis)
TCR	=	Target Cancer Risk (applied on a chemical by chemical basis)
ITF_i	=	ITF for Exposure Pathway *i* of *n* pathways relevant to exposure medium and receptor.

6.2 Site Specific Target Criteria

6.2.1 CoPC Assessed on the Basis of Threshold Toxicity Criteria

As described in **Section 5.2.5,** to allow for the presence of mixtures of chemicals at locations across the Site, non-carcinogenic and/or non-genotoxic CoPC have been assigned proportional hazard indices. This differs from the standard approach (enHealth, 2004) which allocates a target hazard quotient of 1 for each individual chemical and specifies that in setting risk-based environmental health criteria exposure to a substance should not exceed the ADI.

The target hazard quotient (as outlined in **Section 5.2.5**) was applied to Scenario 2 (Intrusive Maintenance) and allow for collocation of contaminants in soil and groundwater.

6.2.2 CoPC Assessed on the Basis of Non-Threshold Toxicity Criteria

For CoPC considered to be genotoxic carcinogens and assessed on the basis of non-threshold toxicity criteria, an incremental cancer risk of 1×10^{-5} has been adopted as the acceptable cancer risk threshold for each individual chemical, based on the considerations in **Section 5.4.1.1.**

As described in **Section 5.2.4** carcinogenic PAHs (cPAH) were assessed in combination, rather than individually. This approach was taken to allow for the co-location of cPAH across the Site.

6.2.3 Considerations for SSTC derivation

Where SSTC are derived for scenarios where receptor exposure is assumed to occur only via the vapour inhalation pathway, if the calculated soil SSTC was greater than the soil concentration at which dissolved pore water and vapour phases become saturated (C_{sat}), the soil SSTC corresponds to an estimated pore vapour concentration greater than the chemical component saturated vapour concentration limit and the specific target risk level cannot be physically achieved in the defined scenario, even where PSH is present (USEPA, 2004a). In these cases, the calculated SSTC is not considered appropriate (refer also to **Section 6.2.4**).

Similarly, where the calculated groundwater SSTC was greater than the theoretical pure component aqueous solubility, the SSTC corresponds to an estimated source vapour concentration greater than the saturated vapour concentration limit and the specified target risk level cannot be achieved, even where PSH is present (USEPA, 2004a). In these cases the calculated SSTC is not considered appropriate (refer also to **Section 6.2.4**).

However, in cases where receptor exposure may occur through a combination of vapour and direct contact or dust inhalation pathways, the SSTC cannot be saturation or solubility limited for the non-vapour exposure pathways. Therefore, in order to avoid unnecessarily low SSTC where a portion of chemical exposure is solubility or saturation limited, but where the remainder of exposure is not, SSTC were checked for sensitivity to saturation or solubility limiting of vapour exposure and revised (where necessary) based on the following procedure.

a) Forward risk was estimated across all exposure pathways relevant to the environmental media (for each chemical) using the SSTC as the input concentration but incorporating the solubility or saturation limit for risk estimation of vapour pathways (i.e. using the minimum of the SSTC or the saturation/solubility limit as input concentration).

b) If the estimated forward risk was equal to the target risk level used for SSTC estimation, vapour pathways are not saturation or solubility limited and no SSTC revision is necessary.

c) If forward risk was less than target risk level adopted for SSTC derivation, saturation or solubility limited risk was calculated for vapour pathways, using the following equation:

$$Risk_{vap} = \sum_{i=1}^{n} ITF_{vap,i} * C_{sat/sol}$$

Where:

$Risk_{vap}$	=	Saturation or solubility limited risk due to vapour pathways (unitless)
$ITF_{vap,I}$	=	ITF for Vapour Exposure Pathway *i* of *n* vapour exposure pathways relevant to exposure medium and receptor.
$C_{sat/sol}$	=	C_{sat} (for soil exposure pathways) or aqueous solubility limit (for groundwater pathways).

d) $Risk_{vap}$ was subtracted from the target risk level, and this value ($Risk_{non\text{-}vap}$) was used as target risk for estimation of revised SSTC, using the following equation:

$$SSTC_{rev} = \frac{Risk_{non-vap}}{\sum_{i=1}^{n} ITF_{non-vap,i}}$$

Where:

$SSTC_{rev}$	=	SSTC revised for saturation/solubility limiting of vapour risk components
$Risk_{non\text{-}vap}$	=	Target risk for SSTC less saturation/solubility limited risk component (i.e. residual target risk which can be allocated to non-vapour pathways)
$ITF_{non\text{-}vap,I}$	=	ITF for Non-Vapour Exposure Pathway *i* of *n* Non-Vapour Exposure Pathways Relevant to Exposure Medium and Receptor.

The calculations of SSTC are detailed in **Appendix C**.

6.2.4 Saturation and Solubility Considerations in SSTC Derivation

The SSTC represents an acceptable chemical concentration in soil or groundwater based on the chemical properties of a pure or surrogate chemical.

The derived SSTCs are, in some instances numerous orders of magnitude greater than the theoretical saturation/ solubility limits which indicates the use of derived SSTCs (which have not been limited by saturation or solubility) for some chemicals is an overconservative estimate. For some chemicals, the derived SSTCs presented in **Table 23** and **Table 24**are likely to be equal to separated phase concentrations within soil and groundwater. The calculated SSTC therefore indicate that from a human health perspective, separated phase or grossly impacted material does not present a health risk for a number of scenarios.

The removal of separated phase/ grossly impacted material to the extent practicable is an important remediation objective for the Site (**Section 4.2.4**). It is therefore considered that SSTC presented for human health for remediation purposes need to support this objective.

To address this and establish reasonable and realistic SSTCs for soil and groundwater given the presence of chemical mixtures across the Site, the following steps were undertaken.

1) Risk and odour SSTCs were derived for soil and groundwater and compared to saturation /solubility limits and maximum Site concentrations.

2) Where derived SSTC's were greater than 10 times the theoretical saturation/ solubility limits the SSTC were considered to be approaching separated phase/ grossly impacted material that require removal to meet the remediation objectives for the Site. In these instances no SSTC was proposed.

3) Where SSTCs are not saturation or solubility limited, or are within 10 times the saturation/ solubility limits the SSTC was adopted.

4) TPH fractions are a heterogeneous mixture of potentially hundreds of compounds and the derivation of an SSTC based on the theoretical chemical properties for these fractions is considered to be associated with a high degree of inaccuracy. Moreover, the maximum Site concentrations indicated that the derived SSTCs were reasonable and achievable as remediation objectives for the Site. Therefore, although the derived soil and groundwater SSTCs for TPH fractions are over 10 times the saturation/solubility limits:

    a) the derived SSTC has been adopted has been adopted for groundwater; and

    b) the maximum soil concentrations present at the Site have been adopted as the SSTC for soil.

    c) It is noted that the TPH results reported during historical investigations is a total of the aliphatic and aromatic fraction. Therefore, although the aliphatic TPH C_{29}-C_{36} was excluded as a CoPC during the screening process (**Section 5.4.3**), the SSTC for both groundwater and soil considers the total of both the aliphatic and aromatic components.

5) SSTCs for carcinogenic PAHs were determined as a "total cPAH" based on the SSTC derived for benzo(a)pyrene. It is noted that for both groundwater and soil the derived SSTCs were greater than 10 times the saturation and solubility limits (relating to benzo(a)pyrene), respectively. However as cPAH has been observed to be a significant contributor to human health risk, and has been identified in soil and groundwater samples at concentrations greater than the saturation / solubility limits, the derived SSTC has been adopted.

The SSTCs derived for soil and groundwater for the chemicals identified as significantly contributing to the human health risk for the Scenario 2 (Intrusive Maintenance) receptor (see **Section 5.4.2.2**) are presented in are presented in **Table 23** and **Table 24** below.

Table 23 Comparison of Derived and Proposed Groundwater SSTC

Chemical	Solubility Limits (mg/L)	Maximum Site Concentration (mg/L)	GroundwaterSSTC – Human Health (mg/L)	
			Derived	Proposed
Acenaphthylene	16.1	43	46.9	47
Ammonia	482000	350	153	150
Benzene	1,790	41	3.35	3.4
cPAH [(a)]	0.00162 (benzo(a)pyrene)	-	0.995	1
Fluoranthene	0.26	26	11.3	##
Naphthalene	31	280	28.6	29
Phenanthrene	1.2	74	36.1	##
Pyrene	0.14	28	13	##
TPH C_{10}-C_{14} aliphatic	0.1	1700	4.3	21 [(c)]
TPH C_{10}-C_{14} aromatic	25.3		17	
TPH C_{15}-C_{28} aliphatic [(b)]	0.0001	1500	215	220 [(c)]
TPH C_{15}-C_{28} aromatic [(b)]	1.1		4.58	
TPH C_{29}-C_{36} aliphatic [(b)]	0.000003	330	247	250 [(c)]
TPH C_{29}-C_{36} aromatic [(b)]	0.0066		2.5	

Notes:

- ## = an SSTC has not been determined for remediation purposes as the derived level is at least 10 times greater than saturation/ solubility limits
- (a) cPAH = carcinogenic PAHs. Includes: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h) anthracene and indeno (1,2,3-c d)pyrene. The application of cPAH requires adjustment of the individual concentrations for each constituent listed in accordance with the TEFs outlined in Table 2 of PAH toxicity profile, Appendix D. The sum of the adjusted TEF concentrations is compared to the cPAH value presented above..
- (b) SSTC is greater than 10 times the solubility limit but the derived SSTC has been adopted as it is not considered appropriate to exclude this complex and chemically diverse group of chemicals based on the solubility/ saturation characteristics of an analytical surrogate.
- (c) The TPH SSTC presented are a sum of the derived SSTC for aliphatic and aromatic compounds.

Key Assumptions:

- There are significant biodegradation processes occurring within sub-surface soils based on measured oxygen concentrations beneath the sub-surface. To account for these biodegradation processes, a 10 fold factor (Davis 2009) has been adopted for Site specific target criteria for soil for the paved and unpaved areas of the Site, where biodegradation processes are considered to be significant.
- Risks associated with mixtures of chemicals have been modelled by applying proportional risks as follows: BTEX (HI 0.25 each), PAH (HI 0.2), TPH (HI 0.25 total for aliphatic and aromatic per fraction), all other chemicals HI = 1.
- Chemicals are assumed to be volatile if Henry's Law constant is greater than 1 x 10^{-5} atm-m^3/mole (USEPA, 2004).

Table 24 Comparison of Derived and Proposed Soil SSTC

Chemical	Saturation Limits (mg/kg)	Maximum Soil Concentration (mg/kg) (0m-2mbgs)	Soil SSTC – Human Health (mg/kg)	
			Derived	Proposed
Acenaphthylene	163	1000	19 000	##
Benzene	659.5	61	376	380
cPAH [(a)]	1.9 (benzo(a)pyrene)	-	67	67
Fluoranthene	28.9	2100	13 200	##
Naphthalene	96.6	8400	4330	##
Phenanthrene	38.4	3100	19 800	##
Pyrene	14.7	1700	9900	##
TPH C_{10}-C_{14} aliphatic [(b)]	111.1	54 000	64 500	54 000
TPH C_{10}-C_{14} aromatic [(b)]	154.3		25 700	
TPH C_{15}-C_{28} aliphatic [(b)]	70.2	72 000	489 000	72 000
TPH C_{15}-C_{28} aromatic [(b)]	80.4		7340	
TPH C_{29}-C_{36} aliphatic [(b)]	3.2	21 000	489 000	21 000
TPH C_{29}-C_{36} aromatic [(b)]	1.6		7340	

Notes:

- ## = an SSTC has not been determined for remediation purposes because the derived value is at least 10 times greater than the saturation limit
- (a) cPAH = carcinogenic PAHs. Includes: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h) anthracene and indeno (1,2,3-c d)pyrene. The application of cPAH requires adjustment of the individual concentrations for each constituent listed in accordance with the TEFs outlined in Table 2 of PAH toxicity profile, Appendix D. The sum of the adjusted TEF concentrations is compared to the cPAH value presented above..
- (b) SSTC is greater than 10 times the saturation limit but it is not considered appropriate to exclude this complex and chemically diverse group of chemicals based on the saturation characteristics of an analytical surrogate. The SSTC adopted is the lowest value of the derived SSTC or the maximum observed concentrations on-Site:
- (c) As noted in **Section 6.2.4**, the SSTC adopted for soil are based on the maximum soil concentrations reported on Site which are lower than the derived SSTC.

6.3 Comparison of SSTC to Site Concentrations

6.3.1 Groundwater

SSTC for groundwater are compared to reported CoPC concentrations in Site groundwater samples. This comparison is presented in **Table T3**.

The nature and extent of groundwater SSTC exceedances are summarised in **Table 25** below. **Figure F3** in **Appendix B** provides a site plan and sampling locations.

Table 25 Summary of Groundwater SSTC Exceedances

Locations where SSTC Exceeded Observed Site Concentrations*	Chemicals with Groundwater SSTC**				
	Ammonia (150 mg/L)	Benzene (3.4 mg/L)	cPAH (1 mg/L)	Naphthalene (29 mg/L)	TPH C_{10}–C_{36}
BH54/MW54	×	×	×	×	✓
BH087/MW15	×	✓	×	×	✓
BH200/MW200	×	✓	×	×	✓
BH204/MW204S	×	×	×	×	✓
BH204D/MW204D	×	✓	×	×	✓
BH205/MW205	×	✓	✓	✓	✓
BH206/MW206	×	✓	×	×	✓
BH209/MW209	×	×	×	×	×
BH210/MW210	×	×	×	×	×
BH400/MW400	×	×	×	×	×
MW10_Coffey / MW10	✓	✓	×	✓	✓
MW15_Coffey / MW15	×	✓	×	✓	✓
MW3/MW3	×	×	×	×	×
MW7 / MW7	✓	✓	×	×	✓

Notes:
✓ Chemical exceeded SSTC during at least one groundwater sampling event.
× Chemical did not exceed SSTC during any groundwater sampling event.
* Sampling locations where no exceedance of the SSTC was observed are not presented in this table.

6.3.2 Soil

SSTC for soil have been compared to reported CoPC concentrations in Site soil samples which are presented in **Table T2** in **Appendix A**.

The nature and extent of soil SSTC exceedances are summarised in **Table 26** below. **Figure F3** in **Appendix B** provides a site plan and sampling locations.

Table 26 Summary of Soil SSTC Exceedances

Site Locations/ Depths(m bgs) where SSTC Exceeded Observed Site Concentrations*	Soil SSTC		
	Benzene 380 mg/kg	cPAH 67 mg/kg	TPH C_{10}–C_{36}
AECOM_BH54_1-1.5	×	✓	×
AECOM_BH55_1-1.2	×	✓	×
AECOM_BH64_1-1.2	×	✓	×
BH073_1.5-1.95	×	✓	×
BH087_1.5-1.95	×	✓	×
BH145_0.3-0.5	×	✓	×
BH200_1	×	✓	×
BH204S_1	×	✓	×
BH204D_1.5	×	✓	×

Notes:
✓ Chemical exceeded SSTC at this sample location.
× Chemical did not exceed SSTC at this sample location.
* Sampling locations where no exceedance of the SSTC was observed are not presented in this table.

7.0 Aesthetic Impacts

7.1 Odour

It has been AECOM's experience that the chemical contaminants generally associated with gasworks sites are highly odorous and thus it is expected that odours are likely to be emitted during remediation of the Site as might be required to remove the NSW EPA Remediation Declaration. It is for this reason that the current HHERA has attempted to provide an indication of the chemicals likely to be present at the Site at concentrations that have the potential to be odorous. In an attempt to aid the remediation process:

- an odour-based risk assessment has been undertaken; and
- SSTC ($SSTC_{odour}$) have been derived, these SSTC provide an indication of the chemicals which are likely to create odours in outdoor spaces.

The odour based risk assessment and derivation of odour- based SSTC ($SSTC_{odour}$) was undertaken using the risk modelling spreadsheets for Scenario 1 and Scenario 2, as described in **Section 5.3.4** but with the following modifications.

- Threshold toxicity (dose-response) values were replaced with relevant chemical-specific odour threshold values, where available. Odour thresholds were adopted from Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profiles for specific chemicals or chemical groups, or from the IRIS database (USEPA, 2010). Adopted odour threshold values and their sources are summarised in **Table T5** in **Appendix A**. These odour thresholds have been considered to be most relevant to the current HHERA as they have been reviewed by ATSDR and IRIS and found to be acceptable, this approach is consistent with recommended sources published by enHealth (2004) and NEPC (1999).
- It should be noted that each chemical may have a broad range of published odour threshold values, some of which may be lower than those adopted in the current HHERA. Odour values are very subjective and are based on the sensitivity of the people used in the study. Hence there is a large variability in values which may be adopted. It is considered that there is not a high degree of precision and accuracy within the currently available published odour values. This is because odour thresholds are based a threshold at which some members of the population may be able to detect the odour under certain conditions. In reality the thresholds that the population is able to detect odours at are highly dependent on weather conditions such as wind speed and temperature and sensitivity of the individual. In consideration of variability in the available odour thresholds, a number of other conservative assumptions have been adopted during the calculation of odour based SSTC, such as: removal of the 10 fold soil partitioning factor that was adopted during the calculation of the health based $SSTC_{odour}$ (see below); and assumption of 24 hour a day and 365 days a year exposure (see below). The assumptions adopted by AECOM are considered to remove any uncertainty that might be associated with the selected odour thresholds used in the development of the $SSTC_{odour}$. AECOM considers that the adopted odour values are therefore appropriate.
- Non-threshold toxicity values were not considered, as they are not relevant to odour generation.
- As the olfactory capacity of humans is highly variable, and to ensure the derived odour SSTCs are suitably protective, the 10 fold soil partitioning applied to TPH and BTEX in the derivation of risk based SSTCs (see **Section 5.3.2**) has been removed.
- Both volatile and semi-volatile CoPC were included in the vapour emission modelling. This was undertaken since key odour drivers within gasworks waste are typically phenolic compounds, which are classified by USEPA (2004a) as not sufficiently volatile to warrant inclusion in vapour intrusion modelling, but are considered to potentially contribute to odour generation, particularly for intrusive scenarios.
- Receptor exposure time and frequency were set to 24 hours/day and 365 days/year, respectively. This was undertaken to ensure that the odour-based risk assessment and SSTC were based on estimates of average air concentrations within indoor or outdoor air, rather than exposure adjusted air concentrations.
- There is currently limited information available with regards to the effects of chemical mixtures on odour levels, and none of this information specifically addresses odorous gasworks related contaminants. Odour emissions from chemical mixtures are dependent upon a number of factors such as the ratio of chemicals present, environmental factors and the specific combination of chemicals. In an attempt to account for the mixtures likely to be present at the Site the mixtures approach adopted during derivation of risk based

SSTCs has also been adopted for calculation of odour based SSTCs. This approach has been outlined in **Section 5.2.5.**

- The modelling assumptions for each Scenario as detailed within **Section 5.3** have been applied to the risk assessment and derivation of $SSTC_{odour}$, with the exceptions noted above.

The estimated risk and derived $SSTC_{odour}$ are detailed in **Appendix G** and **Appendix H** and summarised in **Table 27** below**.**

Odour risks were identified to be above the adopted threshold of 1 for Scenario 2 (Intrusive Maintenance) receptors only. This calculated threshold risk indicates the risk of odour occurring during intrusive maintenance works is likely; this supports observations of odour impacts during site investigations. Based on the modelled exposure concentrations odour impacts at the Site are primarily associated with phenol as shown in **Appendix H**. AECOM notes, based on the modelled exposure scenarios, Scenario 1 receptors may not observe odour impacts at the Site.

Although a risk of odour was identified for Scenario 2 (Intrusive Maintenance), $SSTC_{odour}$ have been identified to be greater than the SSTC for soil and groundwater derived to be protective of human health.

Table 27 Odour Risk Assessment and SSTC Consideration

Calculated Threshold Risk	Chemical	Soil (mg/kg)		Groundwater (mg/L)	
		$SSTC_{odou}$	SSTC	$SSTC_{odou}$	SSTC
Scenario 1					
4.6×10^{-6}	Acenaphthene	1.52×10^{8}	-	1.68×10^{7}	-
	Ammonia	2.66×10^{8}	-	7.45×10^{9}	-
	Benzene	2.82×10^{8}	-	8.65×10^{7}	-
	Cyanide	1.25×10^{6}	-	3.54×10^{7}	-
	Ethylbenzene	1.28×10^{7}	-	1.46×10^{6}	-
	Naphthalene	1.44×10^{7}	-	5.18×10^{6}	-
	Phenol	3.07×10^{9}	-	7.85×10^{9}	-
	Toluene	1.13×10^{8}	-	2.3×10^{7}	-
	Xylenes	1.16×10^{8}	-	1.56×10^{7}	-
Scenario 2					
1.2	Acenaphthene	2.65×10^{8}	-	2.22×10^{4}	-
	Ammonia	4.7×10^{10}	-	3.97×10^{6}	-
	Benzene	7.16×10^{10}	67	6.02×10^{6}	3.4
	Cyanide	3.31×10^{4}	-	1.41×10^{5}	-
	Ethylbenzene	1.31×10^{9}	-	1.1×10^{5}	-
	Naphthalene	2.31×10^{8}	-	1.94×10^{4}	-
	Phenol	3.88×10^{8}	-	3.4×10^{4}	-
	Toluene	1.98×10^{10}	-	1.66×10^{6}	-
	Xylenes	2.85×10^{9}	-	2.39×10^{5}	-

None of the reported groundwater and soil concentrations from the Site exceed the $SSTC_{odour}$ identified for Scenario 1 (Paved Recreation). Concentrations of naphthalene and phenol in groundwater were observed to be greater than the adopted $SSTC_{odour}$ for Scenario 2 (Intrusive Maintenance) receptors at the following locations BH087, BH205, MW10_Coffey, MW15_Coffey and MW7. Furthermore, observations during intrusive Site investigations suggest that relatively small scale excavations or intrusive works have the potential to result in localised odour issues.

The prediction, based on comparison of the $SSTC_{odour}$ with reported Site concentrations, of a slightly elevated risk that odour issues may occur is considered to be consistent with observations during previous investigations and AECOM's experience on other gasworks sites. Odour issues are also considered likely to occur as a result of one or more of the following:

- Compounds not specifically identified in analytical suites may contribute to odour (i.e. there are many hydrocarbon compounds within mixtures of gas works waste that cannot be specifically identified and which may contribute to odour);
- Cumulative effects from chemical mixtures may result in odours even where concentrations of individual compounds are below relevant odour thresholds.

It is expected that remediation of the Site based on derived human health criteria (SSTC) will result in significantly reduced *in-situ* chemical concentrations and thus odour generation will be significantly reduced.

7.2 Visual Amenity

7.2.1 Fill Material

It is noted that observations during previous intrusive works have indicated the presence of highly variable fill material at the Site, including gravel, sand, bricks, timber, slag and steel. Black staining, tar and surface sheen were also noted in the footprint of the former Retort House and Purifying Beds. Under the current Site usage these materials are located beneath concrete/hardstand and do not pose a risk to visual amenity, but the material has potential to impact visual amenity at the Site if exposed.

AECOM also notes (refer to **Section 4.2.4)** that it is a requirement in section 3.5.1 of NSW DEC (2007) *Guidelines for the Assessment and Management of Groundwater Contamination* that "*Where light NAPLs (LNAPLs) or dense NAPLs (DNAPLs) are present in the subsurface they must be removed or treated as much as practicable*". It is noted throughout this report, that DNAPL is referred to as SPGWT.

7.2.2 Potential Sheen Impacts to Surface Water Bodies

Sheen has been reported in a number of groundwater monitoring wells, primarily within the Site in close proximity to locations in which free tar has been reported in groundwater monitoring bores and/or in which SPGWT was noted in borehole logs (see **Figure F8**).

These observations suggest that under the current hydrogeologic regime, although SPGWT is present within the former gasworks footprint, the sheen impacts to groundwater are not laterally extensive.

8.0 Ecological Risk Assessment

8.1 Methodology and Scope

The ecological risk assessment has been undertaken with consideration of the following Australian guidance documents:

- *National Environmental Protection (Assessment of Site Contamination) Measure 1999*, Schedule B(5), Ecological Risk Assessment. (NEPC, 1999c); and
- *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 (ANZECC, 2000).

As required by the NSW EPA, the point of compliance for the purpose of assessing ecological risk is the down hydraulic gradient boundary of the Site. In the absence of any other information, the level of protection of groundwater at the down hydraulic gradient boundary of the Site has been based on the level of protection required for the nearest surface water receptor, Darling Harbour. This approach is consistent with the policies of the NSW EPA, in particular:

- The *Contaminated Land Management (CLM) Act* (1997), section 9, which requires adoption of the precautionary principle where the lack of scientific certainty is not a reason for postponing measures. With respect to the Site, this relates to the protection of groundwater dependant ecosystems down hydraulic gradient of the Site and the requirement for remediation to the extent practicable (even in the absence of data demonstrating the presence, or otherwise, of such ecosystems now, or in the future).
- The Department of Environment and Conservation NSW (now the NSW EPA) *Guidelines for the Assessment and Management of Groundwater Contamination*, March 2007, section 1, which reemphasise the requirements of the *CLM Act* (1997) requiring protection of groundwater ecosystems according to the precautionary principle.
- The *ANZECC 2000 Water Quality Guidelines*, section 1, require that the protection of underground aquatic ecosystems and their novel fauna require the highest level of protection.
- The *National Environment Protection Measure Schedule B(6)* (NEPC, 1999) which states that determination of the point of use of groundwater is a juristical matter and that the transfer of contaminated groundwater from a contaminated Site is not considered to be acceptable , even if the relevant guidelines are achieved at the point of use / discharge.

In accordance with application of the EPA policy and directions as described above , the scope of work for the ecological risk assessment comprised the following:

- Identification of appropriate ecological receptors, including consideration of both terrestrial and aquatic ecosystems (including groundwater dependant ecosystems).
- Identification of relevant marine water quality criteria (MWQC) from a nationally adopted hierarchy of acceptable guidance documents plus consideration of additional international sources based on the protection of the nearest surface water receptor, Darling Harbour.
- Identification of potential risk associated with the CoPC based on the comparison of the concentration of CoPC (reported both within the Site and at the Site boundary) with the adopted MWQC.
- Assessment of whether (or not) the concentrations of CoPC within the Site and at the down hydraulic gradient Site boundary represent a risk to groundwater dependant ecosystems.

The assessment includes groundwater concentrations both within the Site and at the Site boundary in consideration of uncertainties regarding whether existing groundwater monitoring results are representative of groundwater leaving the Site boundary (refer to **Section 3.3**).

In accordance with ANZECC (2000), exceedances of the MWQC should be interpreted as indicating that there is a potential for adverse risks to ecological receptors that require further consideration. Further consideration as to the extent of remedial works required to mitigate the identified risks will be made as part of a separate report describing the extent of remediation to the extent practicable.

8.1.1 Chemicals of Potential Concern

As discussed in **Section 4.3**, the CoPC considered within this HHERA (and therefore considered in the ecological risk assessment) are those defined within the NSW EPA Declaration, as follows:

- PAHs: acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, and pyrene.
- BTEX: benzene, toluene, ethylbenzene and xylenes.
- TPH.
- Ammonia.
- Phenol.
- Cyanide.

8.2 Background

8.2.1 Terrestrial Habitat

The Site currently comprises paved open space with minimal terrestrial organisms. The Site and surrounding terrestrial area have been extensively developed, contain minimal natural vegetation and do not contain threatened or vulnerable terrestrial species, populations, communities or significant habitats (NSW DOP, 2007). The terrestrial habitat at the Site is considered to have a low level of environmental sensitivity.

It is considered that an assessment of the potential for Site related contamination to impact the current limited terrestrial environment is not warranted, as these species are currently healthy and have been present in their current location for 20 years or longer. Therefore, no further assessment of the terrestrial habitat has been undertaken.

8.2.2 Aquatic Habitat

8.2.2.1 Groundwater

There has been no testing conducted of the groundwater and sediments beneath the Site to determine if groundwater dependant ecosystems exist. It is understood in NSW and Australia, that little is known and understood about these ecosystems and their novel fauna. The lack of scientific knowledge is not considered to be reasonable grounds for not considering that there may be groundwater dependant ecosystems present at a given Site, whether currently or in the future.

As outlined in **Section 8.1** above, the NSW EPA has directed that the point of compliance for the assessment of ecological risk is at the down hydraulic gradient Site boundary, in order to be protective of such groundwater dependant ecosystems.

8.2.2.2 Surface Water

The closest surface water aquatic ecological receptor/receiving environment is Darling Harbour located to the west of the Site, beyond the ORWN Area. Darling Harbour and the adjacent Sydney Harbour are highly urbanised estuaries. Sydney Harbour is used for a mixture of purposes including recreational purposes such as boating, swimming and fishing and for commercial purposes including cargo and passenger transport. The area of Darling Harbour to the north of the Site currently serves as a temporary passenger terminal for cruise vessels.

Surface Water

Surface water quality in Darling Harbour has not been extensively investigated to AECOM's knowledge. Analytical results for a sample of surface water collected from a stilling well adjacent the Site as part of the groundwater discharge study (AECOM, 2010d) did not indicate the presence of metals above ANZECC (2000) trigger values for marine water. PAHs or other hydrocarbons were not reported above laboratory detection limits.

Sediment

Surface sediments within Sydney Harbour have been reported to contain elevated levels of heavy metals, pesticides and PAHs (Irvine and Birch, 1998; Birch and Taylor, 1999; Birch and Taylor, 2000; McReady et al, 2000), presumably as a result of the urbanised and industrial history of the surrounding area, including the former gasworks (AECOM 2010c).

Based on observations of the benthic sedimentary environment adjacent to the Site (as reported by ERM, 2008b), the benthic sedimentary habitat near the Site contains anthropogenic debris including chains, bricks, steel and old fencing. Sandstone rock armour was observed on the surface of the harbour floor within 10 m of the wharf edge and minimal shell fragments or organic matter were reported in the upper 1.2 m of sediment.

PAH concentrations reported in sediments directly adjacent to Barangaroo (i.e. sediments that may be impacted by Barangaroo-derived contaminants) (ERM, 2008) and in sediments within regional sampling locations within Sydney Harbour (McReady et. al. 2006) are summarised in the **Table 28** below. The results are also compared with ANZECC (2000) interim sediment quality guideline (ISQG) trigger values for sediment.

Reported concentrations of PAHs in sediments adjacent Barangaroo were higher than those reported in other regional locations; however maximum and mean concentrations were generally within the same order of magnitude as regional concentrations. **Table 28** below indicates that the PAH concentrations were marginally elevated in sediment adjacent to Barangaroo, but significantly elevated concentrations of PAHs in sediments have not been reported.

Table 28 PAHs and Metals in Sediments adjacent to Barangaroo and in Regional Samples (Sydney Harbour)

Chem	ERM (2008) Sediment Data (Adjacent site)				Sydney Harbour Regional Data (McReady et al 2006)					ISQG Low – ISQG High
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev		
PAHs										
ACE	0.005	9.36	0.29	1	0.006	0.33	0.092	0.88	(a)	0.016 – 0.5
ACY	0.015	37.3	1.5	4.2	0.012	5.78	0.6	0.74	(a)	0.044 – 0.64
ANT	0.011	56.5	2	6.4	0.012	3.18	0.66	0.70	(a)	0.085 – 1.1
BAA	0.031	80	3.6	9.1	0.019	8.78	1.8	2.2	(a)	0.261 – 1.6
BAP	0.01	59.2	3.2	6.8	0.011	11.2	2.4	2.7	(a)	0.43 – 1.6
BBF	0.051	63.8	3.5	7.3	0.119	12.8	3	3.4	(b)	--
BEP	0.028	29.7	1.6	3.4	0.023	5.01	1.1	1.2	(a)	--
BGP	0.054	26.3	1.6	3.1	0.032	7.86	1.5	1.8	(a)	--
BKF	0.027	22.4	1.5	2.6	0.026	16.5	1.5	2.2	(a)	--
CHR	0.028	53.6	2.7	6.1	0.012	9.37	1.9	2.1	(a)	0.384 – 2.8
DAH	0.019	8.52	0.64	1.1	0.021	1.76	0.29	0.34	(a)	0.063 – 0.26
FLT	0.054	185	8	21	0.121	16.2	4.1	4.7	(a)	0.6 – 5.1
FLU	0.005	22.4	0.78	2.6	0.011	0.731	0.15	0.15	(b)	0.019 – 0.54
ICDP	0.048	23.6	1.5	2.8	0.03	6.34	1.3	1.6	(a)	--
NAP	0.013	3.35	0.37	0.47	0.016	1.10	0.22	0.21	(a)	0.16 – 2.1
PHE	0.02	146	5	17	0.013	7.47	1.4	1.8	(a)	0.24 – 1.5
PYR	0.055	139	6.4	16	0.161	233	4.9	5.9	(b)	0.665 – 2.6
Sum PAH	0.528	992	46	113	0.668	361	28.5	35.2	(c)	4 – 45

Notes:

- ACE: acenaphthene; ACY: acenaphthylene; ANT: anthracene; BAA: benzo(a)anthracene; BAP: benzo(a)pyrene; BBF: benzo(b)fluoranthene; BEP: benzo(e)pyrene; BGP: benzo(g,h,i)perylene; BKF: benzo(k)fluoranthene; CHR: chrysene;

DAH; dibenzo(a,h)anthracene; FLT: fluoranthene; FLU: fluorene; ICDP: indeno(1,2,3-cd)pyrene; NAP: naphthalene; PHE: phenanthrene; PYR: pyrene; Sum PAH: Sum of PAHs

- (a) Statistical results include values in Sydney Harbour, Cooks River and NSW south coast estuaries and lakes (n=103).
- (b) Statistical results based on Sydney Harbour samples only (n=69).
- (c) Statistics for Sum of PAHs not reported by McReady et al (2006). Values are sums of each statistical measure for individual PAHs.
- -- No published ISQG High or Low available.

Worley Parsons (2010) reported that a diverse range of benthic marine organisms were identified in sediments adjacent to Barangaroo and other Harbour study sites and that soft sediment habitat is available throughout Darling Harbour. The report also commented on the high level of boating activity and lack of suitable aquatic feeding and nesting habitat at Barangaroo, as well as the low likelihood that any species of threatened fauna utilise this area and the relative absence of known top marine fauna such as fish and sharks.

However, the fact that a range of benthic marine organisms were identified in sediments from the Barangaroo area and that soft sediment habitat is present, means that improvement of the waterway consistent with the management goals for the catchment is practical and that remediation is an important component of ecological improvement over time.

The conceptual site model is presented in **Figure F6** in **Appendix B**.

8.2.3 Protection of Groundwater Dependant Ecosystems

The determination of potential risks to the environment requires consideration of the potential for risks to be posed to groundwater dependant ecosystems and their novel fauna. This is in accordance with the requirements of the NSW EPA which require that the level of protection of groundwater at the down hydraulic gradient boundary of the Site is based on the level of protection required for the nearest surface water receptor, Darling Harbour.

The *National Environment Protection Measure Schedule B(6)* (NEPC, 1999) states that:

- groundwater is considered contaminated when it is not suitable for its current or realistic future use and/or presents an unacceptable risk to the environment in the discharge environment;
- the relevant guideline values are used to define acceptable water quality at the point of use; and
- this interpretation is not intended to infer that the transfer of contaminated groundwater from a contaminated site is acceptable - even if the relevant guidelines values are achieved at the point of use, and.
- the point of use is a juristical matter.

The ANZECC (2000) guidelines apply to both groundwater and surface water. Groundwater needs to be managed in such a way that it will not cause established water quality objectives to be exceeded (refer to **Section 8.4**).

8.2.4 Management Objectives for Darling Harbour

Guidance from the NSW EPA (NSW DECCW (2010)) indicates that although Darling Harbour is classified as a waterway affected by urban development, the applicable aquatic ecosystem management objectives are:

- protection of aquatic ecosystems;
- protection of visual amenity; and
- achievement of secondary contact recreation and primary contact recreation quality goals over a period of some five years.

These publicly available objectives are considered to reflect community expectations about the harbour.

The aim of the NSW EPA guidance is to make aquatic ecosystems as healthy as possible. It notes that, although a return to natural aquatic ecosystems may be impractical in the short term, an improvement in ecological health is desirable and necessary.

The NSW EPA has therefore requested that in order to meet the objective outlined above the following protection objectives should apply to the down hydraulic gradient Site boundary (which will also be protective of Darling Harbour):

- to reduce impacts to Darling Harbour to a level in keeping with the status ‘slightly to moderately disturbed’; and
- that the concentrations of Site contaminants reaching the receptor do not exceed:
    - ANZECC (2000) 95% species protection marine trigger values;

- ANZECC (2000) 99% species protection marine trigger values for potentially bioaccumulative contaminants; or
- other appropriate guideline values described in **Section 8.4** which provide a similar level of ecological protection to the ANZECC (2000) trigger values.

8.3 Conceptual Site Model

The Site layout is presented in **Figure F2** in **Appendix B**. The Site is currently vacant and consists of roadway (Hickson Road), concrete slab and limited plantings. The shortest distance to the most sensitive ecological receptor, Darling Harbour is approximately ninety meters, with the maximum distance being one hundred and thirty meters (refer to **Section 2.2**).

Groundwater is present at the Site at a depth of approximately 2 mbgs. As there are no sensitive terrestrial receptors identified on the Site (see **Section 8.2.1** above), the consideration of Site related CoPC within soil will be based on the potential for chemicals in soil to leach into groundwater only. A conceptual layout of the Site is shown in **Figure F6** in **Appendix B**.

8.4 Marine Water Quality Protection

As noted in the *National Environment Protection Measure Schedule B(6)* (NEPC, 1999), outlined in **Section 8.2.3**, the relevant guideline for the protection of groundwater is based on protection of potential current and future groundwater dependant ecosystems which require the highest level of protection in accordance with the ANZECC 2000. It is considered that this approach will also be protective of surface water quality at Darling Harbour.

Therefore, Tier 1 screening criteria relevant to protection of aquatic ecological receptors within Darling Harbour are those published by ANZECC (2000) for assessment of surface water and sediment have been adopted based on the most appropriate level of protection, specifically:

- Groundwater and surface water: ANZECC (2000) trigger values for marine water (95% protection level). Low reliability trigger values have been adopted where no other value is available; and
- Groundwater and surface water: ANZECC (2000) trigger values for marine water (99% protection level) for chemicals with the potential to have bioaccumulative impacts. Low reliability trigger values have been adopted where no other value is available.

In addition, where ANZECC (2000) guidelines did not include appropriate criteria, the following secondary sources were adopted:

- CCME (1999) Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg, and
- Oakridge (Suter and Tsao, 1996) Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota, 1996 Revision. Risk Assessment Program Health Sciences Research Division. US Department of Energy Office of Environmental Management. Tier II Secondary Chronic Values. June.

The selected MWQC are summarised in **Table 29.** These guidelines were used in selection of CoPCs (refer to **Section 8.4.1**) and assessment of ecological risk.

Table 29 Marine Water Quality Criteria

Analyte	Criteria (µg/L)	Source
Low MW PAHs		
Acenaphthene	5.8	CCME (1999) Freshwater Guideline
Acenaphthylene	5.8	Adopted criteria for Acenaphthene as surrogate
Anthracene	0.1 [a]	ANZECC (2000) 99% Marine Water Trigger Value (0.01 µg/L) identified to be lower than LOR.
Fluorene	3	CCME (1999) Freshwater Guideline
Naphthalene	70	ANZECC (2000) 95% Marine Water Trigger Value, moderate reliability
Phenanthrene	0.6 [a]	ANZECC (2000) 99% Marine Water Trigger Value
High MW PAHs		
Benz(a)anthracene	0.1 [a,b]	Value for high molecular weight PAHs is based on the ANZECC (2000) 99% low reliability Marine Water Trigger Value for Benzo(a)pyrene.
Benzo(a)pyrene		
Benzo(b)fluoranthene		
Benzo(g,h,i)perylene		
Benzo(k)fluoranthene		
Chrysene		
Dibenz(a,h)anthracene		
Indeno(1,2,3-c,d)pyrene		
Fluoranthene	1	ANZECC (2000) 99% Marine Water Trigger Value
Pyrene	0.025 [a]	CCME (1999) Freshwater Guideline
Other Organics		
Phenol	400	ANZECC (2000) 95% Marine Water Trigger Value
Petroleum Hydrocarbons		
Benzene	700	ANZECC (2000) 95% Marine Water Trigger Value, moderate reliability
Ethylbenzene	80	ANZECC (2000) 95% Fresh Water Trigger Value, low reliability
Toluene	180	ANZECC (2000) 95% Marine Water Trigger Value, low reliability
Xylene (m & p)	75	ANZECC (2000) 95% Marine Water Trigger Value, low reliability for *m*-xylene.
Xylene (o)	350	Adoption of the ANZECC (2000) 95% Marine Water Trigger Value, low reliability for xylene (o).
TPH C_6 - C_9	110	CCME (2008a Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil – Table B-9 values for TPH C_6 to C_8 and $C^{>}_8$ to C_{10}. Criteria calculated from a weighted average assuming a Coal Tar composition of 25% aliphatic and 75% aromatic components
TPH C_{10} - C_{14}	40	CCME (2008a) Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil – Table B-9 values for TPH C>10 to C12 and $C_{>12}$ to C_{16}. Criteria calculated from a weighted average assuming a Coal Tar composition of 25% aliphatic and 75% aromatic components
TPH C15-C28	100	No guidelines values available, therefore the standard laboratory Limit of Reporting (LOR) has been adopted. Refer also to **Section 8.5.2**

Analyte	Criteria (µg/L)	Source
TPH C29-C36	50	No guidelines values available, therefore the standard LOR has been adopted. Refer also to **Section 8.5.2**
Ammonia		
Ammonia as N	4830	ANZECC (2000) 95% Marine Water Trigger Value, moderate reliability, calculated at pH 6.7 statistical distribution method, based on reported average pH (Lab) concentration of 6.7.
Cyanide		
Cyanide	4	ANZECC (2000) 95% Marine Water Trigger Value, moderate reliability

Notes:
(a) It is noted that these MWQC are less than the laboratory standard LOR. The laboratory standard LOR will be adopted in place of the MWQC where: (i) analysis of these chemicals is required; or, (ii) where the MWQC are considered in derivation of risk based criteria. This approach is consistent with Section 3.4.3.2 and Section 8.3.5.4 of ANZECC (2000) and has been agreed with the Auditor and the NSW EPA. It is noted that it is not practical to use the laboratory ultra-trace LOR because: (i) the high salinity present in the water (particularly in areas close to the harbour) will cause interferences in the reporting of some analytes and therefore an increased LOR; (ii) the presence of other contaminants (matrix interference) will raise the LOR; and (iii) groundwater turbidity can lead to raised LOR.

8.4.1 Identification of Chemicals of Potential Concern

The approach adopted for the assessment of chemicals of potential concern (CoPC) (which have been identified in the NSW EPA Declaration) for the ecological risk assessment is summarised below.

1) Do the chemical concentrations reported in groundwater exceed the adopted MWQC, as presented in **Table 29**?

2) Do the chemical concentrations reported in filtered groundwater exceed the MWQC, as presented in **Table 29**?

In applying this approach, the following points were considered:

- sorption to organic matter is a significant factor in retardation of the fate and transport of PAHs and phenols in both the saturated and unsaturated zone;
- there is a significant potential that PAHs present as suspended solids in groundwater will be mobilised by the sampling process and impact on groundwater analysis results;
- the Laboratory Limit of Reporting (LOR) relative to the MWQC - there is inherent difficulty in analysing PAHs and phenols, for example, in highly saline groundwater samples; and
- if the CoPC concentrations reported in filtered groundwater are less than the MWQC, there is no mechanism for the CoPC to impact on the environment.

Where available, only data from the Site has been considered for the identification of CoPCs. However data from areas surrounding the Site have also been taken into consideration where there is insufficient representative Site data.

8.5 Identification of CoPC based on Groundwater Analysis Data

The comparison of groundwater concentrations present at the Site to the adopted MWQC specified in **Section 8.4** above is presented in **Table T6.**

Data gaps associated with the groundwater monitoring results that are representative of groundwater conditions leaving the Site boundary have been identified in **Section 3.4**. As groundwater monitoring locations are not situated immediately adjacent to the Site boundary (in-particular at the down hydraulic gradient Site boundary which is considered to be the point of compliance for assessment of ecological risk (refer to **Section 8.1**)) a number of groundwater monitoring wells at off-Site locations have also been considered within this risk assessment. The off-Site groundwater wells considered in the ecological risk assessment are presented in **Table 5**.

In addition to the on-Site groundwater monitoring wells, three additional off-Site monitoring wells have been considered within the ecological risk assessment. In the absence of sufficient on-Site groundwater data (refer to **Section 3.4**), these monitoring wells are considered representative of groundwater quality at the down hydraulic gradient boundary of the Site. **Table 6** details the off-Site groundwater screening depths and lithologies.

Data corresponding to these sampling locations is presented in **Table T6** in **Appendix A**.

It is noted that there were no identified ecological screening guidelines for TPH C_{15}-C_{28} and TPH C_{29}- C_{36}. The assessment of TPH is discussed further in **Section 8.5.2** below.

8.5.1 Identification of CoPCs present in the Groundwater Soluble Phase

Additional analyses was undertaken by AECOM as part of the Supplementary VMP DGI (AECOM 2011) to confirm whether potential CoPC identified in groundwater were present in the soluble phase and therefore to better understand the potential mobility and bioavailability of the potential CoPCs. These analyses used groundwater samples derived from locations within the Site. The analyses included:

- Standard (Limit of Reporting) PAH and phenol analysis of unfiltered groundwater samples (here on referred to as unfiltered results);
- Ultra-trace (low level) PAH and phenol analysis of twice laboratory filtered (using 0.45µm filter paper) groundwater samples (here on referred to as “Filtered” results). The Laboratory Limit of Reporting (LOR) for all ultra-trace analysis was less than the MWQC;
- Analysis of the residue retained on laboratory filter papers (“Suspended Material”) from each Filtered sample for PAHs.

The additional analysis was undertaken on groundwater samples from 10 groundwater monitoring wells selected to include more significant contamination identified by the previous investigation works at the Site. The locations of the additional groundwater monitoring wells are presented in **Figure F3** in **Appendix B**. Results of the analysis are presented in **Table T7** in **Appendix A**. Review of the results (refer **Table T7** in **Appendix A**) indicates that:

- PAHs and phenols were detected in all but two unfiltered groundwater samples analysed;
- The concentrations of PAHs reported in the filtered samples were significantly lower than the concentrations reported in the unfiltered samples and were typically less than the MWQC. The concentrations of phenol reported within the filtered samples were marginally lower than those in the unfiltered samples. The exceptions to this were exceedances of the MWQC in the filtrate samples for some low molecular weight PAHs (such as acenaphthene, acenaphthylene, anthracene and naphthalene) and phenol.

The differences in concentrations with filtration are summarised in **Table 30** below. The table presents the range in ratios of the unfiltered sample concentrations to the filtered sample concentrations for the range of individual PAHs and phenols. For example, in Sample IT3S, the concentration of PAHs in the unfiltered samples was between 14 and 76 times greater than the concentration reported in the filtered sample.

Because many of the PAHs and phenol (as discussed above) were not reported to be present above the limits of reporting in the dissolved phase, they are not present at soluble concentrations above the adopted MWQC and do not present a risk to potential groundwater dependant ecosystems within groundwater. Therefore, they have not been identified as CoPC for the purpose of the ecological risk assessment. This approach of comparison of filtered groundwater results is in accordance with the application of the ANZECC guidelines where refinement of the approach of direct comparison of unfiltered data to the ANZECC guidelines (which over-estimates potential risk and is too conservative) is adopted.

Table 30 Reduction in Concentration of PAHs and Phenols in Unfiltered versus Filtered Samples

Sample	Detected PAHs *	Detected Phenol *
IT3S	14 to 76	<LOR
IT3M	10	<LOR
IT3D	4.7 to 418	<LOR
MW198	3.5	<LOR
MW200	1.6 to 2.7	1.8
MW204S	7.8 to 546	<LOR
MW209	5.4 to 62	<LOR
MW210	10.3 to 42	<LOR
MW401	4.1 to 94	2.3
MW62	All < LOR	<LOR

* Values presented are the ratios of the unfiltered sample concentrations to the filtered sample concentrations, and therefore indicate the reduction in concentration due to filtering.

It is also noted that:

- the results of the analysis of the Suspended Material (i.e. filter cake) demonstrate that the difference between the unfiltered and filtered groundwater concentrations can be explained by the contaminant concentrations reported in the suspended material (i.e. mass balance was achieved between between the mass of chemical present in the unfiltered sample and that present in the filtrate and filter cake;
- high molecular weight PAHs (specifically: benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno (1,2,3-cd)pyrene, and pyrene) were not detected above the MWQC in any of the Filtered samples. One sample (MW200) exhibited matrix effects with elevated LOR marginally above the MWQC;
- these findings are consistent with the published chemical properties of benzo(a)pyrene (and the other high molecular weight PAHs) which are not considered as leachable / mobile if bound to soil/sediment based on its reported log Kow >3.7 / log Koc >3.95 (based on Heemsbergen D, *et al* 2009);
- phenol was detected above the MWQC in one Filtered sample only (MW200). These findings are consistent with the published chemical properties of this chemical; It is also noted that MW200 is located in the centre of the Site and groundwater between this location and the Site boundary was not observed to contain phenol concentrations exceeding the adopted screening value for phenol.
- PAHs and phenol which are bound in the solid phase are less bioavailable to potential groundwater dependant ecosystems than those in the dissolved phase because they are likely to be tightly bound in the solid matrix;
- because the listed PAHs are not present in the dissolved phase they are not considered to be bioavailable to potential groundwater dependant ecosystems and subsequently marine ecological receptors within Darling Harbour.

Based on the review described above, AECOM considers those chemicals which are present within groundwater (filtered) above the adopted MWQC as potential CoPC.

8.5.2 Consideration of TPH as a CoPC

TPH as reported by analytical laboratories is complex mixture of potentially hundreds of compounds which are solvent extractable and are responsive to the detector employed. The concentrations of TPH reported within the Site are likely to be a combination of multiple chemicals - mostly associated with coal tar based on the historical use of the Site as a gas works.

Further consideration has been given to the question of TPH presence at gasworks sites. According to ATSDR (2002):

Coal tars are complex combinations of polycyclic aromatic hydrocarbons (PAHs), phenols, heterocyclic oxygen, sulfur, and nitrogen compounds. PAH composition of coal tars is variable. Analyses of PAHs in four coal tar samples revealed 2- to 20-fold differences in concentration of selected PAHs among the samples. For example, benzo[a]pyrene ranged from non-detectable levels to 1.7, 3.9, and 6.4 g/kg of coal tar. By comparison, coal tar creosotes have an oily liquid consistency and range in color from yellowish-dark green to brown. The coal tar creosotes consist of PAHs and PAH derivatives. At least 75% of the coal tar creosote mixture is PAHs. Coal tar pitch is a shiny, dark brown-to-black residue that contains PAHs and their methyl and polymethyl derivatives, as well as heteronuclear compounds.

Coal tar creosotes, coal tar, coal tar pitch, and coal tar pitch volatiles are composed of many individual compounds of varying physical and chemical characteristics. In addition, the composition of each, although referred to by specific name (e.g., coal tar creosote) is not consistent. For instance, the components and properties of the mixture depend on the temperature of the destructive distillation (carbonization) and on the nature of the carbon-containing material used as a feedstock for combustion.

In consideration of these definitions, the following observations can be made:

- there is a general expectation that PAHs have a much higher molar toxicity than the other substances that will be routinely quantified in a TPH analysis. Therefore, a focus on PAHs is likely to address both the class of compounds that is among the most abundant in coal tar and among the most toxic; and
- since the TPH concentrations measured at a gasworks typically reflect an underlying composition that is substantially different than that of various new or used petroleum products (on which TPH guidelines are typically based), it is difficult to place the numbers in a meaningful context: the values cannot be compared to toxicological thresholds based on experimental or field exposures to petroleum whole products or constituents.

Review of TPH chromatograms for representative soil and groundwater samples from Barangaroo South by the analytical laboratory (**Appendix I**) suggests that:

- the observed profiles are representative of those typically associated with coal tar;
- the general character of the samples is more aromatic than a typical fresh petroleum hydrocarbon product as the aliphatic component appears negligible;
- the profiles variously include BTEX, various alkylated benzenes, phenol, alkylated phenols, PAHs, and alkylated PAHs; and
- more than 50% of the sample is typically comprised of compounds not targeted by standard PAH, BTEX or phenols analysis.

In consideration of these observations, AECOM considers the elevated concentrations and widespread distribution of TPH requires further ecological risk characterisation to ensure compounds not targeted by the standard PAH, BTEX and phenols analysis are appropriately identified and assessed.

8.5.3 Identification of CoPCs based on Leachate Analysis Data

There have been a number of assessments of the potential for Site related contamination present within soils to leach at the Site.

Analyses undertaken by AECOM as part of the Supplementary VMP DGI (AECOM 2011) provided further confirmation of whether or not a particular contaminant is leachable, particularly in cases where the groundwater screening criteria is at or near the laboratory standard LOR. This leachate testing was undertaken using a neutral leachate solution, which is considered to be the most appropriate analysis method to simulate any leaching effects of soils *in-situ* from the infiltration of rain and surface water at the Site.

Results of the leachate analysis is presented in **Table T8** in **Appendix A**. The additional analysis included ultra-trace (low level) neutral leachate testing of PAH, phenols, BTEX, and inorganics. The laboratory limits of reporting (LOR) for all ultra-trace analysis were less than the adopted MWQC. The results of these analyses were also used to predict the potential leaching relationship between soil and groundwater. The additional ultra trace leachate analyses were undertaken on soil samples from the Site and Public Domain areas which exhibited evidence of gasworks contamination.

The results of the VMP DGI (AECOM, 2011) indicated:

- cyanide was not detected above the LOR in leachate samples. While it is noted that the laboratory LOR was equal to the MWQC, it is not considered to be a CoPC because numerous studies have demonstrated that the most dominant species of cyanide present in soil and groundwater at former gasworks sites are the relatively nontoxic strong metal-cyanide complexes (primarily the iron-complexed species). These studies have demonstrated that free cyanide is generally not detectable in soils or groundwater collected from former gasworks sites, and this is also the case at the Site. The presence of significant concentrations of iron in soil and groundwater at the Site suggest that the majority of the cyanide present at the Site would be bonded to iron, forming comparatively non-toxic complexes;
- high molecular weight PAHs exhibited very limited, if any, leachability, however it is noted that higher molecular weight PAHs are not present in groundwater filtrate and therefore, as presented in **Table 31** below, they are not considered further as potential CoPCs.
- in 4 out of the 10 samples the laboratory was unable to achieve the ultra-trace LOR. Matrix effects, possibly related to seawater salinity effects and/or the presence of organic compounds, interfered with (raised) the achievable LOR;
- of the organics listed above, anthracene, acenaphthalene, fluoranthene, fluorene, naphthalene, phenanthrene and pyrene exhibited leaching behaviour. It should be noted that pyrene has been excluded as a potential CoPC above as it is not present in the soluble phase (i.e. within filtered groundwater).

8.5.4 Selected CoPC

Based on the review described above, **Table 31** below presents a summary of those chemicals which require further consideration in the ecological risk assessment.

Table 31 Identification of CoPC in Groundwater for the Purpose of the Ecological Risk Assessment

Chemical	Exceeds MWQC (✓ / ×)	Exceeds MWQC in Filtered Samples(✓ / ×)	Selected CoPC
Low Molecular Weight PAHs			
Acenaphthene	✓	✓	✓
Acenaphthylene	✓	✓	✓
Anthracene	✓	×	✓ (b)
Fluorene	✓	×	✓ (b)
Naphthalene	✓	✓	✓
Phenanthrene	✓	×	✓ (b)
High Molecular Weight PAHs			
Benz(a)anthracene	✓	×	×
Benzo(a)pyrene	✓	×	×
Benzo(b)fluoranthene	✓	×	×
Benzo(g,h,i)perylene	✓	×	×
Benzo(k)fluoranthene	✓	×	×
Chrysene	✓	×	×
Dibenz(a,h)anthracene	✓	×	×
Indeno(1,2,3-c,d)pyrene	✓	×	×
Fluoranthene	✓	×	×
Pyrene	✓	×	×
Phenol			
Phenol	✓	✓	✓

Chemical	Exceeds MWQC (✓ / ×)	Exceeds MWQC in Filtered Samples(✓ / ×)	Selected CoPC
Low Molecular Weight PAHs			
Petroleum Hydrocarbons			
Benzene	✓	Not applicable (a)	✓
Ethylbenzene	✓		✓
Toluene	✓		✓
Xylene (m & p)	✓		✓
Xylene (o)	✓		✓
TPH C6 - C9	✓		✓
TPH C10 - C14	✓		✓
TPH C15-C28	✓		✓
TPH C29-C36	✓		✓
Inorganics			
Ammonia as N	✓	Not applicable (a)	✓
Cyanide	✓		× (See **Section 8.5.3)**

Note:
a. It is noted that filtered groundwater analysis was only performed for PAHs and Phenols. The other potential CoPC have been retained on the absence of filtrate data.
b. Whilst anthracene and fluorene were not present in the filtered groundwater samples they have been included as a CoPC as they are considered to be a lower molecular weight PAH and have the potential to be present within the soluble phase

8.6 Ecological Risk Assessment

8.6.1 Nature and Frequency of CoPC across the Site

The exceedances of groundwater monitoring concentrations within the Site and at the down-hydraulic gradient Site boundary of the adopted MWQC are presented in **Table T6** in **Appendix A** and are identified in **Figure F7** in **Appendix B**.

8.6.2 Mixtures

The assessment of potential exposures to mixtures of chemicals has not been undertaken within this assessment.

8.6.3 Conclusions

MWQC have been selected as suitable screening criteria that are protective of the environment. Based on consultation with the NSW EPA, the assessment of ecological risk is based on whether groundwater concentrations within the Site and at the Site boundary exceed the MWQC (refer to **Section 8.2.3**), in order to protect groundwater dependant ecosystems which may be present down hydraulic gradient of the Site boundary currently or in the future.

CoPC considered by the ecological risk assessment are based on those chemicals identified in the NSW EPA Declaration and the considerations of **Section 8.5.**

It is noted that the analytical composition of chemicals of potential concern within the Site are: (a) consistent with those expected in association with historic gasworks; and, (b) similar in composition to those reported in areas down hydraulic gradient of the Site (ORWN), suggesting that impacted groundwater is migrating off Site.

Exceedances of the MWQC have been identified in groundwater within the Site and at the Site boundary, indicating an unacceptable risk to the environment.

Based on the identified MWQC exceedances, remediation is required to minimise the risk of adverse impact to the environment. The assessment of remedial requirements to address this adverse risk will be discussed within the *VMP Remediation Extent* Report, (AECOM 2012b).

9.0 Uncertainties

9.1 Human Health

Risk assessments and development of health risk-based soil and groundwater criteria involve a number of assumptions regarding Site conditions, human exposure and chemical toxicity. These assumptions are based on Site-specific information (where available), but it is not always possible to fully predict or describe Site conditions and human activities at a Site for the exposure period considered in the risk assessment. The assumptions adopted for this risk assessment have therefore been selected to be conservative in nature, in order to evaluate an assumed reasonable maximum exposure scenario and provide a deliberate margin of safety.

A more detailed discussion of some of the uncertainties associated with different components of the risk assessment process is provided in the following sections.

9.1.1 Sampling and Analysis

Data collected from the Site have been based on the knowledge of the Site history and hydrogeological conditions. The laboratory analytical schedule has also been selected based on a knowledge of former site activities and hence has focussed on chemicals which were known or expected to be present at, or to have been formerly used at, the Site. There is the potential for chemicals to be present on the Site which have not been characterised based on omission from site history records.

Overall, the data utilised in this risk assessment are considered to be representative of environmental conditions at the Site at the time of sampling.

The identification of CoPC in groundwater has considered use of current guidelines that are based on the more conservative endpoint of drinking water. While not all adopted guidelines specifically address vapour migration and intrusion issues, the guidelines are designed to be protective of all uses and exposure pathways (including volatilisation). The approach adopted, however, is considered appropriate for the identification of key chemicals that warrant more detailed assessment.

9.1.2 Human Exposure Parameters

Risk assessments require the adoption of several assumptions in order to assess potential human exposure. This risk assessment includes assumptions about general characteristics and patterns of human exposure relevant to the Site and surrounding areas. The assumptions used are conservative and developed to provide an estimate of reasonable maximum exposures rather than the actual exposures. This approach tends to overestimate the risks.

It is also noted that a number of the exposure guideline values derived from enHealth (2004) and NEPC (1999a) tend to be conservative as they are designed to be protective of the most highly exposed members of the population and their use may lead to an overestimation of risk for the majority of receptors.

9.1.3 Vapour Transport Modelling

The assumptions adopted for vapour transport modelling are generally considered to be conservative and likely to overestimate actual vapour concentrations at the Site. The use of a model requires the simplification of many complex processes in the subsurface. To address this simplification, the vapour models available (as adopted in this HHERA) are considered to be conservative such that uncertainties are addressed through the overestimation of actual concentrations.

It should be noted that the vapour model used is designed to be a first tier screening tool (Johnson and Ettinger, 1991) and is considered likely to overestimate air concentrations (and associated risks) due to the incorporation of a number of conservative assumptions, including the following:

- Chemical concentrations in soil and groundwater were assumed to remain constant over the duration of exposure (i.e. it was assumed that the source was non-depleting and not subject to natural biodegradation processes).
- Equilibrium partitioning between chemicals in soil or groundwater and chemical vapours in the source zone was assumed.
- Steady-state vapour and liquid-phase diffusion through the vadose zone was assumed.
- No biodegradation or loss of chemical during diffusion towards the ground surface with slab on grade has been considered. Biodegradation effects have been considered for paved areas of the Site.
- Steady, well mixed dispersion of emanating vapours within the ambient mixing space is assumed.

Overall, the vapour model is expected to provide an over-estimation of the actual vapour exposure concentrations. Further, where Site-specific input parameters were not available, conservative estimates for some input parameters were used which may lead to an over-estimation of risk.

9.1.4 Toxicity Assessment

In general, the available scientific information is insufficient to provide a thorough understanding of all of the potential toxic properties of chemicals to which humans may be exposed. It is necessary, therefore, to extrapolate these properties from data obtained under other conditions of exposure and involving experimental laboratory animals.

This may introduce two primary types of uncertainties into the risk assessment, as follows:

- those related to extrapolating from one species to another; and
- those related to extrapolating from the high exposure doses, usually used in experimental animal studies, to the lower doses usually estimated for human exposure situations.

The majority of the toxicological knowledge of chemicals comes from experiments with laboratory animals, although there may be interspecies differences in chemical absorption, metabolism, excretion and toxic response. There may also be uncertainties concerning the relevance of animal studies using exposure routes that differ from human exposure routes. In addition, the frequent necessity to extrapolate results of short-term or sub-chronic animal studies to humans exposed over a lifetime has inherent uncertainty.

In order to adjust for these uncertainties, ADIs and RfDs incorporate safety factors that may vary from 10 to 1000.

Further, the USEPA assumes that humans are as sensitive to carcinogens as the most sensitive animal species. The policy decision, while designed to minimise the potential for underestimating risk, introduces the potential to overestimate carcinogenic risk. Conversely, it also does not allow for the possibility that humans may be more sensitive than the most sensitive animal species. The model used by the USEPA to determine slope factors is a linearised multistage model, which provides a conservative estimate of cancer risk at low doses and is likely to overestimate the actual slope factor. It is assumed in this approach that a genotoxic mechanism applies, however, most carcinogens do not actually cause cancer by this mechanism.

The result is that the use of slope factors has the general effect of overestimating the incremental cancer risks.

The approach for evaluating risks to mixtures of chemicals assesses dose additively and does not account for potential synergism, antagonism or differences in target organ specificity and mechanism of action. In general, the additive approach has the effect of overestimating the risks. This is because chemicals that have no additive effects are included together as well as chemicals that may have additive effects.

Uncertainties in deriving toxicity values for TPH fractions also incorporate a number of uncertainties and assumptions including:

- the composition of the TPH fractions present at the Site may vary from the surrogate chemical or chemical mixture upon which adopted toxicity criteria are based; and
- the composition of the TPH fractions present at the Site may change with weathering in the environment.

9.1.4.1 Dermal Assessment

9.1.4.1.1 PAHs

The assessment of dermal toxicity associated with exposure to carcinogenic PAHs in soil has been assessed using the Knafla et al (2005) dermal cancer slope factor of 25 mg/kg/day^{-1}. This factor was not adopted in the assessment of exposure risks associated with dermal contact to groundwater as it is not expected that excavations and trenches will readily fill with water over a day of maintenance.

If the Knafla et al (2005) dermal slope factor is adopted for benzo(a)pyrene and for other carcinogenic PAHs in groundwater , it will reduce the SSTC by 60-fold, as shown in **Appendix J**.

Table 32 Sensitivity Analysis – Dermal Slope Factor for Carcinogenic PAHs (Scenario 2 only)

Carcinogenic PAH	Groundwater SSTC (mg/L)	
	Based on NHMRC (2004) CSF	Based on Knafla et al (2006) CSF
cPAH/ Benzo(a)pyrene	1	0.0173

Derivation of a groundwater SSTC for BaP using the Knafla dermal slope factor generates an SSTC of 0. 0173 mg/L in contrast to the SSTC of 1 mg/L derived using the NHMRC (2004) cancer slope factor. While the difference in SSTCs is significant (a 60 fold reduction), it is considered unnecessarily conservative considering the current average depth to groundwater across the site is greater than 2mbgs. It is considered that whilst a trench has been modelled to fill with groundwater during maintenance, this will not be a common scenario within the VMP HHERA Site boundary.

9.1.4.1.2 Volatile Organic Compounds

The assessment of dermal absorption for volatile compounds such as BTEX was not conducted as it is considered that most studies involving dermal absorption assessment lead to artificially high absorption values and in reality these compounds are anticipated to volatilise readily from the skin (USEPA Region III, 1995).

It is noted that the USEPA Region III (1995) suggest dermal absorption factors of 0.05% for benzene and 3% for other volatile compounds such as toluene, ethylbenzene and xylene.

A comparison of the assessment of potential risks incorporating the dermal absorption factors is illustrated in **Table 33** below. For comparative purposes, a default absorption value of 3% was adopted for BTEX.

Table 33 Comparison of Calculated Risks with the inclusion of dermal absorption factors for volatile chemicals

Pathway	Calculated Threshold Risk	Calculated Non-Threshold Risk
Dermal contact with soil (no absorption of volatile chemicals)	1.26	9.6×10^{-5}
Dermal contact with soil (volatile absorption)	1.27	9.6×10^{-5}
Dermal contact with groundwater (no absorption of volatile chemicals)	127	1.34×10^{-4}
Dermal contact with groundwater (volatile absorption)	127	1.34×10^{-4}

Table 33 demonstrates that the contribution of the dermal absorption factors to the total risk estimation pathways adopted by the intrusive maintenance worker assessment (which is the only exposure pathway where direct contact with soil and groundwater has been considered) is negligible.

9.1.4.2 Potential Background Exposure to CoPC

When evaluating potential health effects or deriving health-based investigation levels for chemicals assessed on the basis of a threshold dose-response criteria, total exposure to a given chemical (i.e. the sum of the background exposure and the substance exposure from contaminated media) should not exceed the TDI (enHealth, 2004; NEPC, 1999a). As background intakes have not been accounted for in the derivation of human health based SSTC for this HHERA, background concentrations of volatile CoPC (where available) have been compared to RfCs adopted for assessment of threshold inhalation health effects in **Table 34** below. Only background air concentrations of CoPC have been evaluated, since the primary exposure pathway of concern for the human health based SSTC derived in this HHERA is the vapour inhalation pathway.

Table 34 Comparison of Urban Background Concentrations of CoPC to Adopted RfCs

Chemical	Adopted RfC (mg/m^3)	Typical Urban Air Background Concentration (mg/m^3)	Background/RfC Ratio	Source of Background Concentration
Acenaphthene	0.21	< 0.0000045	<0.001	DEC (2004) [1]
Acenaphthylene	0.21	< 0.0000045	<0.001	DEC (2004) [1]
Ammonia	0.0695	0.0013	<0.02	ATSDR (2004)
Anthracene	3.5	< 0.0000045	<0.001	DEC (2004) [1]
Benzene	0.0096	0.004	0.4	DEH (2003) [2]
Ethylbenzene	22	0.004	<0.001	DEH (2003) [2]
Fluoranthene	0.14	< 0.0000045	<0.001	DEC (2004) [1]
Fluorene	0.14	< 0.0000045	<0.001	DEC (2004) [1]
Naphthalene	0.003	< 0.0000045	<0.001	DEC (2004) [1]
Phenanthrene	0.21	< 0.0000045	<0.001	DEC (2004) [1]
Phenol	0.2	0.002	0.01	ATSDR (2008b)
Pyrene	0.105	< 0.0000045	<0.001	DEC (2004) [1]
Toluene	0.38	0.025	0.07	DEH (2003) [2]
Xylenes	0.87	0.023	0.03	DEH (2003) [2]

Note:
[1] Value is for total PAHs but has conservatively been adopted for individual PAHs.
[2] Mean personal exposure level for winter and summer for four urban cities in Australia.

The comparison in **Table 34** above indicates that typical background concentrations of CoPC assessed on the basis of threshold inhalation toxicity criteria and for which background air data are available, are generally less than 10% of the respective RfCs, with the exception of benzene. While background concentrations of some other compounds approached 10% of their respective RfCs (e.g. toluene), the background contributions are considered to be negligible in comparison to the overall uncertainty associated with the derivation of the RfCs themselves (considered to be at least an order of magnitude) and it is therefore not considered warranted to correct for them.

In the case of benzene, mean urban background air concentrations reported by DEH (2003) were approximately 40% of the adopted RfC. Accounting for background exposure would therefore result in inhalation-based SSTC for threshold effects which are approximately 40% lower than those derived in this HHERA. However, adjustment for background would have no effect on the adopted human health SSTC for benzene, since benzene SSTC were driven by non-threshold, rather than threshold, health effects.

Based on the above, background correction of RfC used in the derivation of human health based SSTC for this HHERA is not considered necessary, as correction would have negligible effect on the derived SSTC.

9.1.5 Sensitivity Analysis

Table 35 Sensitivity of Modelling Input Parameters

Parameter	Range of Values	Value Adopted in Risk Assessment	Effect on derived SSTC	Outcome in Risk Assessment
Depth to Groundwater	1.38 to 2.92 mbgs	2.0 mbgs	Value will increase with increased depth	Value adopted is likely to be representative of the average depth to groundwater across the Site
Geology	A range of geological conditions have been encountered on the Site which are predominantly sand, gravel and some clay	Sand < 12% fines	Value will increase with increased clay content	Assumption of sand across the Site with <12% fines is conservative
Soil Bulk Density	Sand- range 1.5-1.7 g/cm3	1.66 g/cm3	Value will increase with decreased bulk density	Conservative assumption with higher of the range adopted resulting in a lower SSTC
Biodegradation Adjustment	For the paved and unpaved scenario biodegradation range of 10-100 fold factors	10 fold factor	Value will increase with a higher biodegradation rate	Conservative assumption to account for actual biodegradation rates are unknown. Oxygen measurements within the soil support the evidence of biodegradation
Soil Partitioning Equation Adjustment	Adjustment due to the conservative nature of the predicted values. Over prediction has been shown to range from 10 to 1000 times	10 fold factor	Value will increase with a higher biodegradation rate	Conservative assumption to account for over-estimation for derived soil SSTC.

9.1.6 Overall

The quantification of risks to human health and derivation of SSTC presented in this report has considered a range of issues that are associated with uncertainties inherent in the Site-specific data, toxicological data and assumptions adopted. A number of these uncertainties and issues that warrant consideration in the interpretation of the risk estimates have been identified.

In addition to these uncertainties, a number of exposure and vapour model parameter values are selected to represent a variable range of physiological, behavioural, chemical and physical conditions. These variables are considered to be better represented as a distribution rather than a single point value. The outcome of the assessment can therefore be affected by the variability associated with key parameters (most sensitive values).

However, it should be highlighted that the assessment presented in this report has adopted conservative or reasonable upper-bound values for these variables in most cases. The compounding effect of utilising multiple reasonable upper limits for quantitative parameters in the assessment is expected to give rise to an overestimation of actual exposure and associated health risk.

9.2 Ecological Uncertainties

Risk assessments involve a number of assumptions regarding Site conditions, potential ecological exposure and chemical toxicity. These assumptions are based on Site-specific information (where available), but it is not always possible to fully predict or describe Site conditions and ecological changes or conditions at a Site for the exposure periods or durations considered in the risk assessment. The assumptions adopted for this ecological risk assessment have, therefore, been selected to evaluate an assumed reasonable maximum exposure scenario over time and to provide a deliberate margin of safety.

9.2.1 Sampling and Analysis

Data collected from the Site have been based on the knowledge of the site history and hydrogeological conditions. The laboratory analytical schedule has also been selected based on a knowledge of former site activities and hence has focussed on chemicals which were known or expected to be present at, or to have been formerly used at the site. There is the potential for chemicals to be present on the Site which have not been characterised based on omission from site history records.

Overall, the data utilised in this risk assessment are considered to be representative of environmental conditions at the Site at the time of sampling and has been the subject of further data gap analysis and verification over a significant area of the site and of a separate tidal discharge study and report.

The identification of CoPC in groundwater has used nationally and internationally recognised MWQC that are based on conservative environment protection endpoints. The approach adopted is considered appropriate for the identification of key chemicals that warrant further detailed assessment.

There has been no sampling conducted at the Site to determine if groundwater dependant ecosystems exist at the Site. It is noted that in NSW and Australia, little is understood and known about these ecosystems and their novel fauna and hence appropriate sampling and identification testing is not well established. For the purposes of this risk assessment, the EPA has requested that the highest level of protection be applied to protect such ecosystems whether present currently or in the future.

9.2.2 Leachability

Leachability testing was performed on samples where either the soil concentrations exceeded the adopted screening guidelines and or on field observations.

The majority of the samples collected for leachate sampling reside within the fill, and it is therefore expected that some variation of leach concentrations will occur.

Leachate testing was conducted under neutral leachate conditions, which is considered to be the most representative of available analytical methods for measurement of potential leachate concentrations of contaminants which may leach from soils *in-situ* at the Site from surface water infiltration. It is noted that the use of external leachate simulation testing in a laboratory environment is likely to be conservative estimate of potential leachate fractions as the procedure involves end over end tumbling, which is more aggressive than what would naturally occur in the environment.

9.2.3 Toxicity Considerations

In addition to the uncertainty considerations detailed above for human health with respect to toxicity the following is noted to be relevant for ecological endpoints.

The adoption of the MWQC as the toxicological endpoint is considered to be conservative as the majority of the guidelines are based of single species studies. Single species studies often are over simplified and consider unrealistic routes of environmental exposure. It is understood that often, only single species studies are available, and therefore a number of conservative arbitrary factors are usually applied to the developed value in order to apply a single species value to field data.

There is also limited data which accounts for potential synergistic and antagonistic effects which may occur within the ecosystem when it is exposed to more than one chemical. If any of the constituents of concern at a Site act by a similar mode of action, total risks could be higher than estimated. Conversely, if the constituents of concern at the Site act antagonistically, total risks could be lower than estimated.

In general, the available field-based scientific information is insufficient to provide a thorough understanding of all of the potential toxic properties of chemicals to which ecological species and habitats may be exposed. It is necessary, therefore, to extrapolate these properties from data obtained under other conditions of exposure involving field studies and experimental laboratory animals.

This may introduce several types of uncertainty, as follows:

- those related to extrapolating from laboratory to field conditions;
- those related to extrapolating from one species to another; and
- those related to extrapolating from the high exposure doses, usually used in laboratory studies, to the lower doses usually estimated for environmental exposure situations.

In order to adjust for these uncertainties, water quality guidelines and species protection approaches incorporate safety factors and ranges.

Adverse effects to individuals do not necessarily imply adverse effects at the population or community level. In general, the goal of ecological risk assessment is to protect communities and populations (except in the case of rare species) and not each individual in that population. There may be interspecies differences in chemical absorption, metabolism, excretion and toxic response including developmental and habitat-related effects. There may also be uncertainties concerning the specific relevance of a general water quality guideline to a specific species or habitat situation. In addition, the frequent necessity to extrapolate results of short-term or sub-chronic animal studies to environmental exposures and over a lifecycle or prolonged time has inherent uncertainty. Most toxicity water quality guidelines or reference values for dose-based evaluations are based on individual-level adverse effects. Risk estimates based on individual risk may overestimate risk at the appropriate population level.

Toxicity guidelines predominantly are derived from studies of the adverse effects of a single constituent. Exposures to ecological receptors may involve multiple constituents, where additive, synergistic, or antagonistic interactions could occur. Data generally are not adequate to permit any quantitative adjustment in toxicity values or risk calculations based on inter-chemical interactions.

10.0 Conclusions and Recommendations

10.1 Conclusions

The objectives of this HHERA were to:

- assess the risk to human health and the environment that the Site represents in its current form; and
- develop Site-specific human health target criteria (SSTC) for soil and groundwater for use in defining the remediation end-point for the Site, where this end-point is defined as removal of the NSW EPA Declaration relating to the Site.

The focus of the VMP HHERA is on the chemicals specified within the NSW EPA Declaration, specifically:

- Polycyclic Aromatic Hydrocarbons (PAHs);
- Benzene, Toluene, Ethylbenzene and Xylene (BTEX);
- Total Petroleum Hydrocarbons (TPH);
- Ammonia;
- Phenol; and
- Cyanide.

Other contamination identified on the Site by previous investigations (for example heavy metals), which are not listed in the NSW EPA Declaration, will be assessed as part of the PDA HHERA.

Previous investigations have reported gasworks related contamination of soil and groundwater within the Site boundary and beyond the Site boundary to the west and south.

Based on human health risk assessment (**Section 5.0)** and ecological risk assessment (**Section 8.0**) and with consideration of the uncertainties and limitations of available data and information, the following conclusions are provided with respect to potential for human health, odour, aesthetic or ecological risks at the Site under the current land use scenario.

<u>Human Health Risks</u>

Unacceptable human health risks have been identified for the following scenario and remediation is required to make the Site fit for its current landuse. The following specific issue was identified:

a) Scenario 2 (Intrusive Maintenance): The highest reported soil concentrations of total carcinogenic PAHs and maximum reported groundwater concentrations of benzene; naphthalene; fluoranthene; phenanthrene; pyrene; TPH C_{10}-C_{14}, TPH C_{15}-C_{28} and TPH C_{29}-$C_{36;}$ may result in adverse health risks to short-term intrusive maintenance workers who come into direct contact with soil and groundwater during trenching activities. Locations in Hickson Road where free tar has been reported are of particular significance, based on the potential for direct contact and indirect groundwater-derived vapour exposures.

Unacceptable human health risks are not expected to be associated with Scenario 1 (Paved Recreation) as SSTCs for this scenario were not exceeded by reported Site concentrations, it is also noted that the number of exposure routes for this scenario are significantly less than for the intrusive maintenance worker.

The development of human health SSTCs has considered the potential for mixtures of chemicals to be present at the Site.

AECOM understands that health risks to residents or other occupants of buildings adjacent the Site (e.g. on the east side of Hickson Road) associated with existing groundwater contamination have been assessed, that the assessment was endorsed by a NSW EPA accredited site auditor and that the risks are currently being effectively managed (as referenced by the NSW EPA Declaration 21122). Furthermore, it is expected that remediation of Hickson Road will further reduce the potential for risk to occupants of adjacent buildings. Potential health risks associated with existing soil and groundwater contamination identified west (in the ORWN Area) and south (in the ORWS Area) of the Site will be or have been addressed as part of the risk assessments relating to those specific areas.

Odour Risks

Odour-based SSTC for Scenarios 1 and 2 have been calculated and are observed to be lower than the SSTC derived to be protective of human health. However:

- gasworks waste is inherently odorous material; and
- it is possible that some odorous material could remain at the Site following remediation.

Visual Amenity Risks

Visual amenity issues are not considered significant on the Site under current land use scenarios.

Ecological Risks

Exceedances of the MWQC have been identified in groundwater within the Site and at the Site boundary, indicating the potential for an unacceptable risk to the environment. Remediation is required to minimise the risk of adverse impact to the environment.

It is noted that the analytical composition of chemicals of potential concern within the Site are: (a) consistent with those expected in association with historic gasworks; and, (b) similar in composition to those reported in areas down hydraulic gradient of the Site (ORWN), suggesting that impacted groundwater is migrating off Site.

10.2 Recommendations

Based on the above conclusions, and with consideration of the uncertainties and limitations of available data and information, the following recommendations are provided in relation to addressing the NSW EPA Remediation Site Declaration 21122:

a) The results of the HHERA indicate that there are multiple lines of evidence that soil and groundwater concentrations within the Site and at the Site boundary represent an unacceptable risk to human health and ecological receptors and that remediation is required to address both human health and ecological protection with respect to the Remediation Site Declaration 21122.

b) Removal and/or remediation of separate phase gasworks waste and tar, to the extent practicable, should be undertaken as the primary remediation objective to minimise the risk to environment and human health.

c) Following remediation, groundwater should meet the Groundwater SSTC (**Table 25**), and to the extent practicable, approach the MWQC (**Table 29**), at the Site boundary.

d) With respect to the protection of the environment, the objective of meeting MWQC is for the ultimate protection of ecosystems within groundwater, with the level of protection determined by the water quality at Darling Harbour. As such, remediation of the soil within the unsaturated and saturated zones is required, to the extent practicable, as a secondary remediation objective to protect groundwater quality leaving the Site.

i) Soil within the unsaturated zone (<2.0 meters below ground surface [mbgs]) at the Site should be remediated, where practicable, to the Soil SSTC (which were derived to protect of human health) presented in **Table 24**.

j) The Remedial Action Plan (RAP) should include consideration of mitigation measures for the appropriate management of asbestos that may be potentially encountered during the remediation works.

k) Validation of groundwater will be undertaken by comparison of:

- individual groundwater monitoring results with the lowest of the derived SSTC (presented in **Table 23**); and
- groundwater monitoring results at the down-hydraulic gradient Site boundary with the MWQC (presented within **Table 29**), to the extent practicable.

l) The Rap will describe the validation of soil following remediation which will be undertaken in accordance with the following:

- use of systematic sampling patterns;
- collection of an appropriate number of samples for estimation of the arithmetic average concentration of contaminant(s) within relevant environmental media and exposure areas; and
- estimation of the 95% upper confidence limit (UCL) of the arithmetic average concentration.

11.0 Limitations

This document was prepared by AECOM Australia Pty Ltd (AECOM) for the sole use of Lend Lease (Millers Point) Pty Ltd, the only intended beneficiary of our work. Any advice, opinions or recommendations contained in this document should be read and relied upon only in the context of the document as a whole and are considered current to the date of this document. Any other party should satisfy themselves that the scope of work conducted and reported herein meets their specific needs before relying on this document. AECOM cannot be held liable for any third party reliance on this document, as AECOM is not aware of the specific needs of the third party. No other party should rely on the document without the prior written consent of AECOM, and AECOM undertakes no duty to, nor accepts any responsibility to, any third party who may rely upon this document.

This document was prepared for the specific purpose described in Section 1.0 and as agreed to by Lend Lease (Millers Point) Pty Ltd. From a technical perspective, the subsurface environment at any site may present substantial uncertainty. It is a heterogeneous, complex environment, in which small subsurface features or changes in geologic conditions can have substantial impacts on water and chemical movement. Uncertainties may also affect source characterisation assessment of chemical fate and transport in the environment, assessment of exposure risks and health effects, and remedial action performance.

AECOM's professional opinions are based upon its professional judgement, experience, and training. These opinions are also based upon data derived from the testing and analysis described in this document and other referred AECOM document. These opinions are also based on data derived by others as provided by Lend Lease (Millers Point) Pty Ltd and the Barangaroo Delivery Authority. It is possible that additional testing and analysis might produce different results and/or different opinions. AECOM has limited its investigation to the scope agreed upon with Lend Lease (Millers Point Pty) Ltd. AECOM believes that its opinions are reasonably supported by the testing and analysis that have been done, and that those opinions have been developed according to the professional standard of care for the environmental consulting profession in this area at the date of this document. That standard of care may change and new methods and practices of investigation, testing, analysis and remediation may develop in the future, which might produce different results. AECOM's professional opinions contained in this document are subject to modification if additional information is obtained, through further investigation, observations, or validation testing and analysis during remedial activities.

12.0 References

AECOM, 2010a. *Data Gap Investigation, Other Remediation Works (South) Area Hickson Road, Millers Point NSW*. AECOM Australia Pty Ltd, 27 May 2010.

AECOM 2010e. *Sampling Analysis and Quality Plan, Declaration Area – Issue 2 VMP and PDA Works, NSW EPA Declaration Area 21122, former Millers Point Gasworks*. AECOM Australia Pty Ltd, 19 July 2010.

AECOM, 2010b, *Data Gap Investigation EPA Declaration Area (Parts of Barangaroo Site and Hickson Road), Millers Point, NSW.* AECOM Australia Pty Ltd, 23 September 2010.

AECOM, 2010c. *Data Gap Investigation, Other Remediation Works (North) Area Hickson Road, Millers Point NSW*. AECOM Australia Pty Ltd. 20 October 2010.

AECOM, 2010d. *Groundwater Discharge Study, Stage 1 Barangaroo Development, Hickson Road, Darling Harbour. New South Wales.* AECOM Australia Pty Ltd, 3 November 2010.

AECOM, 2011a, *Human Health and Ecological Risk Assessment, Declaration Site (Development works) Remediation works*. AECOM Australia Pty Ltd, 9 June, 2011.

AECOM 2011b, *Human Health and Ecological Risk Assessment Addendum- Other Remediaiton Works (South) Area, Barangaroo*. AECOM Australia Pty Ltd, 4 July 2011.

AECOM 2011c, *Amended Remedial Action Plan Barangaroo ORWS Area*. AECOM Australia Pty Ltd, 7 July 2011.

AECOM 2012a, *Supplementary Data Gap Investigation, VMP Area, Hickson Road, Millers Point, NSW*, (AECOM, 2012). AECOM Australia Pty Ltd, 9 March, 2012.

AECOM 2012b, DRAFT *VMP Remediation Extent* Report, VMP Remediation Works Area, (Parts of Barangaroo and Hickson Rd), Millers Point, NSW (Privileged and Confidential), 3 September 2012.

ANZECC, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and Agriculture and Resourced Management Council of Australia and New Zealand.

ARUP Geotechnics, 1986. *Upgrading Wharf 7/8 Darling Harbour, Geotechnical Site Investigation.* January 1986.

ASTM International, 2002. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. E1739 – 95 (reapproved 2002).

ATSDR, 2004. *Toxicological Profile for Ammonia.* Agency for Toxic Substances and Disease Registry. September 2004.

ATSDR, 2005. *Toxicological Profile for Naphthalene, 1-Methylnaphthalene and 2-Methylnaphthalene.* Agency for Toxic Substances and Disease Registry. August 2005.

ATSDR, 2008a. *Toxicological Profile for Cresols.* Agency for Toxic Substances and Disease Registry. September 2008.

ATSDR, 2008b. *Toxicological Profile for Phenol.* Agency for Toxic Substances and Disease Registry. September 2008.

Birch G.F., Taylor, S.E., 1999. *Source of heavy metals in sediments o f the Port Jackson estuary*, Australia. Sci Total Environ 1999; 227:123–38.

Birch G.F., Taylor, S.E., 2000. *Distribution and possible sources of organochlorine residues in sediments of a large urban estuary, Port Jackson, Sydney*. Aust J Earth Sci 2000;47:749– 56.

BOM, 2010. *Climate statistics for Australian locations, Monthly climate statistics, All years of record.* Australian Government, Bureau of Meteorology. http://www.bom.gov.au/climate/averages/Tables/cw_066062.shtml

Bradley L.J.N., Magee B.H., and Allen, S.L., *Background Levels of PAHs and Selected Metals in New England Urban Soils*, Journal of Soil Contamination 1994; 3: 1-13

Broomham, R, 2007. *Land at Millers Point Ownership and History*. June 2007

CCME, 1999. *Canadian environmental quality guidelines*. Canadian Council of Ministers of the Environment, Winnipeg.

CCME, 1999a. *Canadian Soil Quality Guidelines: Free Cyanide, Scientific Support Document, Environment Canada*. Canadian Council of Ministers for the Environment.

CCME, 1999b. *Canadian Soil Quality Guidelines: Napthalene, Scientific Support Document, Environment Canada*. Canadian Council of Ministers for the Environment.

CCME, 1999c. *Canadian Soil Quality Guidelines: Phenol, Scientific Support Document, Environment Canada*. Canadian Council of Ministers for the Environment.

CCME, 2008a. *Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale. Supporting Technical Document.* PN 1399. Canadian Council of Ministers for the Environment. January

CCME, 2008b. *Canadian Soil Quality Guidelines: Carcinogenic, Other Polycyclic Aromatic Hydrocarbons, Scientific Support Document*, *Environment Canada*. Canadian Council of Ministers for the Environment.

City of Sydney, 2005. *Sydney Local Environmental Plan 2005, Gazetted 9 December 2005*, as amended.

Coffey, 1998. *Wharf 8 Darling Harbour Environmental Soil Quality Assessment*, March, Coffey Partners International Pty Ltd

Coffey, 2008. *Preliminary Environmental Investigation 30-38 Hickson Road Millers Point NSW*. 12 May 2008. Project Ref: ENVILCOV00437AA-R04. Coffey Partners International Pty Ltd

Davis GB, Patterson BM and Trefry MG, *Evidence for Instantaneous Oxygen-Limited Biodegradation of Petroleum Hydrocarbon Vapours in the Subsurface,* Groundwater Monitoring and Remediation 29, no 1/ Winter 2009/ pages 126-137DEH, 2003. Technical Report No. 6: *BTEX Personal Exposure Monitoring in Four Australian Cities,* Environment Australia, Department of Environment and Heritage, April 2003.

Davis, GB, Patterson, BM and Trefry, MG, 2009. *Biodegradation of petroleum hydrocarbon vapours,* CRC CARE Technical Report no. 12. CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

enHealth, 2004. *Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards*. June 2004.

Environment Agency, 2009. *Soil Guideline Values for Benzene in Soil*, Science Report SC050021/ benzene SGV, Environment Agency, March 2009.

Environment Australia, 2003. *Technical Report 6: BTEX Personal Exposure Monitoring in Four Australian Cities*. Commonwealth of Australia, April 2003.

EPHC, 2006. *National Water Quality Management Strategy, National Guidelines for Water Recycling: Managing Health and Environmental Risks.* Environment Protection and Heritage Council, Natural Resource Management Ministerial Council and Australia Health Ministers' Conference. November 2006.

ERM. 2007. *Environmental Site Assessment, East Darling Harbour, Sydney, NSW, Final Report.* 21 June. ERM Australia Pty Ltd

ERM 2008a. *Additional Investigation Works at Barangaroo, Hickson Road, Millers Point, NSW*. Rev 03. July 2008, ERM Australia Pty Ltd

ERM. 2008b. *Preliminary Sediment Screening Works at East Darling Harbour, Adjacent to Barangaroo, NSW, DRAFT, Rev 03*. August.

ERM. 2008c. *DRAFT Stage 2 Remedial Action Plan for Barangaroo, Hickson Road, Sydney*. September 2008.

ERM. 2010. *Overarching Remedial Action Plan for the Barangaroo Project Site, Sydney*. 1 June 2010.

Friebel, E. and Nadebaum, P., 2011. *Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 1: Technical development document* CRC Care Technical Report no. 10, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia. September 2011.

Hawas O, Hawker D, Chan A, Cohen D, Christensen E, Golding G and Vowles P. 2002. *Characterisation and Identification of Sources of Volatile Organic Compounds in an Industrial Air in Brisbane*. 16th International Clean Air and Environment Conference of the Clean Air Society of Australia and New Zealand, 18-22 August, 2002. Available on-line: www.ansto.gov.au/__data/assets/pdf_file/0013/40450/16thCleanAirNZOlgapapAug02.pdf.

Heemsbergen D, Warne M, McLaughlin M, and Kookana R, 2009) *The Australian methodology to Derive Ecological Investigation Levels in Contaminated Soils*, CSIRO Land and Water Science Report 43/09

Herbert C, 1983, *Sydney 1:100 000 Geological Sheet 9130*, 1st edition. Geological Survey of New South Wales, Sydney.

Irvine, I and Birch, GR, 1998. *Distribution of heavy metals in surficial sediments of Port Jackson, Sydney, Australia*. Aust J Earth Sci 45, pp. 169–174

ITRC, 2007, *Vapor Intrusion Pathway: A Practical Guideline,* The Interstate Technology & Regulatory Council, Washington, DC, January 2007.

Jeffery and Katauskas, 2006. *Geotechnical Report development of Wharves 3-8 at East Darling Harbour*. August 2006.

Johnson, PC and Ettinger RA, 1991. *Heuristic model for predicting the intrusion rate of contaminant vapors into buildings*. Environ. Sci. Technology*.* 25:1445-1452.

Jury, W.A., Spencer, W.F. and Farmer, W.J., 1983. *Behavior Assessment Model for Trace Organics in Soil: I, Model Description.* Journal of Environmental Quality. Vol. 12, pp. 558-564.

Knafla, A., Phillipps, K.A., Brecher, R.W., Petrovic, S. and Richardson, M. 2006. *Development of a dermal cancer slope factor for benzo[a]pyrene.* Regulatory Toxicology and Pharmacology 45:159-168.

McCready, S., Birch, G.F., Long, E.R.,2006. *Metallic and organic contaminants in sediments of Sydney Harbour, Australia and vicinity — A chemical dataset for evaluating sediment quality guidelines*. Environment International 32 (2006) 455 – 465

McCready, S., Slee, D., Birch, G. F. and Taylor, S. E., 2000. *The distribution of polycyclic aromatic hydrocarbons in surficial sediments of Sydney Harbour, Australia*. Marine Pollution Bulletin, 40/11, 999-1006

NEPC, 1999a. *National Environmental Protection (Assessment of Site Contamination) Measure, Schedule B(4), Guideline on Health Risk Assessment Methodology*. National Environment Protection Council.

NEPC, 1999b. *National Environmental Protection (Assessment of Site Contamination) Measure, Schedule B(7), Guideline on Health-Based Investigation Levels.* National Environment Protection Council.

NEPC, 1999c. *National Environmental Protection (Assessment of Site Contamination) Measure, Schedule B(5), Guideline on Ecological Risk Assessment.* National Environment Protection Council.

NEPC, 1999d. *National Environmental Protection (Assessment of Site Contamination) Measure, Schedule B(1), Guideline on the Investigation Levels for Soil and Groundwater.* National Environment Protection Council.

NEPC, 1999e. *National Environmental Protection (Assessment of Site Contamination) Measure, Schedule B(6), Guidelines for the Assessment and Management of Groundwater Contamination.* National Environment Protection Council.

NEPC, 2004. *National Environment Protection (Air Toxics) Measure*. National Environment Protection Council. 3 December 2004.

NEPM, 1999. *National Environmental Protection (Assessment of Site Contamination) Measure*. National Environment Protection Council.

NEPM, 2010. *DRAFT National Environmental Protection (Assessment of Site Contamination) Measure*. National Environment Protection Council.

NHMRC, 1999. *Toxicity Assessment for Carcinogenic Soil Contaminants*. National Health and Medical Research Council, endorsed 6 September 1999.

NHMRC, 2004. *Australian Drinking Water Guidelines*. National Health and Medical Research Council and Natural Resource Management Ministerial Council. 2004.

NHMRC, 2011. *Australian Drinking Water Guidelines*. National Health and Medical Research Council and Natural Resource Management Ministerial Council. January 2011.

Noel Arnold & Associates Pty Ltd, June, 1996. *Initial Environmental Assessment, Sydney Ports Corporation, Darling Harbour Berths 3-8 Hickson Road, Darling Harbour*

NSW DEC, 2004. *Ambient Concentrations of Polycyclic Aromatic Hydrocarbon Species in NSW*. Internal Working Paper no. 3, Ambient Air Quality Research Project (1996-2001). Department of Environment and Conservation (NSW). DEC 2004/40, ISBN: 1 74137 055 8.

NSW DEC, 2005. *Information for the assessment of former gasworks sites*. Department of Environment and Conservation (NSW). DEC 2005/237, ISBN: 1 74137 386 7, July 2005.

NSW DEC, 2006. Guidelines for the NSW Site Auditor Scheme (2nd edition). Department of Environment and Conservation (NSW)NSW DEC 2006. Guidelines for the NSW Site Auditor Scheme (2nd Edition). April 2006.

NSW DEC, 2007 *Guidelines for the Assessment and Management of Groundwater Contamination*. NSW DECC, 2009. *Waste Classification Guidelines Part 1: Classifying Waste*. NSW Department of Environment and Climate Change.

NSW DECCW, 2010 'Catchment at a Glance: Sydney Harbour and Parramatta River http://www.environment.nsw.gov.au/ieo/sydneyharbour/caag.htm (Accessed 25.11.10)

NSW Department of Planning, 2007. *State Environmental Planning Policy (Major Projects) 2005* (Amendment No 18), Gazetted 12 October 2007, as amended.

NSW DoP, 2007. *Major Project Assessment: Barangaroo – Demolition Proposed by Sydney Harbour Foreshore Authority.* Director General's Environmental Assessment Report. New South Wales Department of Planning. November 2007.

NSW EPA, 1994. *Contaminated Sites: Guidelines for Assessing Service Station Sites*. NSW Environment Protection Authority.

NTP, 2001. *Summary of Data for Chemical Selection, Dibenzofuran,132-64-9* ***(b***ackground sheet for nomination to NTP Testing Program). National Toxicology Program, Department of Health and Human Services. http://ntp.niehs.nih.gov/ntp/htdocs/Chem_Background/ExSumPdf/Dibenzofuran.pdf. Nomination Date: 7 March 2001.

Standards Australia, 2002. Australian Standard (AS) AS1668.2-02 *The use of ventilation and air conditioning in buildings – Ventilation design for indoor air contaminant control*. AS1668.2-02, Standards Australia, 2005.

Standards Australia, 2005 . Australian Standard (AS4482.1) *Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds. AS4482.1 Standards Australia, 2005.*

State Government of Victoria, 2001. *State Environment Protection Policy (SEPP)* – Air Quality Management. Victoria Government Gazette, No S 240, 21 December 2001.

TPHCWG, 1997a. *Total Petroleum Hydrocarbon Criteria Working Group Series Volume 4: Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH).* Total Petroleum Hydrocarbon Criteria Working Group. Amherst Scientific Publishers, Amherst.

TPHCWG, 1997b. *Total Petroleum Hydrocarbon Criteria Working Group Series Volume 3: Selection of Representative of TPH Fractions Based on Fate and Transport Considerations.* Amherst Scientific Publishers, Amherst. July, 1997.

University of Tennessee, 2010. *Risk Assessment Information System (RAIS).* On-line database available at: rais.ornl.gov. Accessed April 2010.

URS, 2001. *Contamination Review for Darling Harbour – Berths 3/8,* July, URS Australia Pty Ltd.

USEPA, 1989. *Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual.* United States Environmental Protection Agency. EPA/540/1-89/002 December 1989 .

USEPA, 1990. *Guidance for Data Useability in Risk Assessment.* United States Environment Protection Agency.

USEPA, 1995. *Region III: "Assessing Dermal Contact with Soil"* – http://www.epa.gov/reg3hwmd/risk/human/info/solabsg2.htm

USEPA, 1996. *Soil Screening Guidance: Technical Background Document*, EPA. Document Number EPA/540/R-95/128, July 1996.

USEPA 1997. *Exposure Factors Handbook*. National Center for Environmental Assessment. United States Environmental Protection Agency. Office of Research and Development .August 1997.EPA/600/P-95/002F.

USEPA, 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, United States Environmental Protection Agency, OSWER 9355.4-24, December 2002.

USEPA, 2003. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks for the Protection of Benthic Organisms: PAH Mixtures*, EPA/600/R-02/013

USEPA, 2004a. *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings.* United States Environmental Protection Agency, Office of Emergency and Remedial Response. Revised February 22, 2004.

USEPA, 2004b. *Risk Assessment Guidelines for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final*. United States Environmental Protection Agency. EPA/540/R/99/005, July 2004.

USEPA, 2005. *Guidelines for Carcinogen Risk Assessment.* United States Environmental Protection Agency. EPA/630/P-03/001F, March 2005.

USEPA, 2009b. *Risk Assessment Guidance for Superfund (RAGS) Volume 1: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).* Office of Superfund and Technology Innovation. US Environmental Protection Agency. Washington DC. EPA-540-R-070-002. OSWER 9285.7-82. January 2009.

USEPA, 2010. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Centre for Environmental Assessment, Office of Research and Development. Available on-line at: http://www.epa.gov/iris/.

USEPA, 2012. *Regional Screening Levels for Chemical Contaminants at Superfund Sites.* Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_Table/Generic_Tables/index.htm. Tables accessed last updated April 2012.Van den Berg et al., 1998. *Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife.* Environ Health Perspect. 1998 December; 106(12): 775–792.

Washington State, 1997. *Default Hydrogeologic Parameter data for deriving Soil Concentrations for Groundwater Protection (WAC 173-340-747)*, http://www.ecy.wa.gov/programs/tcp/tools/toolmain.html (accessed 1st December 2010).

WHO, 2000a. *Air Quality Guidelines for Europe. Second Edition.* World Health Organization (WHO), Regional Office for Europe. WHO Regional Publications, European Series, No. 91.

WHO, 2000b. *Guidelines for Air Quality*. World Health Organization. Geneva.

WHO, 2006. *Guidelines for Drinking-water Quality. First Addendum to the Third-Edition. Volume 1. Recommendations.* World Health Organization.

WHO, 2008. *Petroleum Products in Drinking-water*. Background document for development of WHO Guidelines for Drinking-water Quality. 2008. WHO/SDE/WSH/05.08/123

Worley Parsons, 2010 *Barangaroo Concept Plan Amendment (MP06_0162 MOD4) - Marine Ecology, Water Quality and Contaminated Sediment Impact Assessment*, July.

This page has been left blank intentionally.

Appendix A

Tables

This page has been left blank intentionally.

Table T1
Human Health Soil Screen - All Depths

Location_Code	Field_ID	Sample_Depth_Range	Sampled_Date_Time	Sample_Type	PAHs Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (ESDAT TOTAL)
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Scenario 1 VMP July 2012									3													40
AECOM_BH33	BH33_0.75-0.85	0.75-0.85	2/12/2010	Normal																		
AECOM_BH33	BH33_5.0-5.2	5-5.2	2/12/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH33	BH33_8.0-8.2	8-8.2	2/12/2010	Normal																		
AECOM_BH34	BH34_1.8-2.2	1.8-2.2	25/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH34	QC240	1.8-2.2	25/02/2010	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH34	QC241	1.8-2.2	25/02/2010	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	<8
AECOM_BH34	BH34_11.0-11.2	11-11.2	25/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH34	BH34_6.0-6.2	6-6.2	25/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH35	BH35_4.9-5.0	4.9-5	22/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH35	BH35_9.9-10.0	9.9-10	22/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH36	BH36_1.0-1.2	1-1.2	3/03/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH36	BH36_15-15.05	15-15.05	3/03/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	1.7	1	0.7	1.7
AECOM_BH36	BH36_4.0-4.4	4-4.4	3/03/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
AECOM_BH36	BH36_8.5-8.9	8.5-8.9	3/03/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH40	BH40_16.5-16.7	16.5-16.7	18/02/2010	Normal	2.5	13.1	10	8.4	6.8	6		2		6	0.6	31.8	12.6	2	137	36.6	19.2	288.6
AECOM_BH40	BH40_17.8-18.0	17.8-18	18/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	1.4	0.8	<0.5	8.2
AECOM_BH40	BH40_19.0-19.4	19-19.4	18/02/2010	Normal	<0.5	2	2	1.4	0.8		0.9	<0.5	<0.5	1.2	<0.5	3.8	2.7	<0.5	10.5	6.6	3.4	37.8
AECOM_BH40	BH40_7.0-7.2	7-7.2	18/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH40	QC54	8.5-8.7	18/02/2010	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH42	BH42_1.0-1.1	1-1.1	23/02/2010	Normal	<0.5	<0.5	<0.5	2	1.5		2.3	0.8	1	1.7	<0.5	2.9	<0.5	0.6	<0.5	1.2	3.2	20.2
AECOM_BH42	BH42_3.2-3.3	3.2-3.3	23/02/2010	Normal	35	250	217	157	113	136		22.9		122	7.9	369	243	23.8	926	660	351	3497.6
AECOM_BH42	BH42_3.5-3.6	3.5-3.6	23/02/2010	Normal	<0.5	0.8	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.8	0.6	<0.5	1	2.4	0.8	11.4
AECOM_BH44	BH44_1.9-2.0	1.9-2	23/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH44	BH44_4.9-5.0	4.9-5	23/02/2010	Normal	11.3	90	41.9	27.6	15.6	18		3.2		22.8	<1.2	59.2	54.5	3.4	410	156	67.2	963.9
AECOM_BH45	BH45_13.2-13.4	13.2-13.4	23/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	1.1	<0.5	<0.5	<0.5	1.2	1	9.8
AECOM_BH45	BH45_3.2-3.4	3.2-3.4	23/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	0.5	<0.5	8
AECOM_BH45	QC230	3.2-3.4	24/02/2010	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.9	<0.5	<0.5	<0.5	1.1	0.8	9.3
AECOM_BH45	BH45_7.2-7.4	7.2-7.4	23/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH45	QC231	7.2-7.4	23/02/2010	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH45	QC232	7.2-7.4	23/02/2010	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
AECOM_BH49	BH49_1.5-1.7	1.5-1.7	22/02/2010	Normal	1.1	11	18.1	35.8	22.7		37	13.2	11.8	32	3.8	76.7	4.5	11.4	9.7	61.4	77.9	428.1
AECOM_BH49	BH49_10.2-10.4	10.2-10.4	22/02/2010	Normal	5.3	32.6	25.8	23.1	11.4		14.8	4.7	6.5	15.3	1.1	54.6	33.4	3.8	343	191	46.7	813.1
AECOM_BH49	BH49_12.2-12.4	12.2-12.4	22/02/2010	Normal	16.5	132	59.1	48.4	35.8	45		8.7		37.8	3.4	161	125	9.8	703	283	137	1760.5
AECOM_BH49	BH49_4.2-4.4	4.2-4.4	22/02/2010	Normal	4.1	23.8	16	23.2	19.2		27.6	9.2	13.4	16.2	2.6	38.8	12.5	7.9	64.7	41.7	53.3	374.2
AECOM_BH49	BH49_6.2-6.4	6.2-6.4	22/02/2010	Normal	0.8	2.3	1.7	3.1	2.5	3		0.6		2.4	<0.5	4.4	2.7	0.7	19.5	5.7	3.7	50.6
AECOM_BH49	QC223	6.2-6.4	22/02/2010	Field_D	1	2.9	2.8	2.5	1.9	2		<0.5		2	<0.5	5.7	4.2	0.5	29.3	14.2	4.8	72.8
AECOM_BH49	QC224	6.2-6.4	22/02/2010	Interlab_D	1	2.2	1.4	1.3	1	1		<0.5		1.1	<0.5	4.1	2.6	<0.5	51.9	6	2.8	76.9
AECOM_BH49	BH49_8.2-8.4	8.2-8.4	22/02/2010	Normal	11.2	55.1	43.6	30.9	16.4		21.4	6.7	12	22.6	2	83.3	62	6	373	130	70.3	946.5
AECOM_BH50	BH50_1.3-1.5	1.3-1.5	26/02/2010	Normal	<0.5	<0.5	<0.5	0.6	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	8.1
AECOM_BH51	BH51_0.4-0.5	0.4-0.5	6/03/2010	Normal	<0.5	<0.5	<0.5	1.3	0.9		1.4	0.5	0.7	1.1	<0.5	1.9	<0.5	<0.5	<0.5	0.8	2	14.1
AECOM_BH52	BH52_1.0-1.2	1-1.2	22/02/2010	Normal																		
AECOM_BH52	BH52_2.2-2.6	2.2-2.6	22/02/2010	Normal	<0.5	1	1	2.4	1.6		2.4	0.9	1	1.9	<0.5	4.1	<0.5	0.8	<0.5	2.3	3.9	25.3
AECOM_BH52	QC220	2.2-2.6	22/02/2010	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH52	QC221	2.2-2.6	22/02/2010	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
AECOM_BH52	BH52_4.2-4.4	4.2-4.4	22/02/2010	Normal	36.1	85.7	115	140	82.2		93.8	43.2	52.9	109	11.6	306	123	37.6	55.8	412	291	1994.9
AECOM_BH53	BH53_1.1-1.5	1.1-1.5	6/03/2010	Normal	5.4	13	25.7	52.3	38.1		50.4	16.8	13.8	36.1	4.4	142	15.6	14.7	20.8	91.2	128	668.3
AECOM_BH53	QC208	1.1-1.5	6/03/2010	Field_D	2.3	6.1	10	28.3	20.7		30	8.6	11.2	20.3	2.3	55.7	5.5	7.8	7.1	23.2	47.7	286.8
AECOM_BH53	BH53_2.0-2.4	2-2.4	6/03/2010	Normal	11.4	28.3	84.8	92.8	70.7		77.8	23.9	27.5	63.4	7.1	316	56.1	23.2	48.3	302	277	1510.3
AECOM_BH53	BH53_4.0-4.4	4-4.4	6/03/2010	Normal	108	657	343	275	291	305		53.5		257	12.1	747	344	49	4330	1390	710	9566.6
AECOM_BH54	BH54_1.0-1.4	1-1.4	23/02/2010	Normal	273	1000	1070	912	533		824	248	324	549	72.5	2130	1290	231	6370	3130	1670	20,627
AECOM_BH54	QC228	1-1.4	23/02/2010	Field_D	144	468	509	467	253		488	130	117	341	36.6	1780	653	119	3680	2390	851	12,427
AECOM_BH54	BH54_2.8-3.0	2.8-3	23/02/2010	Normal	11.1	29.3	32.6	27.5	21.7	28		5.8		22.5	2.2	66.1	40.2	6.6	227	131	54.5	678.1
AECOM_BH55	BH55_1.0-1.2	1-1.2	25/02/2010	Normal	80.7	473	482	425	252		300	123	107	282	23.3	1280	460	95	4510	2030	1220	12,143
AECOM_BH55	BH55_2.2-2.4	2.2-2.4	25/02/2010	Normal	25.3	149	119	107	84	102		17.2		87	5.4	274	151	17.5	1740	463	237	3476.4
AECOM_BH55	BH55_2.7-2.9	2.7-2.9	25/02/2010	Normal	67.1	386	341	294	160		187	65	117	200	14.5	783	440	53.3	4810	1840	677	10,435
AECOM_BH58	BH58_10.8-11.2	10.8-11.2	22/02/2010	Normal	0.8	0.9	1.3	3.3	2.2		3.2	1.3	1.7	2.8	<0.5	7.3	0.7	1	1.2	3.6	8.5	40.3
AECOM_BH58	BH58_1.0-1.2	1-1.2	22/02/2010	Normal	0.6	8.2	8.5	16.2	12.7		19	9.8	6.9	14	1.8	36.1	1.5	7.2	2.3	23.4	37.6	205.8
AECOM_BH58	BH58_3.2-3.4	3.2-3.4	22/02/2010	Normal	1.6	1.1	2.2	2.8	2.1		3.6	1.4	1	2.5	<0.5	6.6	1.3	1	10.9	5.9	6.8	51.3
AECOM_BH58	QC225	3.2-3.4	22/02/2010	Field_D	2.4	1.1	3.1	6	3.4		5.1	1.7	2.4	4.1	<0.5	16.5	2	1.2	3.4	11.1	15.5	79.5
AECOM_BH58	QC226	3.2-3.4	22/02/2010	Interlab_D	1.4	1.4	1.8	5.7	5.3	8		2.9		4.9	0.8	10.1	1.1	2.4	2.5	4.7	12.6	57.6
AECOM_BH58	BH58_5.2-5.4	5.2-5.4	22/02/2010	Normal	1.2	0.9	2	3.3	2.6		3.8	1.7	1.9	3.1	<0.5	7.5	1.3	1.4	1.3	6.2	7.4	46.1
AECOM_BH58	BH58_8.6-8.8	8.6-8.8	22/02/2010	Normal	<0.5	2.1	2.2	5.6	5.3	7		1.4		4.6	<0.5	7.9	0.7	1.3	1.2	4.6	10.6	48.5
AECOM_BH59	BH59_1.9-2.0	1.9-2	22/02/2010	Normal	10.3	58.8	60.3	45.9	26.5		35.8	13.1	14.3	32.2	3.2	121	68.3	11.8	453	206	104	1264.5
AECOM_BH59	BH59_3.4-3.5	3.4-3.5	22/02/2010	Normal	104	404	368	271	189	232		44.5		214	21.7	669	462	52.2	3560	1400	603	8362.4
AECOM_BH59	BH59_4.2-4.3	4.2-4.3	22/02/2010	Normal	1.4	9.1	8.3	6.2	3.4		4.6	1.4	2	4.5	<0.5	14.2	8.8	1.2	46.4	23.5	12.6	148.1
AECOM_BH61	BH61_0.3-0.4	0.3-0.4	6/03/2010	Normal																		
AECOM_BH61	BH61_2-2.4	2-2.4	7/03/2010	Normal	4.8	47.6	91.6	217	162		182	41.5	28	164	13.2	423	23.8	39.5	51.2	267	412	2168.2
AECOM_BH61	QC211	2-2.4	7/03/2010	Field_D	5.1	50.2	106	253	189		251	43.4	44.4	196	14.1	500	24.6	42.7	45.3	303	488	2555.8
AECOM_BH61	QC212	2-2.4	7/03/2010	Interlab_D	4.8	55.2	97	220	163		185	36.2	33.9	164	11.7	428	22	36.3	57.4	254	422	2190.5
AECOM_BH61	BH61_3-3.4	3-3.4	7/03/2010	Normal	7.3	47.8	30.1	18.9	14.3	17		4.7		14.6	1.3	60.1	38.4	4.2	318	113	55.7	728.4
AECOM_BH62	BH62_1.0-1.2	1-1.2	26/02/2010	Normal	<0.5	<0.5	<0.5	0.5	<0.5		0.5	<0.5	<0.5	<0.5	<0.5	0.9	<0.5	<0.5	0.7	0.9	0.9	9.4
AECOM_BH62	BH62_11.8-12.0	11.8-12	26/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
AECOM_BH62	BH62_3.4-3.8	3.4-3.8	26/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH62	BH62_5.4-5.6	5.4-5.6	26/02/2010	Normal	<0.5	0.6	2.2	5.1	2.9		4.3	1.7	2.2	4	<0.5	10.8	0.5	1.3	0.5	6.1	10.3	53.5
AECOM_BH64	BH64_10.0-10.3	10-10.3	1/03/2010	Normal																		
AECOM_BH64	BH64_1.0-1.2	1-1.2	1/03/2010	Normal	7.5	51.9	70.8	95.5	69.8		104	37.2	29.4	79.7	10.8	246	31.1	33.2	76.7	261	259	1463.6
AECOM_BH64	BH64_2.5-2.7	2.5-2.7	1/03/2010	Normal																		
AECOM_BH64	BH64_5.5-5.7	5.5-5.7	1/03/2010	Normal																		
AECOM_BH65	BH65_11.2-11.4	11.2-11.4	24/02/2010	Normal	3.1	24.9	11.7	4.7	2.9	3		<0.5		4.5	<0.5	10.8	20.8	<0.5	65	51.5	16.9	218.3
AECOM_BH65	BH65_13.4-13.6	13.4-13.6	24/02/2010	Normal	2.4	7.3	6.6	3.8	2.1		1.8	0.5	0.6	3	<0.5	6.4	10.8	<0.5	34.6	25.1	9.4	115.4
AECOM_BH65	BH65_3.4-3.6	3.4-3.6	24/02/2010	Normal	5.2	13.8	28.1	40.6	27		32.3	17.4	17.2	30.2	3.7	82.9	29.1	13.6	10.1	98.8	82.8	532.8
AECOM_BH65	QC234	3.4-3.6	24/02/2010	Field_D	35.3	61	156	208	135		151	62.4	68.4	162	23.3	463	196	54.3	92.2	644	452	2963.9
AECOM_BH65	BH65_8.2-8.6	8.2-8.6	24/02/2010	Normal	0.8	3	5	9.2	7.9		9.5	4.7	3.9	7.4	1.4	17.1	5	3.9	2.3	15.6	18.3	115
AECOM_BH66	BH66_2.3-2.4	2.3-2.4	24/02/2010	Normal	0.8	1.5	3.5	8.8	10.9		11.9	7.3	4.2	6.9	2.2	12.4	1.5	5.6	5.3	9.2	13	105
AECOM_BH66	BH66_3.2-3.6	3.2-3.6	24/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH66	BH66_7.0-7.2	7-7.2	24/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	0.7	8.4
AECOM_BH67	BH67_0.4-0.43	0.4-0.43	6/03/2010	Normal	<0.5	3.2	3.4	16.2	5.5		20.3	6.3	8.7	17.6	1.6	17.7	<0.5	5.3	0.9	7.9	16.6	132.2
AECOM_BH68	BH68_2.5-2.9	2.5-2.9	2/03/2010	Normal																		
AECOM_BH68	BH68_4.0-4.3	4-4.3	2/03/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
AECOM_BH68	BH68_7.0-7.1	7-7.1	2/03/2010	Normal																		
AECOM_SV09	SV09_0.2-0.4	0.2-0.4	26/02/2010	Normal	1.4	9.9	18.5	45.3	25.4		43.7	14.5	18	33.9	4.2	97.5	3.4	12.6	5.8	69.1	92.2	495.4
BH001	BH001	1	1/05/2006	Normal	1.1	14.4	19.2	65.9	33.4		98.6	25.5	29.6	70.5	10.4	104	3.6	28.6	11.5	84.4	98.4	699.1
BH001	BH001	4	2/05/2006	Normal	<0.5	0.5	0.8	3.3	2.6		3.3	1	1.3	3.1	<0.5	5	<0.5	1	1.3	2.4	5.1	32.2
BH019	BH019 1.5-1.95	1.5-1.95	8/05/2006	Normal	<0.5	<0.5	1	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	1.3	1.4	<0.5	29.3	4.1	1.1	43.2
BH019	BH019 2.5-3.0	2.5-3	8/05/2006	Normal	24.3	82	79.3	70.3	58.2		56.9	22.6	25.5	54.1	6.4	208	110	22.6	700	295	179	1994.2
BH019	BH019 3.0-3.45	3-3.45	8/05/2006	Normal	31.6	120	114	103	86.3		85.3	32.2	37.2	77.6	8.8	295	157	32.9	891	407	255	2733.9
BH020	BH020 0.3-0.5	0.3-0.5	9/05/2006	Normal	0.6	1.6	2.5	6.2	6.8		7.7	3.7	2.3	5.4	0.8	14.6	1.2	3.1	0.8	7.8	15.2	80.3
BH020	BH021 0.3-0.5	0.3-0.5	9/05/2006	Normal	<0.5	0.9	0.9	2.2	2.3		2.8	1.2	1.1	1.8	<0.5	4.5	<0.5	1.2	0.8	2.8	4.8	28.8
BH020	BH020 1.5-2.1	1.5-2.1	9/05/2006	Normal	<0.5	1.3	1.6	3.9	4.4		5	2.5	1.9	3.6	0.6	8.5	0.7	2.1	0.5	4.7	8.7	50.5
BH020	D0905-1	1.5-2.1	9/05/2006	Field_D	<0.5	1.3	1.7	3.4	4		4.6	2.8	1.7	3.1	<0.5	7.5	0.6	2.2	0.5	4.3	7.8	46.5
BH028	BH028_0.3-0.5	0.3-0.5	12/05/2006	Normal																		
BH028	BH028_13-13.5	13-13.5	12/05/2006	Normal	6.7	38.6	20.4	13.2	8.4		9	3.1	3.2	11.1	0.8	28.2	32.3	2.6	183	76	33.9	470.5
BH042	BH042_ 0.3-0.5	0.3-0.5	23/05/2006	Normal	<0.5	1	1.9	4.2	3.9		2.8	2.6	3.6	4.1	0.8	9.2	0.7	2.3	0.7	6.8	8.9	54
BH042	BH042_ 1.5-1.7	1.5-1.7	23/05/2006	Normal	<0.5	0.8	<0.5	2.6	1.9		1.9	1	1.6	2.6	<0.5	2.7	<0.5	1.1	<0.5	0.9	3.5	23.1
BH042	BH042_ 6.0-6.5	6-6.5	23/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH058	BH058-1.5-1.95	1.5-1.95	31/05/2006	Normal	1.2	8.4	11.1	29	25.3		37.9	19.3	11.8	26.9	4.3	65.3	5.1	16.1	5.7	39.5	61.7	368.6
BH058	BH058-6.0-6.5	6-6.5	31/05/2006	Normal	2.7	15.6	6.9	3.6	2		1.6	0.6	0.6	3.2	<0.5	6.6	12.3	<0.5	59.5	28.9	10	155.1
BH059	BH059-1.5-1.95	1.5-1.95	31/05/2006	Normal	<0.5	2.1	2.1	4.3	3.9		4.6	2.5	1.9	3.7	0.5	8.5	0.6	2	1	6.4	8.5	53.1
BH059	BH059-3.0-3.45	3-3.45	31/05/2006	Normal	<0.5	0.7	1	2.5	2.4		3	1.4	1.2	2	<0.5	4.4	0.5	1.2	<0.5	2.6	5	29.4
BH059	BH059-8.5-9.0	8.5-9	31/05/2006	Normal	<0.5	1.4	0.6	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.8	1.2	<0.5	2.7	3	1.2	15.4
BH060	BH060-1.7-2.0	1.7-2	31/05/2006	Normal	<0.5	1.2	1.3	3.6	3.6		6.3	3.5	2.3	3.7	0.9	5.4	<0.5	2.9	0.6	3.2	5.5	45
BH060	D3105-2	1.7-2	31/05/2006	Field_D	<0.5	0.7	0.8	2.5	2.5		4	2.5	1.4	2.4	0.6	4	<0.5	2	<0.5	2.1	3.9	30.9
BH060	BH060-9.5-10.0	9.5-10	31/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	0.5	8.4
BH060	D3105-3	9.5-10	31/05/2006	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	1.4	0.7	9.1
BH062	BH062-1.5-1.95	1.5-1.95	31/05/2006	Normal	<0.5	6.6	5.1	17.1	19.9		29.7	14.4	10.1	16.8	3.6	38.2	1.1	14	4	17.1	30.6	228.8
BH062	BH062-3.0-3.45	3-3.45	31/05/2006	Normal	<0.5	1	1.8	3.5	4.2		5	3	1.8	3.3	0.5	7.4	0.6	2.3	<0.5	4.9	8.1	48.4
BH065	BH065-0.3-0.5	0.3-0.5	1/06/2006	Normal	<0.5	1.1	1.2	3	3.1		3.6	2.1	1.3	2.7	<0.5	5.9	<0.5	1.6	<0.5	3.6	6.2	37.4
BH065	D0106-1	0.3-0.5	1/06/2006	Field_D	<0.5	<0.5	<0.5	0.6	0.6		0.8	<0.5	<0.5	0.6	<0.5	1.1	<0.5	<0.5	<0.5	0.6	1.2	10
BH065	BH065-1.5-1.95	1.5-1.95	1/06/2006	Normal	<0.5	<0.5	0.6	1.1	0.9		1.1	0.6	<0.5	0.8	<0.5	2.4	<0.5	<0.5	<0.5	1.9	2.3	15.2
BH065	BH065-3.0-3.45	3-3.45	1/06/2006	Normal	7	1.4	9.7	9.5	7.7		9.4	4.5	3.5	8.7	0.9	28.3	7.8	3.6	13.9	34.6	25.8	176.3
BH065	D0106-2	3-3.45	1/06/2006	Interlab_D	5.6	0.9	7.1	9.4	7.8	12		4.7		8.5	1.2	24	5.8	4	12	27	22	140
BH065	D0106-2	3-3.45	1/06/2006	Field_D	6.9	5.7	28.6	33.6	26.2		33	14.6	14.7	27.8	3.2	103	10.8	13.3	17.7	112	84.9	536
BH067	BH067-1.5-1.95	1.5-1.95	1/06/2006	Normal	<0.5	<0.5	0.8	1.2	1.3		1.4	0.9	0.6	1.2	<0.5	3.1	0.7	0.7	0.8	2.9	3	20.1
BH067	BH067-3.0-3.45	3-3.45	1/06/2006	Normal	<0.5	1.1	1.8	5.1	4.5		5.7	2.1	2.4	4.3	<0.5	12.5	0.9	1.8	1.5	7.5	11.9	64.1

Table T1
Human Health Soil Screen - All Depths

Location_Code	Field_ID	Sample_Depth_Range	Sampled_Date_Time	Sample_Type	PAHs Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (ESDAT TOTAL)
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Scenario 1 VMP July 2012									3													40
BH070	BH070_0.3-0.5	0.3-0.5	2/05/2006	Normal	<0.5	0.5	0.6	1.3	1.4		1.6	0.7	0.6	1.1	<0.5	3	<0.5	0.6	0.9	2.3	3.1	19.2
BH070	D0206-1	0.3-0.5	2/05/2006	Field_D	<0.5	0.8	1.1	2.9	2.8		3.3	1.5	1.2	2.6	<0.5	5.7	<0.5	1.3	0.8	3.3	5.8	34.6
BH070	D0206-1	0.3-0.5	2/06/2006	Interlab_D	<0.5	0.6	0.8	2.9	2.8	4		2.1		2.5	0.5	5	<0.5	1.7	0.8	3.1	5.3	29.1
BH070	BH070_1.5-1.95	1.5-1.95	2/05/2006	Normal	<0.5	0.7	1.2	2.5	2.5		3.1	1.5	1.2	2.4	<0.5	4.9	<0.5	1.3	<0.5	3.7	5	32
BH071	BH071_1.5-1.95	1.5-1.95	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH071	BH071_3.0-3.45	3-3.45	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH072	BH072_0.3-0.5	0.3-0.5	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH072	BH072_3.0-3.45	3-3.45	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH072	BH072_9.5-10.0	9.5-10	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH073	BH073_1.5-1.95	1.5-1.95	2/05/2006	Normal	20.6	87.8	77.3	107	100		99.3	44	33.5	88.7	10.7	252	56.5	41.4	14.8	190	228	1451.6
BH073	BH073_2.0-2.4	2-2.4	2/05/2006	Normal	4.4	24.4	18.7	19	15.3		15.6	6.3	6.2	14.6	1.5	48.8	20.8	5.7	80.5	58.3	43	383.1
BH074	BH074_1.5-1.95	1.5-1.95	2/05/2006	Normal	<0.5	0.6	0.5	1.2	1		1.1	<0.5	<0.5	0.9	<0.5	2.4	<0.5	<0.5	<0.5	1.4	2.2	14.8
BH074	BH074_3.0-3.45	3-3.45	2/05/2006	Normal	<0.5	1.5	2.6	3.7	2.8		3	1.1	1.2	2.8	<0.5	8.2	1.3	1	<0.5	8.6	7.7	47
BH074	BH074_9.5-10.0	9.5-10	2/05/2006	Normal	10.5	80.5	60	41.3	32.7		30.6	11.5	12.9	30.1	3.1	112	71.6	10.7	435	184	96.4	1222.9
BH075	BH075_0.3-0.5	0.3-0.5	6/06/2006	Normal	0.5	8.4	7.9	19.4	19		21.2	11.3	9.4	16.4	2.4	42.7	2.2	9.8	2.8	25.7	43	242.1
BH075	D0606-1	1.5-1.95	6/06/2006	Interlab_D	<0.5	1.3	1	3.3	3.2	5		2.2		2.8	0.6	6.2	<0.5	1.8	0.5	3.3	6.4	33.6
BH075	D0606-1	1.5-1.95	7/06/2006	Field_D	<0.5	0.8	0.5	1.7	1.6		1.7	0.8	0.6	1.5	<0.5	3.3	<0.5	0.6	<0.5	1.7	3.6	20.4
BH075	BH075_3.0-3.45	3-3.45	6/06/2006	Normal	<0.5	<0.5	<0.5	0.9	0.8		1.1	0.6	0.5	0.7	<0.5	1.8	<0.5	<0.5	<0.5	1	1.9	12.8
BH087	BH087 1.5-1.95	1.5-1.95	8/06/2006	Normal	21.6	177	136	114	78.5		83.6	34	35.2	69.5	8.6	325	182	31.2	925	496	265	2982.2
BH087	BH087 3.0-3.45	3-3.45	8/06/2006	Normal	24.4	158	120	97.4	79.6		79.6	34	31.9	70.7	8.6	285	160	30.5	1030	439	247	2895.7
BH087	BH087 7.0-7.5	7-7.5	8/06/2006	Normal	23.7	135	104	64.5	49		45.7	20	19.9	50	5.3	163	125	17.4	1090	333	173	2418.5
BH089	BH089 0.3-0.5	0.3-0.5	9/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.8	<0.5	<0.5	<0.5	0.7	0.7	8.7
BH089	BH089 1.5-1.95	1.5-1.95	9/06/2006	Normal	<0.5	2.5	2.3	3.7	3.3		3.4	1.6	1.7	3.1	<0.5	7.7	2	1.4	9	8.3	7.4	58.4
BH089	BH089 3.0-3.45	3-3.45	9/06/2006	Normal	<0.5	2.3	3.4	6.2	5.6		5.9	2.6	2.7	5.4	0.6	13.5	1.1	2.3	0.7	11.5	13	77.3
BH090	BH090 1.5-1.95	1.5-1.95	9/06/2006	Normal	<0.5	<0.5	<0.5	0.6	0.7		0.8	<0.5	<0.5	0.5	<0.5	1.1	<0.5	<0.5	<0.5	0.8	1.1	10.1
BH090	D0906-2	1.5-1.95	9/06/2006	Field_D	<0.5	<0.5	0.5	1.7	1.6		1.6	0.8	0.8	1.4	<0.5	3.2	<0.5	0.7	<0.5	1.7	3.3	19.8
BH090	D0906-2	1.5-1.95	9/06/2006	Interlab_D	<0.5	<0.5	<0.5	1.4	1.3	2		0.9		1.3	<0.5	2.5	<0.5	0.7	<0.5	1.4	2.5	15
BH090	BH090 3.0-3.45	3-3.45	9/06/2006	Normal	<0.5	1	2	3.5	3.3		3.3	1.6	1.7	3.1	<0.5	7.1	<0.5	1.4	<0.5	6.3	7.3	43.6
BH109	BH109 0.3_0.5	0.3-0.5	27/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH109	BH109 3.0_3.45	3-3.45	27/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH109	BH109 9.5_10.0	9.5-10	27/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH113	BH113 1.5_1.95	1.5-1.95	27/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH113	BH113 3.0_3.45	3-3.45	27/06/2006	Normal	<0.5	<0.5	0.6	0.9	0.7		0.8	<0.5	<0.5	0.8	<0.5	1.8	<0.5	<0.5	<0.5	1.8	1.8	13.2
BH114	BH114 0.3_0.5	0.3-0.5	28/06/2006	Normal	<0.5	<0.5	<0.5	1.2	1.7		2	1.3	0.9	1.2	<0.5	2.3	<0.5	0.9	<0.5	1	2.5	18
BH114	BH114 3.0_3.45	3-3.45	28/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH115	BH115 0.8_1.0	0.8-1	28/06/2006	Normal																		
BH115	D2806_1	0.8-1	28/06/2006	Field_D																		
BH115	BH115 1.5_1.95	1.5-1.95	28/06/2006	Normal	<0.5	<0.5	<0.5	0.8	0.7		0.9	<0.5	<0.5	0.7	<0.5	1.7	<0.5	<0.5	<0.5	1	1.6	11.9
BH115	D2806_2	1.5-1.95	28/06/2006	Field_D	<0.5	<0.5	0.5	1.2	1.1		1.4	0.7	0.6	1.1	<0.5	2.9	<0.5	0.5	<0.5	1.9	2.6	17
BH115	BH115 3.0_3.45	3-3.45	28/06/2006	Normal	<0.5	<0.5	<0.5	0.7	0.6		0.8	<0.5	<0.5	0.6	<0.5	1.6	<0.5	<0.5	<0.5	0.8	1.4	11
BH119	BH119 1.6_2.05	1.6-2.05	30/06/2006	Normal	<0.5	<0.5	<0.5	0.6	0.8		0.9	0.6	<0.5	0.6	<0.5	1	<0.5	<0.5	<0.5	0.5	1	10
BH119	BH119 7.5_8.0	7.5-8	30/06/2006	Normal	53.5	273	236	152	149		113	59.9	71.3	121	27.4	550	313	57.2	1620	880	497	5173.3
BH119	BH119 9.5_10.0	9.5-10	30/06/2006	Normal	39.7	240	163	88.9	80		55.5	23.5	43.5	69.8	9	289	239	26.4	1210	504	244	3325.3
BH132	BH132_1.5-1.95	1.5-1.95	6/07/2006	Normal	0.9	3.5	5.4	19.5	17.1		21.9	8.8	9	14.8	2.3	29.5	2	7.1	3.8	16.1	27.5	189.2
BH132	BH132_8.0-8.5	8-8.5	6/07/2006	Normal	18.4	148	57	45	28		27.4	11	11.6	37.5	3	77.6	76.9	8.3	825	228	97.6	1700.3
BH133	BH133_0.3-0.5	0.3-0.5	6/07/2006	Normal	<0.5	1	0.9	2.2	2.1		2.6	1.4	0.9	1.9	<0.5	4	<0.5	1	1.3	2.7	4	27.5
BH133	BH133 1.5_1.95	1.5-1.95	6/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH135	BH135A-0.4-0.6	0.4-0.6	11/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH135	BH135A-3.0-3.45	3-3.45	11/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH137	BH137 1.5_1.95	1.5-1.95	6/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	0.5		0.6	<0.5	<0.5	<0.5	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	0.8	8.7
BH137	BH137 3.0_3.45	3-3.45	6/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH141	BH141 1.5_1.95	1.5-1.95	7/07/2006	Normal	1.8	11.8	14.6	28.2	24.6		25.2	12.2	10.6	24.1	2.5	72.2	4.5	9.6	2.3	38.4	67.9	350.5
BH141	BH141 3.0_3.45	3-3.45	7/07/2006	Normal	127	600	499	429	344		359	149	140	328	35.4	1160	725	124	5840	1820	980	13,659
BH145	BH145-0.3-0.5	0.3-0.5	11/07/2006	Normal	1.5	22	24.1	81.4	72.4		91.3	45.6	36.4	72	11.9	130	5.6	36.1	8.8	61.6	149	849.7
BH145	D1107-01	0.3-0.5	11/07/2006	Field_D	1.5	24.2	26.2	85.7	78.1		96.1	48.8	37.1	76	13.1	132	6.3	38.9	11.6	65.6	152	893.2
BH145	D1107-1	0.3-0.5	11/07/2006	Interlab_D	1.4	18	32	123	139	150		64		111	22	219	6.7	59	10	127	230	1162.1
BH145	BH145-3.0-3.45	3-3.45	11/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	0.7	8.4
BH146	BH146-1.5-1.95	1.5-1.95	11/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH146	BH146-3.0-3.33	3-3.33	11/07/2006	Normal	8.8	58.8	35.4	89.7	67.3		72.8	33	28.9	69	8.5	184	10.9	31.4	28.3	26.6	198	951.4
BH146	BH146-4.1-4.6	4.1-4.6	11/07/2006	Normal	16	78.8	58.6	43.5	32.9		37.2	16.2	14.8	34.7	4.1	107	71.6	14.2	454	186	105	1274.6
BH156	BH156_0.4-0.5	0.4-0.5	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH156	D1408-4	0.4-0.5	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
BH156	BH156_0.9-1.0	0.9-1	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH156	D1408-5	0.9-1	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	0.5	7
BH159	BH159_0.25-0.35		14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH159	D1408-8	0.25-0.35	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
BH160	D1408-11		14/08/2006	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH160	BH160_0.3-0.4	0.3-0.4	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH160	D1408-11	0.3-0.4	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
BH161	BH161_0.3-0.4	0.3-0.4	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH161	D1408-12	0.3-0.4	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
BH197	BH197/0.4	0.4	3/03/2008	Normal	<0.5	<0.5	0.5	0.6	<0.5		0.6	0.5	<0.5	<0.5	<0.5	3.5	0.6	<0.5	<0.5	2.9	2.9	16.1
BH197	BH197/5.0	5	9/04/2008	Normal	5.1	27	19.2	57.7	34.2		31.4	9.2	15.7	36.5	3	86.6	10.1	9.5	83	23.6	95	546.8
BH197	BH197/6.5	6.5	9/04/2008	Normal	<0.5	<0.5	0.5	0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	1	0.6	<0.5	4.8	1.6	1	14.5
BH197	D02-090408	6.5	9/04/2008	Interlab_D	0.5	0.9	1.7	1.9	1.6	2		0.7		1.6	<0.5	4.5	2	0.7	18.4	6.6	4.2	45.8
BH197	BH197/11.5	11.5	9/04/2008	Normal	1.7	9.9	3.6	2.7	1.2		1	<0.5	<0.5	1.7	<0.5	3.8	9.2	<0.5	31.1	19.3	6.1	93.3
BH197	BH197/15.9	15.9	10/04/2008	Normal	<0.5	1	0.7	0.6	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	1.3	1	<0.5	2	2.7	1.2	14.5
BH197	BH197/18.6	18.6	10/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH198	BH198/3.0	3	6/03/2008	Normal	3.4	16.3	12.7	13.3	26.3		26.5	12.7	10.5	12.7	4.3	26.6	4.7	11.8	17.2	21	54.8	274.8
BH198	D01-060308	3	6/03/2008	Field_D	2.3	25.6	16.3	20.6	29.8		29.6	11.9	8.8	21	4.5	44.5	6.1	10.8	11.1	15.8	87.5	346.2
BH198	BH198/4.5	4.5	6/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	<0.5	<0.5	8.5
BH198	BH198/6.9	6.9	6/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH199	BH199/2.7	2.7	11/03/2008	Normal	2	11.6	9	20.3	14.4		14.6	5.4	6.5	14.6	1.3	42.7	3.8	4.8	1.5	25.3	39.4	217.2
BH199	BH199/3.7	3.7	11/03/2008	Normal	14.2	47.2	44.7	39.8	27.4		29.8	10.3	11.9	28	2.5	122	69	10.4	439	164	98.7	1158.9
BH199	D01-110308	3.7	11/03/2008	Interlab_D	29.6	77.9	81.8	96.8	70.2	95		29.2		73	10	254	173	25.6	974	461	218	2574
BH199	BH199/5.6	5.6	11/03/2008	Normal	<0.5	1.4	1.3	1.8	1.1		1	<0.5	0.6	1.4	<0.5	4.8	1	<0.5	3.5	2.9	4.4	27.2
BH199	BH 199/6.0	6	17/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH199	BH199/6.0	6	17/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH200	BH200/1.0	1	7/04/2008	Normal	5.2	54.8	75.7	158	113		158	30.4	48.2	128	11.6	320	14.8	34.4	64.4	269	296	1781.5
BH200	BH200/2.5	2.5	7/04/2008	Normal	1	6.7	9.9	16.9	12.4		18.2	8.3	7.3	14.6	2.2	34.7	5.4	6.9	10.1	32.4	33.1	220.1
BH200	BH200/6.53	6.53	7/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH201	BH201/2.4	2.4	4/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH201	BH201/10.3	10.3	18/03/2008	Normal	1.5	6.5	5.5	13.1	15.6		16.7	6.7	4.7	11	1.9	21.9	4.3	6.2	5	16.2	23.6	160.4
BH201	BH201/11.0	11	18/03/2008	Normal	<0.5	<0.5	<0.5	0.6	0.6		0.6	<0.5	<0.5	<0.5	<0.5	1.1	<0.5	<0.5	<0.5	<0.5	1.5	9.9
BH202	BH202/2.3	2.3	10/03/2008	Normal	<0.5	1	1.6	6.5	6.5		6.4	3.9	3	5.5	0.9	11.4	<0.5	3.9	1	3.4	11.6	67.6
BH202	BH202/4.7	4.7	10/03/2008	Normal	1.1	0.8	2	4	3.6		3.5	1.7	1.8	3.1	<0.5	8.9	0.8	1.7	<0.5	4.8	9.8	48.6
BH202	BH202/6.8	6.8	10/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH203	BH203/1.9	1.9	10/03/2008	Normal	<0.5	1.4	2.2	5	5.1		5.3	3.4	2.3	4.1	0.9	9.3	<0.5	3.4	<0.5	5.9	9.1	58.9
BH203	BH203/7.3	7.3	10/03/2008	Normal	<0.5	0.8	1.3	2.9	2.6		2.4	1.2	1.1	2.2	<0.5	5.5	0.6	1.2	0.7	3.4	5.6	32.5
BH204	BH204/1.0	1	18/03/2008	Normal	45.2	194	187	128	78.6		68.8	39.8	59	83.5	9.9	373	295	41.3	1180	673	246	3702.1
BH204D	BH204D/1.5	1.5	7/04/2008	Normal	222	605	1200	823	652		587	305	231	631	71.4	1550	1190	247	8410	2700	1510	20,934
BH204D	BH204D/3.0	3	7/04/2008	Normal	85.6	234	283	255	195		210	38.2	40.4	184	13.3	655	384	40.8	1970	1090	545	6223.3
BH204D	BH204D/4.0	4	7/04/2008	Normal	73.4	336	338	299	224		239	42.5	41	212	16.3	777	462	48.3	2930	1290	644	7972.5
BH205	BH205/7.8	7.8	27/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	0.5	<0.5	8.2
BH205	D01_270308	7.8	27/03/2008	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	5.5	<0.5	<0.5	12
BH205	BH205/9.3	9.3	27/03/2008	Normal	11	57.6	30.7	25.2	15.5		14.3	5.6	6.7	20.8	1.6	42.4	42.9	5	291	117	50.8	738.1
BH205	BH205/13.0	13	1/04/2008	Normal	1.2	3.8	3.9	2.9	1.9		2.1	0.6	0.8	2	<0.5	7.5	6	0.6	28.8	13.1	6.3	82
BH205	BH205/13.8	13.8	1/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH205	D01_010408	13.8	1/04/2008	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH205	BH205/19.2	19.2	2/04/2008	Normal	<0.5	0.7	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	0.7	1.4	0.7	9.5
BH205	BH205/22.2	22.2	2/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH206	BH206/0.5	0.5	7/03/2008	Normal	<0.5	4.2	3.9	8.4	7.8		7.7	3.6	3.6	7.5	1.1	15.6	0.9	3.4	1.9	11.8	16.8	98.7
BH206	BH206/1.8	1.8	17/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	8
BH206	BH206/4.6	4.6	17/04/2008	Normal	<0.5	0.6	0.7	1.7	1.2		1.5	0.7	0.6	1.1	<0.5	4	<0.5	0.6	<0.5	2.4	3.6	20.7
BH206	BH206/7.1	7.1	17/04/2008	Normal	1.4	10	5.6	4.1	2.1		1.9	0.7	0.7	2.5	<0.5	6.7	8.3	0.6	39.8	16.9	8.8	110.6
BH206	BH206/10.7	10.7	21/04/2008	Normal	<0.5	1.9	1.6	1.2	0.7		0.8	<0.5	<0.5	0.9	<0.5	2.1	1.4	<0.5	3.5	5.1	2.5	24.2
BH207	BH207/7.45	7.45	3/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH207	BH207/12.0	12	3/04/2008	Normal	<0.5	2.2	1.9	4.4	4.8		5.2	2.5	1.7	3.6	0.6	8.8	0.7	2.2	1.2	4.3	9.5	54.1
BH207	BH207/13.1	13.1	3/04/2008	Normal	<0.5	2.4	2	1.8	1.2		1.3	<0.5	<0.5	1.5	<0.5	3.5	2.4	<0.5	6.1	6.5	4.3	35.5
BH207	BH207/15.0	15	3/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	8.1
BH208	BH208/2.25	2.25	4/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH208	BH208/9.5	9.5	4/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH208	BH208/13.5	13.5	4/04/2008	Normal	<0.5	1.8	3.2	9.4	9.3		11.4	4.9	3	8.9	0.9	20.5	0.7	3.9	0.7	8.4	22.8	110.3
BH209	BH209/2.3	2.3	22/04/2008	Normal	0.7	7.5	4.8	10.8	16.5		19.8	7.7	6.4	8	2.2	20.1	1.9	6.6	2.6	7.6	44.8	168

Table T1
Human Health Soil Screen - All Depths

Location_Code	Field_ID	Sample_Depth_Range	Sampled_Date_Time	Sample_Type	PAHs Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (ESDAT TOTAL)
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Scenario 1 VMP July 2012									3													40
BH209	BH209/4.5	4.5	22/04/2008	Normal	5.9	33.8	19.1	17.7	11.2		11.4	4.5	2.7	12.9	1.2	28.3	24.8	3.4	203	75.5	41.6	497
BH209	BH209/6.1	6.1	22/04/2008	Normal	6.8	54.9	22.3	15.4	9.1		7	3.2	2.9	11	1	24.6	27	2.2	498	86.5	42.1	814
BH209	BH209/9.4	9.4	23/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH210	BH210/1.5	1.5	18/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH210	BH210/15.9	15.9	27/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH211	BH211/14.0	14	26/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH211	BH211/15.5	15.5	26/03/2008	Normal	<0.5	1.9	1.4	0.8	<0.5		<0.5	<0.5	<0.5	0.6	<0.5	1.2	1.2	<0.5	5.2	3.6	1.8	21.2
BH211	BH211/16.05-16.15	16.05-16.15	26/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH4	BH4 0.4-0.5	0.4-0.5	21/02/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
BH4	BH4 2.3-2.4	2.3-2.4	21/02/2008	Normal	<1.2	52.8	12.3	9.4	11.4	23		8.4		8.1	3.9	10.1	<1.2	8.6	4.6	5.3	4.6	141.9
BH4	BH4 4.2-4.3	4.2-4.3	21/02/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
BH405	BH405_13.0-13.2	13-13.2	11/02/2011	Normal	11.2	45.2	40.9	30.2	21.6		25.7	7.5	14.3	23.6	2	72.9	46.5	7.6	208	130	63	750.2
BH405	BH405_14.0-14.4	14-14.4	11/02/2011	Normal	44.9	221	182	130	86.2		96.3	49.1	44.5	93	10.3	301	236	42	1040	470	250	3296.3
BH405	QC609	14-14.4	11/02/2011	Field_D	43.2	213	168	129	84.8		94.3	47.7	45.1	90.2	10.4	290	208	41.6	1010	456	239	3170.3
BH405	BH405_4.0-4.3	4-4.3	10/02/2011	Normal	<0.5	0.9	1.2	5	5.9		8	2.6	2.4	5	<0.5	6.8	<0.5	2.2	<0.5	1.4	17.1	60.5
BH405	BH405_7.0-7.3	7-7.3	10/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH408	BH408_2.0-2.4	2-2.4	14/02/2011	Normal	<0.5	2.2	3.5	6.2	6.3		7.1	4.5	3.1	5.2	0.7	12.6	<0.5	3.6	<0.5	6.6	12.9	76
BH408	BH408_8.0-8.3	8-8.3	15/02/2011	Normal	1.8	6.1	6.2	2.6	1.3		1.1	0.6	<0.5	1.9	<0.5	4.3	7	<0.5	13	9.4	6.9	63.7
BH408	BH408_9.0-9.4	9-9.4	15/02/2011	Normal	4.2	22.9	12.5	9.7	5.6		4.6	2.6	2.3	7.6	0.6	14.5	16.6	2	89.8	38.8	18.3	252.6
BH408	QC613	9-9.4	15/02/2011	Field_D	1.1	6.6	3.9	2.5	1.4		1.1	0.6	0.5	1.9	<0.5	4.2	4.8	<0.5	23.8	11.7	5.2	70.3
BH409	BH409_3.7-4.0	3.7-4	14/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
BH409	BH409_5.0-5.3	5-5.3	14/02/2011	Normal	5.6	2.8	1.9	0.6	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	1.2	2.2	<0.5	33.8	6.8	1.8	60.2
BH409	BH409_6.0-6.4	6-6.4	15/02/2011	Normal																		
BH409	BH409_7.0-7.3	7-7.3	15/02/2011	Normal	<0.5	0.7	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.8	1.1	0.6	11.2
BH5	BH5 0.4-0.5	0.4-0.5	23/02/2008	Normal	<0.5	6.4	4.4	11.8	6.9	20		2.2		4.9	<0.5	15.9	<0.5	3.4	0.7	11.6	14.7	84.4
BH5	BH5 1.2-1.3	1.2-1.3	23/02/2008	Normal	<0.5	<0.5	<0.5	0.6	<0.5	<1		<0.5		<0.5	<0.5	0.8	<0.5	<0.5	1.6	0.7	0.9	9.1
BH8	BH8 0.26-0.4	0.26-0.4	19/02/2008	Normal	<0.5	7.4	5.9	24	16.1	34		4.5		7.6	2.5	23	0.8	7.2	0.9	12.6	24.2	137.2
BH8	BH8 0.6-0.7	0.6-0.7	19/02/2008	Normal	<0.5	17.1	11.5	33.5	31.3	57		4.8		10.5	2	62	1.9	9.5	2.3	24.8	63.3	275
BH9	BH9 0.4-0.5	0.4-0.5	21/02/2008	Normal	<0.5	<0.5	<0.5	0.6	<0.5	<1		<0.5		<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	0.6	7.2
BH9	QC4	0.4-0.5	22/02/2008	Field_D	<0.5	0.6	<0.5	<0.5	<0.5	<1		2.2		<0.5	<0.5	<0.5	0.6	1.2	<0.5	<0.5	<0.5	9.6
BH9	BH9 0.9-1.0	0.9-1	21/02/2008	Normal	<0.5	0.6	0.5	2.6	1.2	2		0.6		1	<0.5	2.6	<0.5	0.7	<0.5	1.6	2.7	16.1
MW10_Coffey	MW10 1.9-2.0	1.9-2	21/02/2008	Normal	<0.5	1.6	2.4	21.1	8.6	14		1.2		7.1	1	16.8	<0.5	2.3	<0.5	7.6	17.5	88.7
MW10_Coffey	QC3	1.9-2	21/02/2008	Field_D	<0.5	2.4	3.7	19.4	9.3	16		0.9		7.4	0.9	16.2	0.7	2.5	<0.5	12.4	17.4	94.2
MW10_Coffey	QC3A	1.9-2	21/02/2008	Normal	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2		<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.35
MW10_Coffey	MW10 4.9-5.0	4.9-5	21/02/2008	Normal	212	652	523	934	278	698		21.8		61	9.4	966	662	52	224	1740	947	7282.2
MW10_Coffey	MW10 8.6-8.7	8.6-8.7	22/02/2008	Normal	511	1700	2150	1470	412	968		26		771	20.3	2440	2100	32.5	10,200	5180	2640	29,653
MW10_Coffey	QC5	8.6-8.7	22/02/2008	Field_D	482	1620	2000	1870	442	975		32.6		181	8.8	2190	1960	38.2	9700	4900	2460	27,885
MW10_Coffey	QC5A	8.6-8.7		Normal	170	260	790	570	330	470		130		410	45	1100	800	140	11,000	2100	1200	19,045
MW15_Coffey	MW15_0.4-0.5	0.4-0.5	10/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
MW15_Coffey	MW15_1.4-1.5	1.4-1.5	10/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
MW15_Coffey	QC1	1.4-1.5	10/04/2008	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
MW15_Coffey	QC1A	1.4-1.5	21/02/2008	Normal																		
MW3	MW3 0.4-0.5	0.4-0.5	23/02/2008	Normal	<0.5	0.6	<0.5	0.8	<0.5	1		1		<0.5	<0.5	0.7	<0.5	0.7	<0.5	0.5	0.8	8.6
MW3	MW3 0.9-1.0	0.9-1	23/02/2008	Normal	1.7	42.5	13.8	44.6	11.7	62		4.2		23.4	2.7	91.1	8.5	8.6	2.5	120	93.2	468.5
MW3	QC6	1.9-2	23/02/2008	Field_D	3.5	30.4	23.6	53.9	24.1	70		5.3		6.1	2.8	83.1	14.6	8.4	17.3	110	86.7	469.8
MW3	MW3 2.9-3.0	2.9-3	23/02/2008	Normal	3.2	20	25.3	15.8	10.9	26		4.4		10.6	1.3	35.8	20.9	5.8	55	65.8	37.2	312
MW6	MW6 0.8-0.9	0.8-0.9	20/02/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
MW6	QC1	0.8-0.9	20/02/2008	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
MW6	QC1A	0.8-0.9	21/02/2008	Normal	<0.1	<0.1	<0.1	0.2	0.14	0.2		<0.1		0.1	<0.1	0.3	<0.1	<0.1	<0.1	0.1	0.3	1.94
MW6	MW6 2.5-2.6	2.5-2.6	20/02/2008	Normal	<0.5	1.9	1.2	3.8	1.7	3		0.6		1.5	<0.5	5	<0.5	0.8	<0.5	2.7	5.2	26.4
MW6	MW6 4.4-4.5	4.4-4.5	20/02/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
MW6	QC2	4.4-4.5	20/02/2008	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7
MW6	QC2A	4.4-4.5	21/02/2008	Normal	<0.1	<0.1	<0.1	0.2	0.16	0.3		<0.1		0.2	<0.1	0.3	<0.1	<0.1	<0.1	0.2	0.4	2.26
MW7	MW7 1.4-1.5	1.4-1.5	25/02/2008	Normal	0.7	7.7	9.6	41.2	32.1	49		1.4		16.1	1.7	36.6	2	6.5	1.6	24.9	35.9	218
MW7	MW7 3.5-3.6	3.5-3.6	25/02/2008	Normal	33.7	48.7	28.7	86.7	59.7	70		2.9		8.6	1.7	62.3	39.6	8.6	150	116	48.8	696
MW7	MW7 4.5-4.6	4.5-4.6	25/02/2008	Normal	210	3060	800	863	359	608		59.8		341	22.9	1470	1160	144	7800	3350	2030	21,670
MW7	QC7	4.5-4.6	25/02/2008	Field_D	28.5	282	102	156	57.6	105		10.8		45.4	10	206	114	22.4	1000	409	258	2701.7
MW7	DUP 8	5-5.1	25/02/2008	Field_D	190	2180	552	648	261	581		33.8		286	21.8	1240	1080	96	8150	3220	1770	19,729
MW7	MW7 5.0-5.1	5-5.1	25/02/2008	Normal	282	4140	1200	1240	677	1170		87.7		582	57.2	2160	1980	196	10,200	4870	3110	30,782
TBH01	DUP 01	0.43-0.5	5/02/2011	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	0.7	8.4
TBH01	TBH01_0.43-0.5	0.43-0.5	5/02/2011	Normal	<0.5	<0.5	0.5	1.9	1.7		1.8	0.6	0.7	1.4	<0.5	3.1	<0.5	0.6	<0.5	1.2	3	19
TBH01	TRIP01	0.43-0.5	5/02/2011	Interlab_D	<0.5	<0.5	<0.5	0.8	1	1.7		0.7		0.7	<0.5	1.3	<0.5	0.6	<0.5	<0.5	1.1	9.7
TBH03	TBH03_1.2-1.3	1.2-1.3	5/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
TBH03	TBH03_1.5-1.6	1.5-1.6	5/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
TBH05	TBH05_0.6-0.7	0.6-0.7	12/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
TBH05	TBH05_1.3-1.7	1.3-1.7	12/02/2011	Normal	<0.5	<0.5	<0.5	0.7	0.7		0.8	<0.5	<0.5	<0.5	<0.5	1	<0.5	<0.5	<0.5	<0.5	0.9	9.6
TBH05	DUP02	1.8-2	12/02/2011	Field_D	0.6	0.7	3.6	14.6	16.1		18.1	11.5	10.9	11.8	2.5	17.8	0.6	10.6	0.8	9.5	14.9	144.6
TBH05	TBH05_1.8-2.0	1.8-2	12/02/2011	Normal	0.6	0.9	3.1	15.6	18.8		23.8	15.1	9.3	13.2	3.4	19.1	<0.5	14	0.6	8.3	16	162.3
TBH06	TBH06_0.55-0.6	0.55-0.6	5/02/2011	Normal	<0.5	<0.5	<0.5	0.9	0.8		0.7	<0.5	<0.5	0.7	<0.5	1.7	<0.5	<0.5	<0.5	0.6	1.9	11.8
TBH06	TBH06_1.5-2.0	1.5-2	12/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8
TBH07	TBH07_0.1-0.15	0.1-0.15	4/02/2011	Normal	<0.5	1.4	1.4	4.7	7.8		8	6.5	2.7	4.8	0.8	6.4	<0.5	4.1	<0.5	1.4	8.6	60.1
TBH08	TBH08_0.13-0.25	0.13-0.25	4/02/2011	Normal	<0.5	<0.5	<0.5	1.3	1.5		1.3	0.7	0.5	1.1	<0.5	2.8	<0.5	<0.5	<0.5	<0.5	3.1	16.3
Statistical Summary																						
Number of Results					306	306	306	306	306	73	233	306	233	306	306	306	306	306	306	306	306	306
Number of Detects					115	175	178	199	190	47	146	173	127	188	118	211	147	164	164	207	217	223
Minimum Concentration					<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.5	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.35
Minimum Detect					0.5	0.5	0.5	0.2	0.14	0.2	0.5	0.5	0.5	0.1	0.5	0.3	0.5	0.5	0.5	0.1	0.3	1.7
Maximum Concentration					511	4140	2150	1870	677	1170	824	305	324	771	72.5	2440	2100	247	11,000	5180	3110	30,782
Maximum Detect					511	4140	2150	1870	677	1170	824	305	324	771	72.5	2440	2100	247	11,000	5180	3110	30,782
Average Concentration					14	78	58	57	32	99	29	11	11	32	3.3	114	68	11	417	194	114	1232
Median Concentration					0.25	0.9	1.15	2.45	1.65	3	1.6	0.7	0.6	1.75	0.25	4.1	0.25	0.7	0.7	3.05	4.1	31.45
Standard Deviation					54	358	223	195	89	242	87	30	32	92	8.7	344	257	29	1583	672	367	4188
Number of Guideline Exceedances					0	0	0	0	128	0	0	0	0	0	0	0	0	0	0	0	0	145
Number of Guideline Exceedances(Detects Only)					0	0	0	0	128	0	0	0	0	0	0	0	0	0	0	0	0	145

Table T1
Human Health Soil Screen - All Depths

					TPH				BTEX						Phenols	Cyanides			Inorganics
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Cyanide (WAD)	Cyanide (Free)	Cyanide Total	Ammonia as N
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					10	50	100	100	0.2	0.2	0.2	0.2	0.2	0.15	0.01	1	1	1	20
Scenario 1 VMP July 2012					10	50	100	100	1.1	5.4	5000	590	690	630	17,000	1000	1000	1000	
Location_ Code	Field_ID	Sample_ Depth_ Range	Sampled_ Date_Time	Sample_ Type															
AECOM_BH33	BH33_0.75-0.85	0.75-0.85	2/12/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
AECOM_BH33	BH33_5.0-5.2	5-5.2	2/12/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH33	BH33_8.0-8.2	8-8.2	2/12/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
AECOM_BH34	BH34_1.8-2.2	1.8-2.2	25/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH34	QC240	1.8-2.2	25/02/2010	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH34	QC241	1.8-2.2	25/02/2010	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1		<1	
AECOM_BH34	BH34_11.0-11.2	11-11.2	25/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH34	BH34_6.0-6.2	6-6.2	25/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH35	BH35_4.9-5.0	4.9-5	22/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH35	BH35_9.9-10.0	9.9-10	22/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH36	BH36_1.0-1.2	1-1.2	3/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH36	BH36_15-15.05	15-15.05	3/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH36	BH36_4.0-4.4	4-4.4	3/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH36	BH36_8.5-8.9	8.5-8.9	3/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH40	BH40_16.5-16.7	16.5-16.7	18/02/2010	Normal					5.4	1.3	14	17.2	5.6	22.8	<0.5	<1	<1		
AECOM_BH40	BH40_17.8-18.0	17.8-18	18/02/2010	Normal					0.8	<0.5	1.5	2.4	1	3.4	<0.5		<1	<1	
AECOM_BH40	BH40_19.0-19.4	19-19.4	18/02/2010	Normal	<10	<50	<100	<100	0.6	<0.5	0.6	<0.5	<0.5	<1	<0.5				
AECOM_BH40	BH40_7.0-7.2	7-7.2	18/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH40	QC54	8.5-8.7	18/02/2010	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH42	BH42_1.0-1.1	1-1.1	23/02/2010	Normal	<10	<50	110	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH42	BH42_3.2-3.3	3.2-3.3	23/02/2010	Normal	234	4680	13,200	4150	1	40.8	1.5	39.9	83.6	123.5	<1.2	<1			
AECOM_BH42	BH42_3.5-3.6	3.5-3.6	23/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH44	BH44_1.9-2.0	1.9-2	23/02/2010	Normal	10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH44	BH44_4.9-5.0	4.9-5	23/02/2010	Normal	147	1040	2650	650	2.1	18.1	5.4	25.7	20.9	46.6	<1.2	<1	<1		
AECOM_BH45	BH45_13.2-13.4	13.2-13.4	23/02/2010	Normal	<10	<50	<100	<100							<0.5				
AECOM_BH45	BH45_3.2-3.4	3.2-3.4	23/02/2010	Normal	10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH45	QC230	3.2-3.4	24/02/2010	Field_D	<10	<50	<100	<100							<0.5				
AECOM_BH45	BH45_7.2-7.4	7.2-7.4	23/02/2010	Normal	12	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH45	QC231	7.2-7.4	23/02/2010	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH45	QC232	7.2-7.4	23/02/2010	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1	<1		
AECOM_BH49	BH49_1.5-1.7	1.5-1.7	22/02/2010	Normal	11	80	1460	790	<0.2	<0.5	<0.5	<0.5	<0.5	<1	1.9				
AECOM_BH49	BH49_10.2-10.4	10.2-10.4	22/02/2010	Normal	56	670	1240	420	5.5	1.4	10.8	9.9	4.7	14.6	1.6	<1	<1		
AECOM_BH49	BH49_12.2-12.4	12.2-12.4	22/02/2010	Normal					10.2	2	16.6	21.2	7.7	28.9	2.8	<1	<1		
AECOM_BH49	BH49_4.2-4.4	4.2-4.4	22/02/2010	Normal	13	250	1610	1080	<0.2	<0.5	<0.5	<0.5	<0.5	<1	15.8				
AECOM_BH49	BH49_6.2-6.4	6.2-6.4	22/02/2010	Normal	<10	160	450	150	1.6	<0.5	1.8	2	0.8	2.8	<0.5	<1	<1		
AECOM_BH49	QC223	6.2-6.4	22/02/2010	Field_D	11	60	260	<100	2.4	<0.5	2.5	2.6	1	3.6	<0.5	<1	<1		
AECOM_BH49	QC224	6.2-6.4	22/02/2010	Interlab_D	10	130	110	<100	3.3	1.3	3.4	4	1.8	5.8	<0.5	<1	<1		
AECOM_BH49	BH49_8.2-8.4	8.2-8.4	22/02/2010	Normal	348	1160	2650	790	49.7	5.2	74.6	61.5	22.6	84.1	<0.5				
AECOM_BH50	BH50_1.3-1.5	1.3-1.5	26/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH51	BH51_0.4-0.5	0.4-0.5	6/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH52	BH52_1.0-1.2	1-1.2	22/02/2010	Normal	78	<50	580	370	0.2	2.7	3.9	20.2	8.7	28.9					
AECOM_BH52	BH52_2.2-2.6	2.2-2.6	22/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH52	QC220	2.2-2.6	22/02/2010	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH52	QC221	2.2-2.6	22/02/2010	Interlab_D	<10	<50	<100	<100	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1	<1		
AECOM_BH52	BH52_4.2-4.4	4.2-4.4	22/02/2010	Normal	10	<50	6600	2370	1.7	1	1.1	1.4	0.7	2.1	7.4	<1	<1		
AECOM_BH53	BH53_1.1-1.5	1.1-1.5	6/03/2010	Normal	<10	<50	1920	1330	0.4	<0.5	<0.5	<0.5	<0.5	<1	1.2				
AECOM_BH53	QC208	1.1-1.5	6/03/2010	Field_D	<10	<50	1040	860	0.3	<0.5	<0.5	<0.5	<0.5	<1	0.8				
AECOM_BH53	BH53_2.0-2.4	2-2.4	6/03/2010	Normal	<10	260	4540	2430	2.7	<0.5	1.4	0.8	<0.5	1.3	3.5	<1		76	
AECOM_BH53	BH53_4.0-4.4	4-4.4	6/03/2010	Normal	3000	28,400	46,800	11,000	678	50.7	670	470	197	667	540	<1		56	
AECOM_BH54	BH54_1.0-1.4	1-1.4	23/02/2010	Normal	72	4380	11,700	3560	2.5	3.5	7.3	25	10.5	35.5	5				
AECOM_BH54	QC228	1-1.4	23/02/2010	Field_D	212	10,300	27,600	8940	4.3	8	21.5	62.2	26.4	88.6	<4	<1	<1		
AECOM_BH54	BH54_2.8-3.0	2.8-3	23/02/2010	Normal	13	900	2980	1000	<0.2	0.8	<0.5	3.2	1.6	4.8	<1.2	<1	<1		
AECOM_BH55	BH55_1.0-1.2	1-1.2	25/02/2010	Normal	109	11,300	19,400	5550	7.8	2.8	14	24.1	10.8	34.9	23.5	8		127	
AECOM_BH55	BH55_2.2-2.4	2.2-2.4	25/02/2010	Normal	304	6420	10,600	3740	22.2	29.6	2.3	48.8	51.6	100.4	<1.2	<1		249	
AECOM_BH55	BH55_2.7-2.9	2.7-2.9	25/02/2010	Normal	104	9150	14,800	4750	9.4	8.9	2	19.8	21.1	40.9	<4	<1		22	
AECOM_BH58	BH58_10.8-11.2	10.8-11.2	22/02/2010	Normal	<10	<50	420	430	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH58	BH58_1.0-1.2	1-1.2	22/02/2010	Normal	<10	<50	550	460	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH58	BH58_3.2-3.4	3.2-3.4	22/02/2010	Normal	<10	80	450	380	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH58	QC225	3.2-3.4	22/02/2010	Field_D	<10	<50	520	400	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH58	QC226	3.2-3.4	22/02/2010	Interlab_D	<10	<50	320	270	<0.2	<0.5	<0.5	<1	<0.5	<1.5	<0.5				
AECOM_BH58	BH58_5.2-5.4	5.2-5.4	22/02/2010	Normal	<10	<50	320	300	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH58	BH58_8.6-8.8	8.6-8.8	22/02/2010	Normal	<10	<50	640	510	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH59	BH59_1.9-2.0	1.9-2	22/02/2010	Normal	<10	980	2290	860	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH59	BH59_3.4-3.5	3.4-3.5	22/02/2010	Normal	459	9120	19,200	6140	82.4	88.3	32.5	103	51.2	154.2	1.8				
AECOM_BH59	BH59_4.2-4.3	4.2-4.3	22/02/2010	Normal	14	140	380	130	3.4	<0.5	2.9	2.4	0.9	3.3	1.6		<1		
AECOM_BH61	BH61_0.3-0.4	0.3-0.4	6/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
AECOM_BH61	BH61_2-2.4	2-2.4	7/03/2010	Normal	67	450	8130	4660	32.7	<0.5	9.5	5.4	1.4	6.8	<0.5	<1		13	
AECOM_BH61	QC211	2-2.4	7/03/2010	Field_D	20	280	6180	3420	7.8	<0.5	2.8	1.9	<0.5	2.4	<0.5				
AECOM_BH61	QC212	2-2.4	7/03/2010	Interlab_D	29	420	8390	4380	13.1	<0.5	4.6	2.6	0.6	3.2	1.9				
AECOM_BH61	BH61_3-3.4	3-3.4	7/03/2010	Normal	75	320	1220	460	11.2	5.9	14.7	16.2	5.8	22	<1.2				
AECOM_BH62	BH62_1.0-1.2	1-1.2	26/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		9	
AECOM_BH62	BH62_11.8-12.0	11.8-12	26/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH62	BH62_3.4-3.8	3.4-3.8	26/02/2010	Normal	<10	<50	140	240	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH62	BH62_5.4-5.6	5.4-5.6	26/02/2010	Normal	<10	<50	390	330	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
AECOM_BH64	BH64_10.0-10.3	10-10.3	1/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
AECOM_BH64	BH64_1.0-1.2	1-1.2	1/03/2010	Normal	<10	260	1970	1000	0.2	<0.5	<0.5	<0.5	<0.5	<1	3.8				
AECOM_BH64	BH64_2.5-2.7	2.5-2.7	1/03/2010	Normal	<10	<50	640	590	<0.2	<0.5	<0.5	<0.5	<0.5	<1				<1	
AECOM_BH64	BH64_5.5-5.7	5.5-5.7	1/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
AECOM_BH65	BH65_11.2-11.4	11.2-11.4	24/02/2010	Normal	14	450	1110	220	<0.2	0.8	<0.5	3.5	2.3	5.8	<0.5	<1	<1		
AECOM_BH65	BH65_13.4-13.6	13.4-13.6	24/02/2010	Normal	<10	100	380	<100	<0.2	<0.5	<0.5	1.1	0.7	1.8	<0.5	<1	<1		
AECOM_BH65	BH65_3.4-3.6	3.4-3.6	24/02/2010	Normal	<10	710	7500	5760	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH65	QC234	3.4-3.6	24/02/2010	Field_D	<10	820	13,200	4920	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<4	<1	<1		
AECOM_BH65	BH65_8.2-8.6	8.2-8.6	24/02/2010	Normal	<10	<50	560	470							<0.5				
AECOM_BH66	BH66_2.3-2.4	2.3-2.4	24/02/2010	Normal	<10	<50	420	390	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH66	BH66_3.2-3.6	3.2-3.6	24/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
AECOM_BH66	BH66_7.0-7.2	7-7.2	24/02/2010	Normal	<10	<50	<100	<100							<0.5				
AECOM_BH67	BH67_0.4-0.43	0.4-0.43	6/03/2010	Normal	<10	<50	700	570	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH68	BH68_2.5-2.9	2.5-2.9	2/03/2010	Normal	<10	<50	320	450											
AECOM_BH68	BH68_4.0-4.3	4-4.3	2/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH68	BH68_7.0-7.1	7-7.1	2/03/2010	Normal	<10	<50	<100	<100											
AECOM_SV09	SV09_0.2-0.4	0.2-0.4	26/02/2010	Normal	<10	120	1920	1240	0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH001	BH001	1	1/05/2006	Normal	3	2360	3280	1190	0.5	<0.2	0.4	0.2	<0.2	0.4				322	
BH001	BH001	4	2/05/2006	Normal	<2	<50	160	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				29.6	
BH019	BH019 1.5-1.95	1.5-1.95	8/05/2006	Normal	50	100	<100	<100											
BH019	BH019 2.5-3.0	2.5-3	8/05/2006	Normal	354	2180	3840	1060											
BH019	BH019 3.0-3.45	3-3.45	8/05/2006	Normal	210	3160	5450	1870											
BH020	BH020 0.3-0.5	0.3-0.5	9/05/2006	Normal	<2	<50	460	350											
BH020	BH021 0.3-0.5	0.3-0.5	9/05/2006	Normal	<2	<50	130	100											
BH020	BH020 1.5-2.1	1.5-2.1	9/05/2006	Normal	<2	<50	280	340											
BH020	D0905-1	1.5-2.1	9/05/2006	Field_D	<2	<50	240	290											
BH028	BH028_0.3-0.5	0.3-0.5	12/05/2006	Normal	<2	<50	200	140	<0.2	<0.2	<0.2	<0.2	<0.2	<0.01					
BH028	BH028_13-13.5	13-13.5	12/05/2006	Normal	119	780	1370	250	8.2	2.7	14.8	15.4	6.9	22.3					
BH042	BH042_0.3-0.5	0.3-0.5	23/05/2006	Normal	<2	<50	150	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH042	BH042_1.5-1.7	1.5-1.7	23/05/2006	Normal	<2	<50	170	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH042	BH042_6.0-6.5	6-6.5	23/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH058	BH058-1.5-1.95	1.5-1.95	31/05/2006	Normal	8	120	1960	1070	0.3	0.3	0.2	<0.2	<0.2	<0.4				69.7	
BH058	BH058-6.0-6.5	6-6.5	31/05/2006	Normal	40	220	510	<100	3.1	5.9	0.4	8.5	4.3	12.8				<1	
BH059	BH059-1.5-1.95	1.5-1.95	31/05/2006	Normal	<2	<50	290	260	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH059	BH059-3.0-3.45	3-3.45	31/05/2006	Normal	<2	<50	170	120	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH059	BH059-8.5-9.0	8.5-9	31/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH060	BH060-1.7-2.0	1.7-2	31/05/2006	Normal	<2	<50	<100	140	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				5.6	
BH060	D3105-2	1.7-2	31/05/2006	Field_D	<2	<50	140	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				5.1	
BH060	BH060-9.5-10.0	9.5-10	31/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH060	D3105-3	9.5-10	31/05/2006	Field_D	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH062	BH062-1.5-1.95	1.5-1.95	31/05/2006	Normal	8	100	610	510	<0.2	<0.2	0.4	0.3	<0.2	0.5				489	
BH062	BH062-3.0-3.45	3-3.45	31/05/2006	Normal	<2	<50	420	410	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				2.6	
BH065	BH065-0.3-0.5	0.3-0.5	1/06/2006	Normal	<2	<50	180	350	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				2.6	
BH065	D0106-1	0.3-0.5	1/06/2006	Field_D	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1.3	
BH065	BH065-1.5-1.95	1.5-1.95	1/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH065	BH065-3.0-3.45	3-3.45	1/06/2006	Normal	3	90	1040	720	<0.2	<0.2	<0.2	0.5	0.3	0.8				12.7	
BH065	D0106-2	3-3.45	1/06/2006	Interlab_D															
BH065	D0106-2	3-3.45	1/06/2006	Field_D	2	140	1350	880	<0.2	<0.2	<0.2	0.3	<0.2	0.5				14.6	
BH067	BH067-1.5-1.95	1.5-1.95	1/06/2006	Normal	<2	<50	480	620	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH067	BH067-3.0-3.45	3-3.45	1/06/2006	Normal	2	<50	1490	3020	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	

Table T1
Human Health Soil Screen - All Depths

					TPH				BTEX						Phenols	Cyanides			Inorganics
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Cyanide (WAD)	Cyanide (Free)	Cyanide Total	Ammonia as N
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					10	50	100	100	0.2	0.2	0.2	0.2	0.2	0.15	0.01	1	1	1	20
Scenario 1 VMP July 2012					10	50	100	100	1.1	5.4	5000	590	690	630	17,000	1000	1000	1000	
Location_ Code	Field_ID	Sample_ Depth_ Range	Sampled_ Date_Time	Sample_ Type															
BH070	BH070_0.3-0.5	0.3-0.5	2/05/2006	Normal	<2	<50	600	210	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH070	D0206-1	0.3-0.5	2/05/2006	Field_D	<2	<50	480	320	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				2	
BH070	D0206-1	0.3-0.5	2/06/2006	Interlab_D															
BH070	BH070_1.5-1.95	1.5-1.95	2/05/2006	Normal	<2	<50	230	340	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH071	BH071_1.5-1.95	1.5-1.95	2/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH071	BH071_3.0-3.45	3-3.45	2/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH072	BH072_0.3-0.5	0.3-0.5	2/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH072	BH072_3.0-3.45	3-3.45	2/05/2006	Normal	<2	<50	120	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH072	BH072_9.5-10.0	9.5-10	2/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH073	BH073_1.5-1.95	1.5-1.95	2/05/2006	Normal	<2	<50	560	270	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				8.7	
BH073	BH073_2.0-2.4	2-2.4	2/05/2006	Normal	8	260	1340	260	<0.2	2.1	<0.2	3.4	2.1	5.5				2.1	
BH074	BH074_1.5-1.95	1.5-1.95	2/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH074	BH074_3.0-3.45	3-3.45	2/05/2006	Normal	3	<50	260	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH074	BH074_9.5-10.0	9.5-10	2/05/2006	Normal	122	1510	2480	870	14.9	1.6	21.1	20.7	7.6	28.3				<1	
BH075	BH075_0.3-0.5	0.3-0.5	6/06/2006	Normal	<2	<50	570	440	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				7.6	
BH075	D0606-1	1.5-1.95	6/06/2006	Interlab_D															
BH075	D0606-1	1.5-1.95	7/06/2006	Field_D	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1.3	
BH075	BH075_3.0-3.45	3-3.45	6/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1.5	
BH087	BH087 1.5-1.95	1.5-1.95	8/06/2006	Normal	20	2230	5820	1520	0.7	1.2	0.8	7.3	3.2	10.5				9.8	
BH087	BH087 3.0-3.45	3-3.45	8/06/2006	Normal	271	4560	7310	1670	15	47.5	24.9	79.9	38.6	118.5				26.7	
BH087	BH087 7.0-7.5	7-7.5	8/06/2006	Normal	442	4360	6720	1550	82.7	24.3	149	116	57.1	173.1				2.1	
BH089	BH089 0.3-0.5	0.3-0.5	9/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH089	BH089 1.5-1.95	1.5-1.95	9/06/2006	Normal	<2	70	440	170	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				2.1	
BH089	BH089 3.0-3.45	3-3.45	9/06/2006	Normal	<2	<50	170	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH090	BH090 1.5-1.95	1.5-1.95	9/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH090	D0906-2	1.5-1.95	9/06/2006	Field_D	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH090	D0906-2	1.5-1.95	9/06/2006	Interlab_D															
BH090	BH090 3.0-3.45	3-3.45	9/06/2006	Normal	<2	<50	140	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH109	BH109 0.3_0.5	0.3-0.5	27/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH109	BH109 3.0_3.45	3-3.45	27/06/2006	Normal	<2	<50	<100	130	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH109	BH109 9.5_10.0	9.5-10	27/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH113	BH113 1.5_1.95	1.5-1.95	27/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH113	BH113 3.0_3.45	3-3.45	27/06/2006	Normal	<2	70	540	470	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1	
BH114	BH114 0.3_0.5	0.3-0.5	28/06/2006	Normal	<2	<50	130	210	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH114	BH114 3.0_3.45	3-3.45	28/06/2006	Normal	<2	60	620	360	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH115	BH115 0.8_1.0	0.8-1	28/06/2006	Normal	<2	<50	560	340	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH115	D2806_1	0.8-1	28/06/2006	Field_D	<2	120	1470	1120	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH115	BH115 1.5_1.95	1.5-1.95	28/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1.1	
BH115	D2806_2	1.5-1.95	28/06/2006	Field_D	<2	<50	280	160	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1	
BH115	BH115 3.0_3.45	3-3.45	28/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH119	BH119 1.6_2.05	1.6-2.05	30/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH119	BH119 7.5_8.0	7.5-8	30/06/2006	Normal	1140	6750	13,000	4690	82.4	63	118	182	69.8	251.8				<1	
BH119	BH119 9.5_10.0	9.5-10	30/06/2006	Normal	1060	5320	7940	2110	97.8	14.7	124	152	53	205				<1	
BH132	BH132_1.5-1.95	1.5-1.95	6/07/2006	Normal	<2	<50	500	390	0.5	<0.2	<0.2	<0.2	<0.2	<0.4				20.5	
BH132	BH132_8.0-8.5	8-8.5	6/07/2006	Normal	1050	1870	3040	1190	140	44.7	232	225	120	345					
BH133	BH133_0.3-0.5	0.3-0.5	6/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH133	BH133 1.5_1.95	1.5-1.95	6/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH135	BH135A-0.4-0.6	0.4-0.6	11/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH135	BH135A-3.0-3.45	3-3.45	11/07/2006	Normal															
BH137	BH137 1.5_1.95	1.5-1.95	6/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH137	BH137 3.0_3.45	3-3.45	6/07/2006	Normal															
BH141	BH141 1.5_1.95	1.5-1.95	7/07/2006	Normal	<2	70	1600	590	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				71.7	
BH141	BH141 3.0_3.45	3-3.45	7/07/2006	Normal	325	1800	4490	1430	41.8	49.1	17.3	86.5	60.3	146.8					
BH145	BH145-0.3-0.5	0.3-0.5	11/07/2006	Normal	4	80	2120	1270	0.2	<0.2	0.4	0.3	<0.2	0.5					
BH145	D1107-01	0.3-0.5	11/07/2006	Field_D	3	240	4360	2640	<0.2	<0.2	0.3	0.2	<0.2	0.4					
BH145	D1107-1	0.3-0.5	11/07/2006	Interlab_D															
BH145	BH145-3.0-3.45	3-3.45	11/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH146	BH146-1.5-1.95	1.5-1.95	11/07/2006	Normal	2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				8.6	
BH146	BH146-3.0-3.33	3-3.33	11/07/2006	Normal															
BH146	BH146-4.1-4.6	4.1-4.6	11/07/2006	Normal	222	3020	3750	860	15.2	13.9	25.3	56	31	87				1.2	
BH156	BH156_0.4-0.5	0.4-0.5	14/08/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH156	D1408-4	0.4-0.5	14/08/2006	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5					
BH156	BH156_0.9-1.0	0.9-1	14/08/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4	<0.5				
BH156	D1408-5	0.9-1	14/08/2006	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5	<0.5				
BH159	BH159_0.25-0.35		14/08/2006	Normal	<2	<50	270	960	<0.2	<0.2	<0.2	0.3	<0.2	0.5				<1	
BH159	D1408-8	0.25-0.35	14/08/2006	Interlab_D	<10	<50	<100	280	<0.2	<0.5	<0.5	<1	<0.5	<1.5					
BH160	D1408-11		14/08/2006	Field_D	<2				<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH160	BH160_0.3-0.4	0.3-0.4	14/08/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4	<0.5				
BH160	D1408-11	0.3-0.4	14/08/2006	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5					
BH161	BH161_0.3-0.4	0.3-0.4	14/08/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH161	D1408-12	0.3-0.4	14/08/2006	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5					
BH197	BH197/0.4	0.4	3/03/2008	Normal	<10	<50	150	450	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH197	BH197/5.0	5	9/04/2008	Normal	26	560	3820	1480	4.8	1.9	8	4.2	1.9	6.1	<0.5			<1	
BH197	BH197/6.5	6.5	9/04/2008	Normal	<10	<50	<100	<100	0.5	<0.5	0.8	0.6	<0.5	1.1	<0.5			<1	
BH197	D02-090408	6.5	9/04/2008	Interlab_D	<10	60	<100	<100	0.5	<0.5	0.7	<1	<0.5	<1.5	1.1			<1	
BH197	BH197/11.5	11.5	9/04/2008	Normal	<10	160	400	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH197	BH197/15.9	15.9	10/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH197	BH197/18.6	18.6	10/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH198	BH198/3.0	3	6/03/2008	Normal	<10	1360	6690	1440	<0.2	<0.5	<0.5	0.7	<0.5	1.2	<0.5			3	
BH198	D01-060308	3	6/03/2008	Field_D	<10	1800	9470	2080	<0.2	<0.5	<0.5	1.1	<0.5	1.6	<0.5			4	
BH198	BH198/4.5	4.5	6/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH198	BH198/6.9	6.9	6/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH199	BH199/2.7	2.7	11/03/2008	Normal	<10	<50	740	380	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			11	
BH199	BH199/3.7	3.7	11/03/2008	Normal	96	950	2620	920	6.4	16.3	2.6	22.4	22.9	45.3	<0.5			1	
BH199	D01-110308	3.7	11/03/2008	Interlab_D	160	1960	3980	1090	8.6	20.4	4.1	30	30.7	60.7	<5			1	
BH199	BH199/5.6	5.6	11/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			1	
BH199	BH 199/6.0	6	17/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH199	BH199/6.0	6	17/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH200	BH200/1.0	1	7/04/2008	Normal	<10	520	10,200	4730	1.6	<0.5	2.2	2	0.8	2.8	6.7			200	
BH200	BH200/2.5	2.5	7/04/2008	Normal	<10	110	1060	500	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			44	
BH200	BH200/6.53	6.53	7/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH201	BH201/2.4	2.4	4/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH201	BH201/10.3	10.3	18/03/2008	Normal	<10	<50	1930	1350	<0.2	0.7	<0.5	<0.5	<0.5	<1	<0.5			2	
BH201	BH201/11.0	11	18/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			2	
BH202	BH202/2.3	2.3	10/03/2008	Normal	<10	<50	240	270	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH202	BH202/4.7	4.7	10/03/2008	Normal	<10	<50	280	340	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH202	BH202/6.8	6.8	10/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH203	BH203/1.9	1.9	10/03/2008	Normal	<10	<50	330	360	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH203	BH203/7.3	7.3	10/03/2008	Normal	<10	<50	560	450	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH204	BH204/1.0	1	18/03/2008	Normal	20	2890	9620	3070	0.6	3.5	1.4	4.2	4.4	8.6	<0.5			8	
BH204D	BH204D/1.5	1.5	7/04/2008	Normal	226	54,200	72,400	20,600	61	7	69.2	67.2	26.9	94.1	1720			575	
BH204D	BH204D/3.0	3	7/04/2008	Normal	289	11,600	19,400	6340	36.8	34.9	49.3	112	39.9	151.9	55.8			76	
BH204D	BH204D/4.0	4	7/04/2008	Normal	215	12,600	22,400	7020	44.3	15.1	53	72.8	26.7	99.5	84.2			44	
BH205	BH205/7.8	7.8	27/03/2008	Normal	<10	<50	<100	<100	1.4	<0.5	0.7	<0.5	<0.5	<1	<0.5			<1	
BH205	D01_270308	7.8	27/03/2008	Interlab_D	<10	<50	130	<100	2	<0.5	1	<1	<0.5	<1.5	<0.5			<1	
BH205	BH205/9.3	9.3	27/03/2008	Normal	138	1500	2710	640	7.5	5.4	34.7	42.4	21.9	64.3	<0.5			<1	
BH205	BH205/13.0	13	1/04/2008	Normal	13	<50	<100	<100	2.5	<0.5	3.3	2.8	1.2	4	<0.5			<1	
BH205	BH205/13.8	13.8	1/04/2008	Normal	<10	<50	<100	<100	0.7	<0.5	0.5	<0.5	<0.5	<1	<0.5			<1	
BH205	D01_010408	13.8	1/04/2008	Field_D	<10	<50	<100	<100	0.8	<0.5	0.5	<0.5	<0.5	<1	<0.5			<1	
BH205	BH205/19.2	19.2	2/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	0.5	<0.5	1	<0.5			<1	
BH205	BH205/22.2	22.2	2/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH206	BH206/0.5	0.5	7/03/2008	Normal	<10	<50	310	180	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			8	
BH206	BH206/1.8	1.8	17/04/2008	Normal	<10	<50	190	340	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH206	BH206/4.6	4.6	17/04/2008	Normal	<10	<50	230	230	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH206	BH206/7.1	7.1	17/04/2008	Normal	15	200	350	<100	<0.2	1	<0.5	2.7	2.2	4.9	<0.5			<1	
BH206	BH206/10.7	10.7	21/04/2008	Normal	<10	<50	110	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH207	BH207/7.45	7.45	3/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH207	BH207/12.0	12	3/04/2008	Normal	<10	<50	430	340	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH207	BH207/13.1	13.1	3/04/2008	Normal	<10	<50	140	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH207	BH207/15.0	15	3/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH208	BH208/2.25	2.25	4/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH208	BH208/9.5	9.5	4/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH208	BH208/13.5	13.5	4/04/2008	Normal	<10	80	3320	2520	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH209	BH209/2.3	2.3	22/04/2008	Normal	<10	<50	880	580	<0.2	<0.5	0.5	<0.5	<0.5	<1	<0.5			<1	

Table T1
Human Health Soil Screen - All Depths

Location_Code	Field_ID	Sample_Depth_Range	Sampled_Date_Time	Sample_Type	TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Cyanide (WAD)	Cyanide (Free)	Cyanide Total	Ammonia as N
					TPH				BTEX						Phenols	Cyanides			Inorganics
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					10	50	100	100	0.2	0.2	0.2	0.2	0.2	0.15	0.01	1	1	1	20
Scenario 1 VMP July 2012					10	50	100	100	1.1	5.4	5000	590	690	630	17,000	1000	1000	1000	
BH209	BH209/4.5	4.5	22/04/2008	Normal	227	1190	1950	460	15.5	37.2	4.3	36	50	86	<0.5			4	
BH209	BH209/6.1	6.1	22/04/2008	Normal	929	2280	2350	430	88.2	34.8	213	165	94.8	259.8	<0.5			<1	
BH209	BH209/9.4	9.4	23/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	10			<1	
BH210	BH210/1.5	1.5	18/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH210	BH210/15.9	15.9	27/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH211	BH211/14.0	14	26/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH211	BH211/15.5	15.5	26/03/2008	Normal	19	<50	<100	<100	3.4	0.6	5.5	3.3	1.8	5.1	<0.5			<1	
BH211	BH211/16.05-16.15	16.05-16.15	26/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH4	BH4 0.4-0.5	0.4-0.5	21/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH4	BH4 2.3-2.4	2.3-2.4	21/02/2008	Normal	<10	200	5700	2960	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<1.2				
BH4	BH4 4.2-4.3	4.2-4.3	21/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH405	BH405_13.0-13.2	13-13.2	11/02/2011	Normal	<10	510	1760	560	0.7	0.6	0.6	3	1.3	4.3					
BH405	BH405_14.0-14.4	14-14.4	11/02/2011	Normal	156	3390	7020	2010	5.9	4	33	57.2	19.4	76.6	<0.02				
BH405	QC609	14-14.4	11/02/2011	Field_D	10	3020	5950	1700	0.6	<0.5	2.7	4	1.4	5.4					
BH405	BH405_4.0-4.3	4-4.3	10/02/2011	Normal	<10	<50	400	620	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
BH405	BH405_7.0-7.3	7-7.3	10/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.01				
BH408	BH408_2.0-2.4	2-2.4	14/02/2011	Normal	<10	<50	190	260	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.01				
BH408	BH408_8.0-8.3	8-8.3	15/02/2011	Normal	<10	100	350	<100	0.6	0.7	<0.5	0.7	0.6	1.3					
BH408	BH408_9.0-9.4	9-9.4	15/02/2011	Normal	24	360	710	150	2.1	4.6	<0.5	5.1	3.8	8.9	<0.05				
BH408	QC613	9-9.4	15/02/2011	Field_D	<10	110	260	<100	0.5	1	<0.5	1.2	1	2.2					
BH409	BH409_3.7-4.0	3.7-4	14/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	0.01				
BH409	BH409_5.0-5.3	5-5.3	14/02/2011	Normal	12	150	180	<100	1.8	3.5	<0.5	1.1	1.8	2.9					
BH409	BH409_6.0-6.4	6-6.4	15/02/2011	Normal	<10	<50			0.3	<0.5	<0.5	<0.5	<0.5	<1				<1	<20
BH409	BH409_7.0-7.3	7-7.3	15/02/2011	Normal	106	<50	<100	<100	2.8	3.5	22.3	17.8	8.9	26.7	<0.01				
BH5	BH5 0.4-0.5	0.4-0.5	23/02/2008	Normal	<10	<50	1060	640	<0.2	<0.5	<0.5	<0.5	<0.5	<1	0.7				
BH5	BH5 1.2-1.3	1.2-1.3	23/02/2008	Normal	<10	<50	<100	<100	2	<0.5	0.7	0.8	<0.5	1.3	<0.5				
BH8	BH8 0.26-0.4	0.26-0.4	19/02/2008	Normal	<10	<50	310	200	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH8	BH8 0.6-0.7	0.6-0.7	19/02/2008	Normal	<10	<50	1380	990	<0.2	<0.5	<0.5	<0.5	<0.5	<1	0.7				
BH9	BH9 0.4-0.5	0.4-0.5	21/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH9	QC4	0.4-0.5	22/02/2008	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH9	BH9 0.9-1.0	0.9-1	21/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW10_Coffey	MW10 1.9-2.0	1.9-2	21/02/2008	Normal	<10	<50	370	460	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW10_Coffey	QC3	1.9-2	21/02/2008	Field_D	<10	<50	450	510	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW10_Coffey	QC3A	1.9-2	21/02/2008	Normal					<0.5	<0.5	<0.5			<1.5	<0.5				
MW10_Coffey	MW10 4.9-5.0	4.9-5	21/02/2008	Normal	64	4600	41,400	14,200	12.4	4.1	2.2	4.1	1.5	5.6	20.8				
MW10_Coffey	MW10 8.6-8.7	8.6-8.7	22/02/2008	Normal	7590	69,400	93,200	19,200	1510	261	2650	1830	746	2576	1400				
MW10_Coffey	QC5	8.6-8.7	22/02/2008	Field_D	7420	67,400	99,200	25,800	1420	261	2560	1870	759	2629	1530				
MW10_Coffey	QC5A	8.6-8.7		Normal	5700	24,000	35,000	6200	790	160	1500			1400	810				
MW15_Coffey	MW15 0.4-0.5	0.4-0.5	10/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW15_Coffey	MW15 1.4-1.5	1.4-1.5	10/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW15_Coffey	QC1	1.4-1.5	10/04/2008	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW15_Coffey	QC1A	1.4-1.5	21/02/2008	Normal					<0.5	<0.5	<0.5			<1.5					
MW3	MW3 0.4-0.5	0.4-0.5	23/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW3	MW3 0.9-1.0	0.9-1	23/02/2008	Normal	<10	1010	2510	760	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW3	QC6	1.9-2	23/02/2008	Field_D	<10	800	5730	1610	0.5	<0.5	0.8	0.8	<0.5	1.3	<0.5				
MW3	MW3 2.9-3.0	2.9-3	23/02/2008	Normal	<10	1100	6760	2080	0.4	0.9	<0.5	1.1	0.7	1.8	<0.5				
MW6	MW6 0.8-0.9	0.8-0.9	20/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW6	QC1	0.8-0.9	20/02/2008	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW6	QC1A	0.8-0.9	21/02/2008	Normal					<0.5	<0.5	<0.5			<1.5	<0.5				
MW6	MW6 2.5-2.6	2.5-2.6	20/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW6	MW6 4.4-4.5	4.4-4.5	20/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW6	QC2	4.4-4.5	20/02/2008	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW6	QC2A	4.4-4.5	21/02/2008	Normal					<0.5	<0.5	<0.5			<1.5	<0.5				
MW7	MW7 1.4-1.5	1.4-1.5	25/02/2008	Normal	<10	<50	1400	1260	0.2	<0.5	<0.5	<0.5	<0.5	<1	0.9				
MW7	MW7 3.5-3.6	3.5-3.6	25/02/2008	Normal	227	2140	5680	2090	87.7	10.3	57.5	49.8	19	68.8	16.3				
MW7	MW7 4.5-4.6	4.5-4.6	25/02/2008	Normal	7710	31,500	61,000	13,600	2080	147	1930	1210	502	1712	3680				
MW7	QC7	4.5-4.6	25/02/2008	Field_D	186	3920	8810	2360	51.4	6.7	53.2	43.4	18.2	61.6	65.5				
MW7	DUP 8	5-5.1	25/02/2008	Field_D	6020	44,100	69,800	15,800	1600	119	1510	969	413	1382	2770				
MW7	MW7 5.0-5.1	5-5.1	25/02/2008	Normal	7890	45,900	65,200	15,200	1980	154	1990	1300	563	1863	4170				
TBH01	DUP 01	0.43-0.5	5/02/2011	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH01	TBH01_0.43-0.5	0.43-0.5	5/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH01	TRIP01	0.43-0.5	5/02/2011	Interlab_D	<10	<50	<100	<100	<0.5	<0.5	<0.5	<1	<0.5	<1.5					
TBH03	TBH03_1.2-1.3	1.2-1.3	5/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH03	TBH03_1.5-1.6	1.5-1.6	5/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH05	TBH05_0.6-0.7	0.6-0.7	12/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH05	TBH05_1.3-1.7	1.3-1.7	12/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH05	DUP02	1.8-2	12/02/2011	Field_D	<10	<50	530	470	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH05	TBH05_1.8-2.0	1.8-2	12/02/2011	Normal	<10	<50	600	610	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH06	TBH06_0.55-0.6	0.55-0.6	5/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH06	TBH06_1.5-2.0	1.5-2	12/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH07	TBH07_0.1-0.15	0.1-0.15	4/02/2011	Normal	<10	<50	280	420	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH08	TBH08_0.13-0.25	0.13-0.25	4/02/2011	Normal	<10	<50	110	260	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
Statistical Summary																			
Number of Results					305	304	303	303	299	299	299	294	294	299	188	41	28	145	1
Number of Detects					79	96	168	150	86	62	77	84	70	85	34	1	0	51	0
Minimum Concentration					<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.01	<0.01	<1	<1	<1	<20
Minimum Detect					2	60	110	100	0.2	0.3	0.2	0.2	0.3	0.4	0.01	8	ND	1	ND
Maximum Concentration					7890	69,400	99,200	25,800	2080	261	2650	1870	759	2629	4170	8	<1	575	<20
Maximum Detect					7890	69,400	99,200	25,800	2080	261	2650	1870	759	2629	4170	8	ND	575	ND
Average Concentration					188	1770	3486	1098	38	6.4	48	34	15	53	90	0.68	0.5	19	
Median Concentration					5	25	170	50	0.1	0.25	0.25	0.25	0.25	0.5	0.25	0.5	0.5	0.5	10
Standard Deviation					1006	7878	11,912	3002	231	28	294	194	81	283	492	1.2	0	73	
Number of Guideline Exceedances					68	96	168	150	60	32	0	5	2	7	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)					68	96	168	150	60	32	0	5	2	7	0	0	0	0	0

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

					PAHs										
					Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5
Scenario 2 VMP July 2012									3						
Location_ Code	**Field_ID**	**Sample_ Depth_ Range**	**Sampled_ Date_Time**	**Sample_ Type**											
AECOM_BH33	BH33_0.75-0.85	0.75-0.85	2/12/2010	Normal											
AECOM_BH34	BH34_1.8-2.2	1.8-2.2	25/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
AECOM_BH34	QC240	1.8-2.2	25/02/2010	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
AECOM_BH34	QC241	1.8-2.2	25/02/2010	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
AECOM_BH36	BH36_1.0-1.2	1-1.2	3/03/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
AECOM_BH42	BH42_1.0-1.1	1-1.1	23/02/2010	Normal	<0.5	<0.5	<0.5	2	1.5		2.3	0.8	1	1.7	<0.5
AECOM_BH44	BH44_1.9-2.0	1.9-2	23/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
AECOM_BH49	BH49_1.5-1.7	1.5-1.7	22/02/2010	Normal	1.1	11	18.1	35.8	22.7		37	13.2	11.8	32	3.8
AECOM_BH50	BH50_1.3-1.5	1.3-1.5	26/02/2010	Normal	<0.5	<0.5	<0.5	0.6	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
AECOM_BH51	BH51_0.4-0.5	0.4-0.5	6/03/2010	Normal	<0.5	<0.5	<0.5	1.3	0.9		1.4	0.5	0.7	1.1	<0.5
AECOM_BH52	BH52_1.0-1.2	1-1.2	22/02/2010	Normal											
AECOM_BH53	BH53_1.1-1.5	1.1-1.5	6/03/2010	Normal	5.4	13	25.7	52.3	38.1		50.4	16.8	13.8	36.1	4.4
AECOM_BH53	QC208	1.1-1.5	6/03/2010	Field_D	2.3	6.1	10	28.3	20.7		30	8.6	11.2	20.3	2.3
AECOM_BH54	BH54_1.0-1.4	1-1.4	23/02/2010	Normal	273	1000	1070	912	533		824	248	324	549	72.5
AECOM_BH54	QC228	1-1.4	23/02/2010	Field_D	144	468	509	467	253		488	130	117	341	36.6
AECOM_BH55	BH55_1.0-1.2	1-1.2	25/02/2010	Normal	80.7	473	482	425	252		300	123	107	282	23.3
AECOM_BH58	BH58_1.0-1.2	1-1.2	22/02/2010	Normal	0.6	8.2	8.5	16.2	12.7		19	9.8	6.9	14	1.8
AECOM_BH59	BH59_1.9-2.0	1.9-2	22/02/2010	Normal	10.3	58.8	60.3	45.9	26.5		35.8	13.1	14.3	32.2	3.2
AECOM_BH61	BH61_0.3-0.4	0.3-0.4	6/03/2010	Normal											
AECOM_BH62	BH62_1.0-1.2	1-1.2	26/02/2010	Normal	<0.5	<0.5	<0.5	0.5	<0.5		0.5	<0.5	<0.5	<0.5	<0.5
AECOM_BH64	BH64_1.0-1.2	1-1.2	1/03/2010	Normal	7.5	51.9	70.8	95.5	69.8		104	37.2	29.4	79.7	10.8
AECOM_BH67	BH67_0.4-0.43	0.4-0.43	6/03/2010	Normal	<0.5	3.2	3.4	16.2	5.5		20.3	6.3	8.7	17.6	1.6
AECOM_SV09	SV09_0.2-0.4	0.2-0.4	26/02/2010	Normal	1.4	9.9	18.5	45.3	25.4		43.7	14.5	18	33.9	4.2
BH001	BH001	1	1/05/2006	Normal	1.1	14.4	19.2	65.9	33.4		98.6	25.5	29.6	70.5	10.4
BH019	BH019 1.5-1.95	1.5-1.95	8/05/2006	Normal	<0.5	<0.5	1	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH020	BH020 0.3-0.5	0.3-0.5	9/05/2006	Normal	0.6	1.6	2.5	6.2	6.8		7.7	3.7	2.3	5.4	0.8
BH020	BH020 1.5-2.1	1.5-2.1	9/05/2006	Normal	<0.5	1.3	1.6	3.9	4.4		5	2.5	1.9	3.6	0.6
BH020	BH021 0.3-0.5	0.3-0.5	9/05/2006	Normal	<0.5	0.9	0.9	2.2	2.3		2.8	1.2	1.1	1.8	<0.5
BH020	D0905-1	1.5-2.1	9/05/2006	Field_D	<0.5	1.3	1.7	3.4	4		4.6	2.8	1.7	3.1	<0.5
BH028	BH028_0.3-0.5	0.3-0.5	12/05/2006	Normal											
BH042	BH042_ 0.3-0.5	0.3-0.5	23/05/2006	Normal	<0.5	1	1.9	4.2	3.9		2.8	2.6	3.6	4.1	0.8
BH042	BH042_ 1.5-1.7	1.5-1.7	23/05/2006	Normal	<0.5	0.8	<0.5	2.6	1.9		1.9	1	1.6	2.6	<0.5
BH058	BH058-1.5-1.95	1.5-1.95	31/05/2006	Normal	1.2	8.4	11.1	29	25.3		37.9	19.3	11.8	26.9	4.3
BH059	BH059-1.5-1.95	1.5-1.95	31/05/2006	Normal	<0.5	2.1	2.1	4.3	3.9		4.6	2.5	1.9	3.7	0.5
BH060	BH060-1.7-2.0	1.7-2	31/05/2006	Normal	<0.5	1.2	1.3	3.6	3.6		6.3	3.5	2.3	3.7	0.9
BH060	D3105-2	1.7-2	31/05/2006	Field_D	<0.5	0.7	0.8	2.5	2.5		4	2.5	1.4	2.4	0.6
BH062	BH062-1.5-1.95	1.5-1.95	31/05/2006	Normal	<0.5	6.6	5.1	17.1	19.9		29.7	14.4	10.1	16.8	3.6
BH065	BH065-0.3-0.5	0.3-0.5	1/06/2006	Normal	<0.5	1.1	1.2	3	3.1		3.6	2.1	1.3	2.7	<0.5
BH065	BH065-1.5-1.95	1.5-1.95	1/06/2006	Normal	<0.5	<0.5	0.6	1.1	0.9		1.1	0.6	<0.5	0.8	<0.5
BH065	D0106-1	0.3-0.5	1/06/2006	Field_D	<0.5	<0.5	<0.5	0.6	0.6		0.8	<0.5	<0.5	0.6	<0.5
BH067	BH067-1.5-1.95	1.5-1.95	1/06/2006	Normal	<0.5	<0.5	0.8	1.2	1.3		1.4	0.9	0.6	1.2	<0.5
BH070	BH070_0.3-0.5	0.3-0.5	2/05/2006	Normal	<0.5	0.5	0.6	1.3	1.4		1.6	0.7	0.6	1.1	<0.5
BH070	BH070_1.5-1.95	1.5-1.95	2/05/2006	Normal	<0.5	0.7	1.2	2.5	2.5		3.1	1.5	1.2	2.4	<0.5
BH070	D0206-1	0.3-0.5	2/05/2006	Field_D	<0.5	0.8	1.1	2.9	2.8		3.3	1.5	1.2	2.6	<0.5
BH070	D0206-1	0.3-0.5	2/06/2006	Interlab_D	<0.5	0.6	0.8	2.9	2.8	4		2.1		2.5	0.5
BH071	BH071_1.5-1.95	1.5-1.95	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH072	BH072_0.3-0.5	0.3-0.5	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH073	BH073_1.5-1.95	1.5-1.95	2/05/2006	Normal	20.6	87.8	77.3	107	100		99.3	44	33.5	88.7	10.7
BH074	BH074_1.5-1.95	1.5-1.95	2/05/2006	Normal	<0.5	0.6	0.5	1.2	1		1.1	<0.5	<0.5	0.9	<0.5
BH075	BH075_0.3-0.5	0.3-0.5	6/06/2006	Normal	0.5	8.4	7.9	19.4	19		21.2	11.3	9.4	16.4	2.4
BH075	D0606-1	1.5-1.95	6/06/2006	Interlab_D	<0.5	1.3	1	3.3	3.2	5		2.2		2.8	0.6
BH075	D0606-1	1.5-1.95	7/06/2006	Field_D	<0.5	0.8	0.5	1.7	1.6		1.7	0.8	0.6	1.5	<0.5
BH087	BH087 1.5-1.95	1.5-1.95	8/06/2006	Normal	21.6	177	136	114	78.5		83.6	34	35.2	69.5	8.6
BH089	BH089 0.3-0.5	0.3-0.5	9/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH089	BH089 1.5-1.95	1.5-1.95	9/06/2006	Normal	<0.5	2.5	2.3	3.7	3.3		3.4	1.6	1.7	3.1	<0.5
BH090	BH090 1.5-1.95	1.5-1.95	9/06/2006	Normal	<0.5	<0.5	<0.5	0.6	0.7		0.8	<0.5	<0.5	0.5	<0.5

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

Location_Code	Field_ID	Sample_Depth_Range	Sampled_Date_Time	Sample_Type	PAHs Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5
Scenario 2 VMP July 2012									3						
BH090	D0906-2	1.5-1.95	9/06/2006	Field_D	<0.5	<0.5	0.5	1.7	1.6		1.6	0.8	0.8	1.4	<0.5
BH090	D0906-2	1.5-1.95	9/06/2006	Interlab_D	<0.5	<0.5	<0.5	1.4	1.3	2		0.9		1.3	<0.5
BH109	BH109 0.3_0.5	0.3-0.5	27/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH113	BH113 1.5_1.95	1.5-1.95	27/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH114	BH114 0.3_0.5	0.3-0.5	28/06/2006	Normal	<0.5	<0.5	<0.5	1.2	1.7		2	1.3	0.9	1.2	<0.5
BH115	BH115 0.8_1.0	0.8-1	28/06/2006	Normal											
BH115	BH115 1.5_1.95	1.5-1.95	28/06/2006	Normal	<0.5	<0.5	<0.5	0.8	0.7		0.9	<0.5	<0.5	0.7	<0.5
BH115	D2806_1	0.8-1	28/06/2006	Field_D											
BH115	D2806_2	1.5-1.95	28/06/2006	Field_D	<0.5	<0.5	0.5	1.2	1.1		1.4	0.7	0.6	1.1	<0.5
BH119	BH119 1.6_2.05	1.6-2.05	30/06/2006	Normal	<0.5	<0.5	<0.5	0.6	0.8		0.9	0.6	<0.5	0.6	<0.5
BH132	BH132_1.5-1.95	1.5-1.95	6/07/2006	Normal	0.9	3.5	5.4	19.5	17.1		21.9	8.8	9	14.8	2.3
BH133	BH133 1.5_1.95	1.5-1.95	6/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH133	BH133_0.3-0.5	0.3-0.5	6/07/2006	Normal	<0.5	1	0.9	2.2	2.1		2.6	1.4	0.9	1.9	<0.5
BH135	BH135A-0.4-0.6	0.4-0.6	11/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH137	BH137 1.5_1.95	1.5-1.95	6/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	0.5		0.6	<0.5	<0.5	<0.5	<0.5
BH141	BH141 1.5_1.95	1.5-1.95	7/07/2006	Normal	1.8	11.8	14.6	28.2	24.6		25.2	12.2	10.6	24.1	2.5
BH145	BH145-0.3-0.5	0.3-0.5	11/07/2006	Normal	1.5	22	24.1	81.4	72.4		91.3	45.6	36.4	72	11.9
BH145	D1107-01	0.3-0.5	11/07/2006	Field_D	1.5	24.2	26.2	85.7	78.1		96.1	48.8	37.1	76	13.1
BH145	D1107-1	0.3-0.5	11/07/2006	Interlab_D	1.4	18	32	123	139	150		64		111	22
BH146	BH146-1.5-1.95	1.5-1.95	11/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH156	BH156_0.4-0.5	0.4-0.5	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH156	BH156_0.9-1.0	0.9-1	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH156	D1408-4	0.4-0.5	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
BH156	D1408-5	0.9-1	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
BH159	BH159_0.25-0.35		14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH159	D1408-8	0.25-0.35	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
BH160	BH160_0.3-0.4	0.3-0.4	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH160	D1408-11		14/08/2006	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH160	D1408-11	0.3-0.4	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
BH161	BH161_0.3-0.4	0.3-0.4	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH161	D1408-12	0.3-0.4	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
BH197	BH197/0.4	0.4	3/03/2008	Normal	<0.5	<0.5	0.5	0.6	<0.5		0.6	0.5	<0.5	<0.5	<0.5
BH200	BH200/1.0	1	7/04/2008	Normal	5.2	54.8	75.7	158	113		158	30.4	48.2	128	11.6
BH203	BH203/1.9	1.9	10/03/2008	Normal	<0.5	1.4	2.2	5	5.1		5.3	3.4	2.3	4.1	0.9
BH204	BH204/1.0	1	18/03/2008	Normal	45.2	194	187	128	78.6		68.8	39.8	59	83.5	9.9
BH204D	BH204D/1.5	1.5	7/04/2008	Normal	222	605	1200	823	652		587	305	231	631	71.4
BH206	BH206/0.5	0.5	7/03/2008	Normal	<0.5	4.2	3.9	8.4	7.8		7.7	3.6	3.6	7.5	1.1
BH206	BH206/1.8	1.8	17/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH210	BH210/1.5	1.5	18/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
BH4	BH4 0.4-0.5	0.4-0.5	21/02/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
BH5	BH5 0.4-0.5	0.4-0.5	23/02/2008	Normal	<0.5	6.4	4.4	11.8	6.9	20		2.2		4.9	<0.5
BH5	BH5 1.2-1.3	1.2-1.3	23/02/2008	Normal	<0.5	<0.5	<0.5	0.6	<0.5	<1		<0.5		<0.5	<0.5
BH8	BH8 0.26-0.4	0.26-0.4	19/02/2008	Normal	<0.5	7.4	5.9	24	16.1	34		4.5		7.6	2.5
BH8	BH8 0.6-0.7	0.6-0.7	19/02/2008	Normal	<0.5	17.1	11.5	33.5	31.3	57		4.8		10.5	2
BH9	BH9 0.4-0.5	0.4-0.5	21/02/2008	Normal	<0.5	<0.5	<0.5	0.6	<0.5	<1		<0.5		<0.5	<0.5
BH9	BH9 0.9-1.0	0.9-1	21/02/2008	Normal	<0.5	0.6	0.5	2.6	1.2	2		0.6		1	<0.5
BH9	QC4	0.4-0.5	22/02/2008	Field_D	<0.5	0.6	<0.5	<0.5	<0.5	<1		2.2		<0.5	<0.5
MW10_Coffey	MW10 1.9-2.0	1.9-2	21/02/2008	Normal	<0.5	1.6	2.4	21.1	8.6	14		1.2		7.1	1
MW10_Coffey	QC3	1.9-2	21/02/2008	Field_D	<0.5	2.4	3.7	19.4	9.3	16		0.9		7.4	0.9
MW10_Coffey	QC3A	1.9-2	21/02/2008	Normal	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2		<0.1		<0.1	<0.1
MW15_Coffey	MW15_0.4-0.5	0.4-0.5	10/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
MW15_Coffey	MW15_1.4-1.5	1.4-1.5	10/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
MW15_Coffey	QC1	1.4-1.5	10/04/2008	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
MW15_Coffey	QC1A	1.4-1.5	21/02/2008	Normal											
MW3	MW3 0.4-0.5	0.4-0.5	23/02/2008	Normal	<0.5	0.6	<0.5	0.8	<0.5	1		1		<0.5	<0.5
MW3	MW3 0.9-1.0	0.9-1	23/02/2008	Normal	1.7	42.5	13.8	44.6	11.7	62		4.2		23.4	2.7
MW3	QC6	1.9-2	23/02/2008	Field_D	3.5	30.4	23.6	53.9	24.1	70		5.3		6.1	2.8
MW6	MW6 0.8-0.9	0.8-0.9	20/02/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
MW6	QC1	0.8-0.9	20/02/2008	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<1		<0.5		<0.5	<0.5
MW6	QC1A	0.8-0.9	21/02/2008	Normal	<0.1	<0.1	<0.1	0.2	0.14	0.2		<0.1		0.1	<0.1
MW7	MW7 1.4-1.5	1.4-1.5	25/02/2008	Normal	0.7	7.7	9.6	41.2	32.1	49		1.4		16.1	1.7
TBH01	DUP 01	0.43-0.5	5/02/2011	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
TBH01	TBH01_0.43-0.5	0.43-0.5	5/02/2011	Normal	<0.5	<0.5	0.5	1.9	1.7		1.8	0.6	0.7	1.4	<0.5
TBH01	TRIP01	0.43-0.5	5/02/2011	Interlab_D	<0.5	<0.5	<0.5	0.8	1	1.7		0.7		0.7	<0.5
TBH03	TBH03_1.2-1.3	1.2-1.3	5/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
TBH03	TBH03_1.5-1.6	1.5-1.6	5/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
TBH05	DUP02	1.8-2	12/02/2011	Field_D	0.6	0.7	3.6	14.6	16.1		18.1	11.5	10.9	11.8	2.5
TBH05	TBH05_0.6-0.7	0.6-0.7	12/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
TBH05	TBH05_1.3-1.7	1.3-1.7	12/02/2011	Normal	<0.5	<0.5	<0.5	0.7	0.7		0.8	<0.5	<0.5	<0.5	<0.5
TBH05	TBH05_1.8-2.0	1.8-2	12/02/2011	Normal	0.6	0.9	3.1	15.6	18.8		23.8	15.1	9.3	13.2	3.4

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

					PAHs										
					Acenaphthene	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a) pyrene**	**Benzo(b)& (k)fluoranthene**	**Benzo(b)fluoranthene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Chrysene**	**Dibenz(a,h)anthracene**
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5
Scenario 2 VMP July 2012									3						
Location_ Code	**Field_ID**	**Sample_ Depth_ Range**	**Sampled_ Date_Time**	**Sample_ Type**											
TBH06	TBH06_0.55-0.6	0.55-0.6	5/02/2011	Normal	<0.5	<0.5	<0.5	0.9	0.8		0.7	<0.5	<0.5	0.7	<0.5
TBH06	TBH06_1.5-2.0	1.5-2	12/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5
TBH07	TBH07_0.1-0.15	0.1-0.15	4/02/2011	Normal	<0.5	1.4	1.4	4.7	7.8		8	6.5	2.7	4.8	0.8
TBH08	TBH08_0.13-0.25	0.13-0.25	4/02/2011	Normal	<0.5	<0.5	<0.5	1.3	1.5		1.3	0.7	0.5	1.1	<0.5
Statistical Summary															
Number of Results					123	123	123	123	123	32	91	123	91	123	123
Number of Detects					29	60	64	82	77	16	64	72	53	75	45
Minimum Concentration					<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.5	<0.1	<0.5	<0.1	<0.1
Minimum Detect					0.5	0.5	0.5	0.2	0.14	0.2	0.5	0.5	0.5	0.1	0.5
Maximum Concentration					273	1000	1200	912	652	150	824	305	324	631	72.5
Maximum Detect					273	1000	1200	912	652	150	824	305	324	631	72.5
Average Concentration					7.2	28	34	35	24	15	39	12	14	25	3.2
Median Concentration					0.25	0.25	0.5	1.3	1.3	0.5	1.8	0.8	0.8	1.1	0.25
Standard Deviation					35	121	157	124	83	32	121	39	45	86	10
Number of Guideline Exceedances					0	0	0	0	47	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)					0	0	0	0	47	0	0	0	0	0	0

Notes;

ND = Not detected above the laboratory limit of reporting

cPAH (SUM) = Sum of carcinogenic PAHs (see text for details)

cPAH (TEF) = Sum of carcinogenic PAHs taking into consideration Toxic Equivalency Factors (as presented in Appendix D).

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

Location_ Code	Field_ID	Sample_ Depth_ Range	Sampled_ Date_Time	Sample_ Type	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (ESDAT TOTAL)	Carcinogenic PAHs cPAH (SUM)	cPAH (TEF)
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	0.5			
Scenario 2 VMP July 2012											40		
AECOM_BH33	BH33_0.75-0.85	0.75-0.85	2/12/2010	Normal									
AECOM_BH34	BH34_1.8-2.2	1.8-2.2	25/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
AECOM_BH34	QC240	1.8-2.2	25/02/2010	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
AECOM_BH34	QC241	1.8-2.2	25/02/2010	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	<8	ND	ND
AECOM_BH36	BH36_1.0-1.2	1-1.2	3/03/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
AECOM_BH42	BH42_1.0-1.1	1-1.1	23/02/2010	Normal	2.9	<0.5	0.6	<0.5	1.2	3.2	20.2	9.9	2.115
AECOM_BH44	BH44_1.9-2.0	1.9-2	23/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
AECOM_BH49	BH49_1.5-1.7	1.5-1.7	22/02/2010	Normal	76.7	4.5	11.4	9.7	61.4	77.9	428.1	167.7	36.552
AECOM_BH50	BH50_1.3-1.5	1.3-1.5	26/02/2010	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	8.1	0.6	0.06
AECOM_BH51	BH51_0.4-0.5	0.4-0.5	6/03/2010	Normal	1.9	<0.5	<0.5	<0.5	0.8	2	14.1	5.9	1.256
AECOM_BH52	BH52_1.0-1.2	1-1.2	22/02/2010	Normal									
AECOM_BH53	BH53_1.1-1.5	1.1-1.5	6/03/2010	Normal	142	15.6	14.7	20.8	91.2	128	668.3	226.6	56.149
AECOM_BH53	QC208	1.1-1.5	6/03/2010	Field_D	55.7	5.5	7.8	7.1	23.2	47.7	286.8	129.2	31.019
AECOM_BH54	BH54_1.0-1.4	1-1.4	23/02/2010	Normal	2130	1290	231	6370	3130	1670	20,627	3,694	843
AECOM_BH54	QC228	1-1.4	23/02/2010	Field_D	1780	653	119	3680	2390	851	12,427	1,952	413
AECOM_BH55	BH55_1.0-1.2	1-1.2	25/02/2010	Normal	1280	460	95	4510	2030	1220	12,143	1,607	372
AECOM_BH58	BH58_1.0-1.2	1-1.2	22/02/2010	Normal	36.1	1.5	7.2	2.3	23.4	37.6	205.8	87.6	19.668
AECOM_BH59	BH59_1.9-2.0	1.9-2	22/02/2010	Normal	121	68.3	11.8	453	206	104	1264.5	182.8	40.933
AECOM_BH61	BH61_0.3-0.4	0.3-0.4	6/03/2010	Normal									
AECOM_BH62	BH62_1.0-1.2	1-1.2	26/02/2010	Normal	0.9	<0.5	<0.5	0.7	0.9	0.9	9.4	1	0.1
AECOM_BH64	BH64_1.0-1.2	1-1.2	1/03/2010	Normal	246	31.1	33.2	76.7	261	259	1463.6	459.6	107.979
AECOM_BH67	BH67_0.4-0.43	0.4-0.43	6/03/2010	Normal	17.7	<0.5	5.3	0.9	7.9	16.6	132.2	81.5	12.389
AECOM_SV09	SV09_0.2-0.4	0.2-0.4	26/02/2010	Normal	97.5	3.4	12.6	5.8	69.1	92.2	495.4	197.6	42.044
BH001	BH001	1	1/05/2006	Normal	104	3.6	28.6	11.5	84.4	98.4	699.1	362.5	67.03
BH019	BH019 1.5-1.95	1.5-1.95	8/05/2006	Normal	1.3	1.4	<0.5	29.3	4.1	1.1	43.2	ND	ND
BH020	BH020 0.3-0.5	0.3-0.5	9/05/2006	Normal	14.6	1.2	3.1	0.8	7.8	15.2	80.3	36	9.621
BH020	BH020 1.5-2.1	1.5-2.1	9/05/2006	Normal	8.5	0.7	2.1	0.5	4.7	8.7	50.5	24	6.351
BH020	BH021 0.3-0.5	0.3-0.5	9/05/2006	Normal	4.5	<0.5	1.2	0.8	2.8	4.8	28.8	12.6	3.06
BH020	D0905-1	1.5-2.1	9/05/2006	Field_D	7.5	0.6	2.2	0.5	4.3	7.8	46.5	21.8	5.249
BH028	BH028_0.3-0.5	0.3-0.5	12/05/2006	Normal									
BH042	BH042_ 0.3-0.5	0.3-0.5	23/05/2006	Normal	9.2	0.7	2.3	0.7	6.8	8.9	54	24.3	6.057
BH042	BH042_ 1.5-1.7	1.5-1.7	23/05/2006	Normal	2.7	<0.5	1.1	<0.5	0.9	3.5	23.1	12.7	2.656
BH058	BH058-1.5-1.95	1.5-1.95	31/05/2006	Normal	65.3	5.1	16.1	5.7	39.5	61.7	368.6	170.6	39.542
BH059	BH059-1.5-1.95	1.5-1.95	31/05/2006	Normal	8.5	0.6	2	1	6.4	8.5	53.1	23.4	5.742
BH060	BH060-1.7-2.0	1.7-2	31/05/2006	Normal	5.4	<0.5	2.9	0.6	3.2	5.5	45	26.8	6.082
BH060	D3105-2	1.7-2	31/05/2006	Field_D	4	<0.5	2	<0.5	2.1	3.9	30.9	17.9	4.139
BH062	BH062-1.5-1.95	1.5-1.95	31/05/2006	Normal	38.2	1.1	14	4	17.1	30.6	228.8	125.6	30.902
BH065	BH065-0.3-0.5	0.3-0.5	1/06/2006	Normal	5.9	<0.5	1.6	<0.5	3.6	6.2	37.4	17.4	4.098
BH065	BH065-1.5-1.95	1.5-1.95	1/06/2006	Normal	2.4	<0.5	<0.5	<0.5	1.9	2.3	15.2	4.5	1.134
BH065	D0106-1	0.3-0.5	1/06/2006	Field_D	1.1	<0.5	<0.5	<0.5	0.6	1.2	10	2.6	0.746
BH067	BH067-1.5-1.95	1.5-1.95	1/06/2006	Normal	3.1	0.7	0.7	0.8	2.9	3	20.1	7.3	1.711
BH070	BH070_0.3-0.5	0.3-0.5	2/05/2006	Normal	3	<0.5	0.6	0.9	2.3	3.1	19.2	7.3	1.828
BH070	BH070_1.5-1.95	1.5-1.95	2/05/2006	Normal	4.9	<0.5	1.3	<0.5	3.7	5	32	14.5	3.349
BH070	D0206-1	0.3-0.5	2/05/2006	Field_D	5.7	<0.5	1.3	0.8	3.3	5.8	34.6	15.6	3.711
BH070	D0206-1	0.3-0.5	2/06/2006	Interlab_D	5	<0.5	1.7	0.8	3.1	5.3	29.1	16.5	4.206
BH071	BH071_1.5-1.95	1.5-1.95	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH072	BH072_0.3-0.5	0.3-0.5	2/05/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH073	BH073_1.5-1.95	1.5-1.95	2/05/2006	Normal	252	56.5	41.4	14.8	190	228	1451.6	524.6	140.147
BH074	BH074_1.5-1.95	1.5-1.95	2/05/2006	Normal	2.4	<0.5	<0.5	<0.5	1.4	2.2	14.8	4.2	1.239
BH075	BH075_0.3-0.5	0.3-0.5	6/06/2006	Normal	42.7	2.2	9.8	2.8	25.7	43	242.1	108.9	27.657
BH075	D0606-1	1.5-1.95	6/06/2006	Interlab_D	6.2	<0.5	1.8	0.5	3.3	6.4	33.6	18.9	4.86
BH075	D0606-1	1.5-1.95	7/06/2006	Field_D	3.3	<0.5	0.6	<0.5	1.7	3.6	20.4	8.5	2.083
BH087	BH087 1.5-1.95	1.5-1.95	8/06/2006	Normal	325	182	31.2	925	496	265	2982.2	454.6	114.535
BH089	BH089 0.3-0.5	0.3-0.5	9/06/2006	Normal	0.8	<0.5	<0.5	<0.5	0.7	0.7	8.7	ND	ND
BH089	BH089 1.5-1.95	1.5-1.95	9/06/2006	Normal	7.7	2	1.4	9	8.3	7.4	58.4	18.2	4.367
BH090	BH090 1.5-1.95	1.5-1.95	9/06/2006	Normal	1.1	<0.5	<0.5	<0.5	0.8	1.1	10.1	2.6	0.845

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

					Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (ESDAT TOTAL)	Carcinogenic PAHs cPAH (SUM)	cPAH (TEF)
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	0.5			
Scenario 2 VMP July 2012											40		
Location_ Code	Field_ID	Sample_ Depth_ Range	Sampled_ Date_Time	Sample_ Type									
BH090	D0906-2	1.5-1.95	9/06/2006	Field_D	3.2	<0.5	0.7	<0.5	1.7	3.3	19.8	8.6	2.102
BH090	D0906-2	1.5-1.95	9/06/2006	Interlab_D	2.5	<0.5	0.7	<0.5	1.4	2.5	15	7.6	1.732
BH109	BH109 0.3_0.5	0.3-0.5	27/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH113	BH113 1.5_1.95	1.5-1.95	27/06/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH114	BH114 0.3_0.5	0.3-0.5	28/06/2006	Normal	2.3	<0.5	0.9	<0.5	1	2.5	18	9.2	2.225
BH115	BH115 0.8_1.0	0.8-1	28/06/2006	Normal									
BH115	BH115 1.5_1.95	1.5-1.95	28/06/2006	Normal	1.7	<0.5	<0.5	<0.5	1	1.6	11.9	3.1	0.877
BH115	D2806_1	0.8-1	28/06/2006	Field_D									
BH115	D2806_2	1.5-1.95	28/06/2006	Field_D	2.9	<0.5	0.5	<0.5	1.9	2.6	17	6.6	1.488
BH119	BH119 1.6_2.05	1.6-2.05	30/06/2006	Normal	1	<0.5	<0.5	<0.5	0.5	1	10	3.5	0.962
BH132	BH132_1.5-1.95	1.5-1.95	6/07/2006	Normal	29.5	2	7.1	3.8	16.1	27.5	189.2	100.5	25.386
BH133	BH133 1.5_1.95	1.5-1.95	6/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH133	BH133_0.3-0.5	0.3-0.5	6/07/2006	Normal	4	<0.5	1	1.3	2.7	4	27.5	12.1	2.803
BH135	BH135A-0.4-0.6	0.4-0.6	11/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH137	BH137 1.5_1.95	1.5-1.95	6/07/2006	Normal	0.8	<0.5	<0.5	<0.5	<0.5	0.8	8.7	1.1	0.56
BH141	BH141 1.5_1.95	1.5-1.95	7/07/2006	Normal	72.2	4.5	9.6	2.3	38.4	67.9	350.5	137	34.823
BH145	BH145-0.3-0.5	0.3-0.5	11/07/2006	Normal	130	5.6	36.1	8.8	61.6	149	849.7	447.1	109.996
BH145	D1107-01	0.3-0.5	11/07/2006	Field_D	132	6.3	38.9	11.6	65.6	152	893.2	473.8	118.228
BH145	D1107-1	0.3-0.5	11/07/2006	Interlab_D	219	6.7	59	10	127	230	1162.1	668	195.95
BH146	BH146-1.5-1.95	1.5-1.95	11/07/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH156	BH156_0.4-0.5	0.4-0.5	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH156	BH156_0.9-1.0	0.9-1	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH156	D1408-4	0.4-0.5	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
BH156	D1408-5	0.9-1	14/08/2006	Interlab_D	0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	ND	ND
BH159	BH159_0.25-0.35		14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH159	D1408-8	0.25-0.35	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
BH160	BH160_0.3-0.4	0.3-0.4	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH160	D1408-11		14/08/2006	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH160	D1408-11	0.3-0.4	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
BH161	BH161_0.3-0.4	0.3-0.4	14/08/2006	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH161	D1408-12	0.3-0.4	14/08/2006	Interlab_D	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
BH197	BH197/0.4	0.4	3/03/2008	Normal	3.5	0.6	<0.5	<0.5	2.9	2.9	16.1	1.7	0.125
BH200	BH200/1.0	1	7/04/2008	Normal	320	14.8	34.4	64.4	269	296	1781.5	681.6	166.044
BH203	BH203/1.9	1.9	10/03/2008	Normal	9.3	<0.5	3.4	<0.5	5.9	9.1	58.9	29.5	7.675
BH204	BH204/1.0	1	18/03/2008	Normal	373	295	41.3	1180	673	246	3702.1	508.9	119.443
BH204D	BH204D/1.5	1.5	7/04/2008	Normal	1550	1190	247	8410	2700	1510	20,934	3,547	922
BH206	BH206/0.5	0.5	7/03/2008	Normal	15.6	0.9	3.4	1.9	11.8	16.8	98.7	43.1	11.321
BH206	BH206/1.8	1.8	17/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	8	ND	ND
BH210	BH210/1.5	1.5	18/03/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
BH4	BH4 0.4-0.5	0.4-0.5	21/02/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
BH5	BH5 0.4-0.5	0.4-0.5	23/02/2008	Normal	15.9	<0.5	3.4	0.7	11.6	14.7	84.4	49.2	10.491
BH5	BH5 1.2-1.3	1.2-1.3	23/02/2008	Normal	0.8	<0.5	<0.5	1.6	0.7	0.9	9.1	0.6	0.06
BH8	BH8 0.26-0.4	0.26-0.4	19/02/2008	Normal	23	0.8	7.2	0.9	12.6	24.2	137.2	95.9	25.241
BH8	BH8 0.6-0.7	0.6-0.7	19/02/2008	Normal	62	1.9	9.5	2.3	24.8	63.3	275	148.6	43.453
BH9	BH9 0.4-0.5	0.4-0.5	21/02/2008	Normal	0.5	<0.5	<0.5	<0.5	<0.5	0.6	7.2	0.6	0.06
BH9	BH9 0.9-1.0	0.9-1	21/02/2008	Normal	2.6	<0.5	0.7	<0.5	1.6	2.7	16.1	8.1	1.746
BH9	QC4	0.4-0.5	22/02/2008	Field_D	<0.5	0.6	1.2	<0.5	<0.5	<0.5	9.6	3.4	0.142
MW10_Coffey	MW10 1.9-2.0	1.9-2	21/02/2008	Normal	16.8	<0.5	2.3	<0.5	7.6	17.5	88.7	55.3	13.423
MW10_Coffey	QC3	1.9-2	21/02/2008	Field_D	16.2	0.7	2.5	<0.5	12.4	17.4	94.2	56.4	14.073
MW10_Coffey	QC3A	1.9-2	21/02/2008	Normal	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.35	ND	ND
MW15_Coffey	MW15_0.4-0.5	0.4-0.5	10/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
MW15_Coffey	MW15_1.4-1.5	1.4-1.5	10/04/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
MW15_Coffey	QC1	1.4-1.5	10/04/2008	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
MW15_Coffey	QC1A	1.4-1.5	21/02/2008	Normal									
MW3	MW3 0.4-0.5	0.4-0.5	23/02/2008	Normal	0.7	<0.5	0.7	<0.5	0.5	0.8	8.6	3.5	0.26
MW3	MW3 0.9-1.0	0.9-1	23/02/2008	Normal	91.1	8.5	8.6	2.5	120	93.2	468.5	157.2	26.196
MW3	QC6	1.9-2	23/02/2008	Field_D	83.1	14.6	8.4	17.3	110	86.7	469.8	170.6	40.244
MW6	MW6 0.8-0.9	0.8-0.9	20/02/2008	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
MW6	QC1	0.8-0.9	20/02/2008	Field_D	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<7	ND	ND
MW6	QC1A	0.8-0.9	21/02/2008	Normal	0.3	<0.1	<0.1	<0.1	0.1	0.3	1.94	0.64	0.181
MW7	MW7 1.4-1.5	1.4-1.5	25/02/2008	Normal	36.6	2	6.5	1.6	24.9	35.9	218	148	43.645
TBH01	DUP 01	0.43-0.5	5/02/2011	Field_D	0.7	<0.5	<0.5	<0.5	<0.5	0.7	8.4	ND	ND
TBH01	TBH01_0.43-0.5	0.43-0.5	5/02/2011	Normal	3.1	<0.5	0.6	<0.5	1.2	3	19	8.7	2.22
TBH01	TRIP01	0.43-0.5	5/02/2011	Interlab_D	1.3	<0.5	0.6	<0.5	<0.5	1.1	9.7	5.5	1.324
TBH03	TBH03_1.2-1.3	1.2-1.3	5/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
TBH03	TBH03_1.5-1.6	1.5-1.6	5/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
TBH05	DUP02	1.8-2	12/02/2011	Field_D	17.8	0.6	10.6	0.8	9.5	14.9	144.6	96.1	24.253
TBH05	TBH05_0.6-0.7	0.6-0.7	12/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
TBH05	TBH05_1.3-1.7	1.3-1.7	12/02/2011	Normal	1	<0.5	<0.5	<0.5	<0.5	0.9	9.6	2.2	0.85
TBH05	TBH05_1.8-2.0	1.8-2	12/02/2011	Normal	19.1	<0.5	14	0.6	8.3	16	162.3	113.2	28.753

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

												Carcinogenic PAHs	
					Fluoranthene	**Fluorene**	**Indeno(1,2,3-c,d)pyrene**	**Naphthalene**	**Phenanthrene**	**Pyrene**	**PAH (ESDAT TOTAL)**	**cPAH (SUM)**	**cPAH (TEF)**
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					0.5	0.5	0.5	0.5	0.5	0.5			
Scenario 2 VMP July 2012											40		
Location_ Code	**Field_ID**	**Sample_ Depth_ Range**	**Sampled_ Date_Time**	**Sample_ Type**									
TBH06	TBH06_0.55-0.6	0.55-0.6	5/02/2011	Normal	1.7	<0.5	<0.5	<0.5	0.6	1.9	11.8	3.1	0.967
TBH06	TBH06_1.5-2.0	1.5-2	12/02/2011	Normal	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<8	ND	ND
TBH07	TBH07_0.1-0.15	0.1-0.15	4/02/2011	Normal	6.4	<0.5	4.1	<0.5	1.4	8.6	60.1	39.4	10.663
TBH08	TBH08_0.13-0.25	0.13-0.25	4/02/2011	Normal	2.8	<0.5	<0.5	<0.5	<0.5	3.1	16.3	6.4	1.828
Statistical Summary													
Number of Results					123	123	123	123	123	123	123	123	123
Number of Detects					86	42	67	51	79	89	89	84	84
Minimum Concentration					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.35	6.4	1.828
Minimum Detect					0.3	0.6	0.5	0.5	0.1	0.3	1.94	0.6	0.06
Maximum Concentration					2130	1290	247	8410	3130	1670	20,934	3693.5	921.56
Maximum Detect					2130	1290	247	8410	3130	1670	20,934	3693.5	921.56
Average Concentration					83	36	11	210	110	69	728	152	37
Median Concentration					2.8	0.25	0.6	0.25	1.4	2.9	18	7.3	1.746
Standard Deviation					308	174	34	1080	465	243	3053	517	124
Number of Guideline Exceedances					0	0	0	0	0	0	46	0	0
Number of Guideline Exceedances(Detects Only)					0	0	0	0	0	0	46	0	0

Notes;
ND = Not detected above the laboratory limit of reporting
cPAH (SUM) = Sum of carcinogenic PAHs (see text for details)
cPAH (TEF) = Sum of carcinogenic PAHs taking into consideration Toxic Equivalency Facto

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

					TPH				BTEX						Phenols	Cyanides			Inorganics
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Cyanide (WAD)	Cyanide (Free)	Cyanide Total	Ammonia as N
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					10	50	100	100	0.2	0.2	0.2	0.2	0.2	0.15	0.01	1	1	1	20
Scenario 2 VMP July 2012					10	50	100	100	1.1	5.4	5000	590	690	630	17,000	1000	1000	1000	
Location_ Code	Field_ID	Sample_ Depth_ Range	Sampled_ Date_Time	Sample_ Type															
AECOM_BH33	BH33_0.75-0.85	0.75-0.85	2/12/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
AECOM_BH34	BH34_1.8-2.2	1.8-2.2	25/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH34	QC240	1.8-2.2	25/02/2010	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH34	QC241	1.8-2.2	25/02/2010	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1		<1	
AECOM_BH36	BH36_1.0-1.2	1-1.2	3/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH42	BH42_1.0-1.1	1-1.1	23/02/2010	Normal	<10	<50	110	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH44	BH44_1.9-2.0	1.9-2	23/02/2010	Normal	10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH49	BH49_1.5-1.7	1.5-1.7	22/02/2010	Normal	11	80	1460	790	<0.2	<0.5	<0.5	<0.5	<0.5	<1	1.9				
AECOM_BH50	BH50_1.3-1.5	1.3-1.5	26/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		<1	
AECOM_BH51	BH51_0.4-0.5	0.4-0.5	6/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH52	BH52_1.0-1.2	1-1.2	22/02/2010	Normal	78	<50	580	370	0.2	2.7	3.9	20.2	8.7	28.9					
AECOM_BH53	BH53_1.1-1.5	1.1-1.5	6/03/2010	Normal	<10	<50	1920	1330	0.4	<0.5	<0.5	<0.5	<0.5	<1	1.2				
AECOM_BH53	QC208	1.1-1.5	6/03/2010	Field_D	<10	<50	1040	860	0.3	<0.5	<0.5	<0.5	<0.5	<1	0.8				
AECOM_BH54	BH54_1.0-1.4	1-1.4	23/02/2010	Normal	72	4380	11,700	3560	2.5	3.5	7.3	25	10.5	35.5	5				
AECOM_BH54	QC228	1-1.4	23/02/2010	Field_D	212	10,300	27,600	8940	4.3	8	21.5	62.2	26.4	88.6	<4	<1	<1		
AECOM_BH55	BH55_1.0-1.2	1-1.2	25/02/2010	Normal	109	11,300	19,400	5550	7.8	2.8	14	24.1	10.8	34.9	23.5	8		127	
AECOM_BH58	BH58_1.0-1.2	1-1.2	22/02/2010	Normal	<10	<50	550	460	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_BH59	BH59_1.9-2.0	1.9-2	22/02/2010	Normal	<10	980	2290	860	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1	<1		
AECOM_BH61	BH61_0.3-0.4	0.3-0.4	6/03/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
AECOM_BH62	BH62_1.0-1.2	1-1.2	26/02/2010	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<1		9	
AECOM_BH64	BH64_1.0-1.2	1-1.2	1/03/2010	Normal	<10	260	1970	1000	0.2	<0.5	<0.5	<0.5	<0.5	<1	3.8				
AECOM_BH67	BH67_0.4-0.43	0.4-0.43	6/03/2010	Normal	<10	<50	700	570	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
AECOM_SV09	SV09_0.2-0.4	0.2-0.4	26/02/2010	Normal	<10	120	1920	1240	0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH001	BH001	1	1/05/2006	Normal	3	2360	3280	1190	0.5	<0.2	0.4	0.2	<0.2	0.4				322	
BH019	BH019 1.5-1.95	1.5-1.95	8/05/2006	Normal	50	100	<100	<100											
BH020	BH020 0.3-0.5	0.3-0.5	9/05/2006	Normal	<2	<50	460	350											
BH020	BH020 1.5-2.1	1.5-2.1	9/05/2006	Normal	<2	<50	280	340											
BH020	BH021 0.3-0.5	0.3-0.5	9/05/2006	Normal	<2	<50	130	100											
BH020	D0905-1	1.5-2.1	9/05/2006	Field_D	<2	<50	240	290											
BH028	BH028_0.3-0.5	0.3-0.5	12/05/2006	Normal	<2	<50	200	140	<0.2	<0.2	<0.2	<0.2	<0.2	<0.01					
BH042	BH042_0.3-0.5	0.3-0.5	23/05/2006	Normal	<2	<50	150	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH042	BH042_1.5-1.7	1.5-1.7	23/05/2006	Normal	<2	<50	170	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH058	BH058-1.5-1.95	1.5-1.95	31/05/2006	Normal	8	120	1960	1070	0.3	0.3	0.2	<0.2	<0.2	<0.4				69.7	
BH059	BH059-1.5-1.95	1.5-1.95	31/05/2006	Normal	<2	<50	290	260	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH060	BH060-1.7-2.0	1.7-2	31/05/2006	Normal	<2	<50	<100	140	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				5.6	
BH060	D3105-2	1.7-2	31/05/2006	Field_D	<2	<50	140	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				5.1	
BH062	BH062-1.5-1.95	1.5-1.95	31/05/2006	Normal	8	100	610	510	<0.2	<0.2	0.4	0.3	<0.2	0.5				489	
BH065	BH065-0.3-0.5	0.3-0.5	1/06/2006	Normal	<2	<50	180	350	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				2.6	
BH065	BH065-1.5-1.95	1.5-1.95	1/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH065	D0106-1	0.3-0.5	1/06/2006	Field_D	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1.3	
BH067	BH067-1.5-1.95	1.5-1.95	1/06/2006	Normal	<2	<50	480	620	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH070	BH070_0.3-0.5	0.3-0.5	2/05/2006	Normal	<2	<50	600	210	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH070	BH070_1.5-1.95	1.5-1.95	2/05/2006	Normal	<2	<50	230	340	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH070	D0206-1	0.3-0.5	2/05/2006	Field_D	<2	<50	480	320	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				2	
BH070	D0206-1	0.3-0.5	2/06/2006	Interlab_D															
BH071	BH071_1.5-1.95	1.5-1.95	2/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH072	BH072_0.3-0.5	0.3-0.5	2/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH073	BH073_1.5-1.95	1.5-1.95	2/05/2006	Normal	<2	<50	560	270	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				8.7	
BH074	BH074_1.5-1.95	1.5-1.95	2/05/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH075	BH075_0.3-0.5	0.3-0.5	6/06/2006	Normal	<2	<50	570	440	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				7.6	
BH075	D0606-1	1.5-1.95	6/06/2006	Interlab_D															
BH075	D0606-1	1.5-1.95	7/06/2006	Field_D	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1.3	
BH087	BH087 1.5-1.95	1.5-1.95	8/06/2006	Normal	20	2230	5820	1520	0.7	1.2	0.8	7.3	3.2	10.5				9.8	
BH089	BH089 0.3-0.5	0.3-0.5	9/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH089	BH089 1.5-1.95	1.5-1.95	9/06/2006	Normal	<2	70	440	170	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				2.1	
BH090	BH090 1.5-1.95	1.5-1.95	9/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

					TPH				BTEX						Phenols	Cyanides			Inorganics
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Cyanide (WAD)	Cyanide (Free)	Cyanide Total	Ammonia as N
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					10	50	100	100	0.2	0.2	0.2	0.2	0.2	0.15	0.01	1	1	1	20
Scenario 2 VMP July 2012					10	50	100	100	1.1	5.4	5000	590	690	630	17,000	1000	1000	1000	
Location_ Code	Field_ID	Sample_ Depth_ Range	Sampled_ Date_Time	Sample_ Type															
BH090	D0906-2	1.5-1.95	9/06/2006	Field_D	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH090	D0906-2	1.5-1.95	9/06/2006	Interlab_D															
BH109	BH109 0.3_0.5	0.3-0.5	27/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH113	BH113 1.5_1.95	1.5-1.95	27/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH114	BH114 0.3_0.5	0.3-0.5	28/06/2006	Normal	<2	<50	130	210	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH115	BH115 0.8_1.0	0.8-1	28/06/2006	Normal	<2	<50	560	340	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH115	BH115 1.5_1.95	1.5-1.95	28/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1.1	
BH115	D2806_1	0.8-1	28/06/2006	Field_D	<2	120	1470	1120	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH115	D2806_2	1.5-1.95	28/06/2006	Field_D	<2	<50	280	160	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				1	
BH119	BH119 1.6_2.05	1.6-2.05	30/06/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH132	BH132_1.5-1.95	1.5-1.95	6/07/2006	Normal	<2	<50	500	390	0.5	<0.2	<0.2	<0.2	<0.2	<0.4				20.5	
BH133	BH133 1.5_1.95	1.5-1.95	6/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH133	BH133_0.3-0.5	0.3-0.5	6/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH135	BH135A-0.4-0.6	0.4-0.6	11/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH137	BH137 1.5_1.95	1.5-1.95	6/07/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH141	BH141 1.5_1.95	1.5-1.95	7/07/2006	Normal	<2	70	1600	590	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				71.7	
BH145	BH145-0.3-0.5	0.3-0.5	11/07/2006	Normal	4	80	2120	1270	0.2	<0.2	0.4	0.3	<0.2	0.5					
BH145	D1107-01	0.3-0.5	11/07/2006	Field_D	3	240	4360	2640	<0.2	<0.2	0.3	0.2	<0.2	0.4					
BH145	D1107-1	0.3-0.5	11/07/2006	Interlab_D															
BH146	BH146-1.5-1.95	1.5-1.95	11/07/2006	Normal	2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				8.6	
BH156	BH156_0.4-0.5	0.4-0.5	14/08/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4				<1	
BH156	BH156_0.9-1.0	0.9-1	14/08/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4	<0.5				
BH156	D1408-4	0.4-0.5	14/08/2006	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5					
BH156	D1408-5	0.9-1	14/08/2006	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5	<0.5				
BH159	BH159_0.25-0.35		14/08/2006	Normal	<2	<50	270	960	<0.2	<0.2	<0.2	0.3	<0.2	0.5				<1	
BH159	D1408-8	0.25-0.35	14/08/2006	Interlab_D	<10	<50	<100	280	<0.2	<0.5	<0.5	<1	<0.5	<1.5					
BH160	BH160_0.3-0.4	0.3-0.4	14/08/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4	<0.5				
BH160	D1408-11		14/08/2006	Field_D	<2				<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH160	D1408-11	0.3-0.4	14/08/2006	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5					
BH161	BH161_0.3-0.4	0.3-0.4	14/08/2006	Normal	<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4					
BH161	D1408-12	0.3-0.4	14/08/2006	Interlab_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<1	<0.5	<1.5					
BH197	BH197/0.4	0.4	3/03/2008	Normal	<10	<50	150	450	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH200	BH200/1.0	1	7/04/2008	Normal	<10	520	10,200	4730	1.6	<0.5	2.2	2	0.8	2.8	6.7			200	
BH203	BH203/1.9	1.9	10/03/2008	Normal	<10	<50	330	360	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH204	BH204/1.0	1	18/03/2008	Normal	20	2890	9620	3070	0.6	3.5	1.4	4.2	4.4	8.6	<0.5			8	
BH204D	BH204D/1.5	1.5	7/04/2008	Normal	226	54,200	72,400	20,600	61	7	69.2	67.2	26.9	94.1	1720			575	
BH206	BH206/0.5	0.5	7/03/2008	Normal	<10	<50	310	180	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			8	
BH206	BH206/1.8	1.8	17/04/2008	Normal	<10	<50	190	340	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH210	BH210/1.5	1.5	18/03/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5			<1	
BH4	BH4 0.4-0.5	0.4-0.5	21/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH5	BH5 0.4-0.5	0.4-0.5	23/02/2008	Normal	<10	<50	1060	640	<0.2	<0.5	<0.5	<0.5	<0.5	<1	0.7				
BH5	BH5 1.2-1.3	1.2-1.3	23/02/2008	Normal	<10	<50	<100	<100	2	<0.5	0.7	0.8	<0.5	1.3	<0.5				
BH8	BH8 0.26-0.4	0.26-0.4	19/02/2008	Normal	<10	<50	310	200	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH8	BH8 0.6-0.7	0.6-0.7	19/02/2008	Normal	<10	<50	1380	990	<0.2	<0.5	<0.5	<0.5	<0.5	<1	0.7				
BH9	BH9 0.4-0.5	0.4-0.5	21/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH9	BH9 0.9-1.0	0.9-1	21/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
BH9	QC4	0.4-0.5	22/02/2008	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW10_Coffey	MW10 1.9-2.0	1.9-2	21/02/2008	Normal	<10	<50	370	460	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW10_Coffey	QC3	1.9-2	21/02/2008	Field_D	<10	<50	450	510	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW10_Coffey	QC3A	1.9-2	21/02/2008	Normal					<0.5	<0.5	<0.5			<1.5	<0.5				
MW15_Coffey	MW15 0.4-0.5	0.4-0.5	10/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW15_Coffey	MW15 1.4-1.5	1.4-1.5	10/04/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW15_Coffey	QC1	1.4-1.5	10/04/2008	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW15_Coffey	QC1A	1.4-1.5	21/02/2008	Normal					<0.5	<0.5	<0.5			<1.5					
MW3	MW3 0.4-0.5	0.4-0.5	23/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW3	MW3 0.9-1.0	0.9-1	23/02/2008	Normal	<10	1010	2510	760	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW3	QC6	1.9-2	23/02/2008	Field_D	<10	800	5730	1610	0.5	<0.5	0.8	0.8	<0.5	1.3	<0.5				
MW6	MW6 0.8-0.9	0.8-0.9	20/02/2008	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW6	QC1	0.8-0.9	20/02/2008	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1	<0.5				
MW6	QC1A	0.8-0.9	21/02/2008	Normal					<0.5	<0.5	<0.5			<1.5	<0.5				
MW7	MW7 1.4-1.5	1.4-1.5	25/02/2008	Normal	<10	<50	1400	1260	0.2	<0.5	<0.5	<0.5	<0.5	<1	0.9				
TBH01	DUP 01	0.43-0.5	5/02/2011	Field_D	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH01	TBH01_0.43-0.5	0.43-0.5	5/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH01	TRIP01	0.43-0.5	5/02/2011	Interlab_D	<10	<50	<100	<100	<0.5	<0.5	<0.5	<1	<0.5	<1.5					
TBH03	TBH03_1.2-1.3	1.2-1.3	5/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH03	TBH03_1.5-1.6	1.5-1.6	5/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH05	DUP02	1.8-2	12/02/2011	Field_D	<10	<50	530	470	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH05	TBH05_0.6-0.7	0.6-0.7	12/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH05	TBH05_1.3-1.7	1.3-1.7	12/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH05	TBH05_1.8-2.0	1.8-2	12/02/2011	Normal	<10	<50	600	610	<0.2	<0.5	<0.5	<0.5	<0.5	<1					

Table T2
Human Health Soil Screen and Selection of CoPC
Soil Profile 0 m to 2 mbgs

					TPH				BTEX						Phenols	Cyanides			Inorganics
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Cyanide (WAD)	Cyanide (Free)	Cyanide Total	Ammonia as N
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					10	50	100	100	0.2	0.2	0.2	0.2	0.2	0.15	0.01	1	1	1	20
Scenario 2 VMP July 2012					10	50	100	100	1.1	5.4	5000	590	690	630	17,000	1000	1000	1000	
Location_ Code	**Field_ID**	**Sample_ Depth_ Range**	**Sampled_ Date_Time**	**Sample_ Type**															
TBH06	TBH06_0.55-0.6	0.55-0.6	5/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH06	TBH06_1.5-2.0	1.5-2	12/02/2011	Normal	<10	<50	<100	<100	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH07	TBH07_0.1-0.15	0.1-0.15	4/02/2011	Normal	<10	<50	280	420	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
TBH08	TBH08_0.13-0.25	0.13-0.25	4/02/2011	Normal	<10	<50	110	260	<0.2	<0.5	<0.5	<0.5	<0.5	<1					
Statistical Summary																			
Number of Results					123	122	122	122	121	121	121	118	118	121	52	9	3	51	0
Number of Detects					16	22	62	60	19	8	15	15	8	15	11	1	0	24	0
Minimum Concentration					<2	<50	<100	<100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.01	<0.5	<1	<1	<1	0
Minimum Detect					2	70	110	100	0.2	0.3	0.2	0.2	0.8	0.4	0.7	8	ND	1	ND
Maximum Concentration					226	54,200	72,400	20,600	61	8	69.2	67.2	26.9	94.1	1720	8	<1	575	0
Maximum Detect					226	54,200	72,400	20,600	61	8	69.2	67.2	26.9	94.1	1720	8	ND	575	ND
Average Concentration					9.6	777	1727	681	0.79	0.41	1.2	2	0.95	2.9	34	1.3	0.5	39	
Median Concentration					5	25	110	50	0.1	0.25	0.25	0.25	0.25	0.5	0.25	0.5	0.5	0.5	
Standard Deviation					30	5093	7327	2144	5.6	1.1	6.7	9.1	3.8	13	238	2.5	0	115	
Number of Guideline Exceedances					10	22	62	60	6	2	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)					10	22	62	60	6	2	0	0	0	0	0	0	0	0	0

Notes;
ND = Not detected above the laboratory limit of reporting
cPAH (SUM) = Sum of carcinogenic PAHs (see text for details)
cPAH (TEF) = Sum of carcinogenic PAHs taking into consideration Toxic Equivalency Facto

Table T3
Human Health Groundwater Screen and Selection of COPC

													PAHs	
					PAH (ESDAT TOTAL)	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL						0.1	0.1	0.1	0.1	0.05	1	0.1	0.1	0.1
Scenario 1 and Scenario 2 VMP July 2012						400	400	1300	0.029	0.01	0.029	0.029	87	0.29
Location_Code	Field_ID	Sampled_ Date_Time	Sample _Type	Monitoring_Unit										
AECOM_BH40	MW40	20/03/2010	Normal		302.4	4	16	3	<0.9	<0.9	<2		<0.9	
AECOM_BH45	MW45	19/03/2010	Normal		34	<2	<2	<2	<2	<2	<4		<2	
AECOM_BH52	MW52	19/03/2010	Normal		34	<2	<2	<2	<2	<2	<4		<2	
AECOM_BH54	MW54	19/03/2010	Normal		9080	72	113	19	3	<2	<4		<2	
AECOM_BH58	MW58	17/03/2010	Normal		<28	<2	<2	<2	<2	<2	<4		<2	
AECOM_BH58	QC237	17/03/2010	Field_D		<28	<2	<2	<2	<2	<2	<4		<2	
AECOM_BH58	QC328	17/03/2010	Interlab_D		<7									
AECOM_BH61	MW61	20/03/2010	Normal		436	6	21	18	16	8	12		3	
AECOM_BH62	MW62	17/03/2010	Normal		24.1	1	<0.9	1	<0.9	0.7	<2		<0.9	
AECOM_BH62	MW62	24/02/2011	Normal		<15.5	<1	<1	<1	<1	<0.5		<1	<1	<1
AECOM_BH62	MW62_FILTRATE	24/02/2011	Normal		1.85	<0.1	<0.1	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
AECOM_BH64	MW64	20/03/2010	Normal		69	3	11	2	<2	<2	<4		<2	
AECOM_BH68	MW68	18/03/2010	Normal		14.8	<0.9	<0.9	<0.9	<0.9	<0.9	<2		<0.9	
AECOM_BH68	MW68	24/02/2011	Normal		<15.5	<1	<1	<1	<1	<0.5		<1	<1	<1
AECOM_BH68	MW68_FILTRATE	24/02/2011	Normal		2.35	<0.1	<0.1	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
BH087	D1408-9	14/08/2006	Interlab_D	Fill	51	7	3	3	<1	<1	<2		<1	
BH087	MW015	25/07/2006	Normal	Fill	23,350	80.1	376	94.7	54.6	41.1		27.8	12.9	29.3
BH087	MW15	25/07/2006	Normal	Fill										
BH087	MW15	14/08/2006	Normal	Fill	15,287	112	696	161	145	91		118	37.5	31.3
BH087	MW15	15/08/2007	Normal	Fill	5152.9	60.8	227	66.3	53.5	45.4		37.1	20.2	26.8
BH087	MW15	12/05/2008	Normal	Fill	2745.3	<18.3	51.5	<18.3	<18.3	<18.3		<18.3	<18.3	<18.3
BH087	MW15	5/12/2008	Normal	Fill										
BH087	MW15	15/03/2010	Normal	Fill	8280	49	155	18	<9	<9	<19		<9	
BH198	D01	9/05/2008	Interlab_D	Fill and Clayey Sand	28	2	7	<1	<1	<1	<2		<1	
BH198	MW198	9/05/2008	Normal	Fill and Clayey Sand	33	2.2	9.7	<1	<1	<0.5		<1	<1	<1
BH198	MW198	5/09/2008	Normal	Fill and Clayey Sand										
BH198	MW198	16/03/2010	Normal	Fill and Clayey Sand	38	2	12	<2	<2	<2	<4		<2	
BH198	MW198	25/02/2011	Normal	Fill and Clayey Sand	15.9	<1	1.4	<1	<1	<0.5		<1	<1	<1
BH198	MW198 FILTRATE	25/02/2011	Normal	Fill and Clayey Sand	2.45	<0.1	0.4	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
BH198	QC323	16/03/2010	Field_D	Fill and Clayey Sand	43	3	16	<2	<2	<2	<4		<2	
BH198	QC324	16/03/2010	Interlab_D	Fill and Clayey Sand	42	<2	16	<2	<2	<2	<4		<2	
BH198	QC618	25/02/2011	Field_D	Fill and Clayey Sand	16.9	<1	2.4	<1	<1	<0.5		<1	<1	<1
BH198	QC618 FILTRATE	25/02/2011	Field_D	Fill and Clayey Sand	2.35	<0.1	0.4	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
BH200	MW200	13/05/2008	Normal	Sandstone Bedrock	2600.5	<19.2	39.1	<19.2	<19.2	<19.2		<19.2	<19.2	<19.2
BH200	MW200	16/03/2010	Normal	Sandstone Bedrock	8109	15	40	<9	<9	<9	<19		<9	
BH200	MW200	28/02/2011	Normal	Sandstone Bedrock	6920	<98	<98	<98	<98	<98		<98	<98	<98
BH200	MW200 FILTRATE	28/02/2011	Normal	Sandstone Bedrock	3009.1	6.4	20.2	<1	<1	<0.5		<1	<1	<1
BH204	MW204 FILTRATE	25/02/2011	Normal	Sandstone Bedrock	1117.95	10.9	5.1	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
BH204	MW204S	15/03/2010	Normal	Sandstone Bedrock	7161	96	55	<9	<9	<9	<19		<9	
BH204	MW204S	25/02/2011	Normal	Sandstone Bedrock	8956.1	85.5	45.4	<10	<10	<10		<10	<10	<10
BH204D	MW204D	13/05/2008	Normal	Fill and Clayey Sand	11,280	122	334	476	254	145		185	63.8	80.9
BH205	MW205	9/05/2008	Normal	Sandstone Bedrock	1924.2	<19.1	66.8	<19.1	<19.1	<19.1		<19.1	<19.1	<19.1
BH205	MW205	5/09/2008	Normal	Sandstone Bedrock										
BH205	MW205	17/03/2010	Normal	Sandstone Bedrock	530,568	4480	43,200	15,400	12,600	9260	9860		1910	
BH206	MW206	12/05/2008	Normal	Clayey Sand	953	6.3	42.6	2.2	<1	<0.9		<1	<1	<1
BH206	MW206	5/12/2008	Normal	Clayey Sand										
BH206	MW206	19/03/2010	Normal	Clayey Sand	21,144	274	1380	680	592	299	362		89	
BH209	D01_120508	12/05/2008	Interlab_D	Fill	277	<10	37	<10	<10	<10	<20		<10	
BH209	MW209	12/05/2008	Normal	Fill	295.7	8.1	50	5.6	<1.8	<1.8		<1.8	<1.8	<1.8
BH209	MW209	5/12/2008	Normal	Fill										
BH209	MW209	16/03/2010	Normal	Fill	761	7	26	4	2	3	<4		<2	
BH209	MW209	28/02/2011	Normal	Fill	33.6	1.8	6.2	1	1	0.8		<1	<1	<1
BH209	MW209 FILTRATE	28/02/2011	Normal	Fill	3.45	<0.1	<0.1	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
BH210	MW210	8/05/2008	Normal	Sandstone Bedrock	1599.7	24.4	156	15.4	3.5	<2		2.2	<2	<2
BH210	MW210	5/08/2008	Normal	Sandstone Bedrock										
BH210	MW210	16/03/2010	Normal	Sandstone Bedrock	56	7	12	2	<2	<2	<4		<2	
BH210	MW210	24/02/2011	Normal	Sandstone Bedrock	22.9	<1	3.1	<1	1.1	0.9		<1	<1	<1
BH210	MW210 FILTRATE	24/02/2011	Normal	Sandstone Bedrock	2.15	<0.1	0.3	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1

Table T3
Human Health Groundwater Screen and Selection of COPC

					PAHs									
					PAH (ESDAT TOTAL)	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL						0.1	0.1	0.1	0.1	0.05	1	0.1	0.1	0.1
Scenario 1 and Scenario 2 VMP July 2012						400	400	1300	0.029	0.01	0.029	0.029	87	0.29
Location_Code	**Field_ID**	**Sampled_ Date_Time**	**Sample _Type**	**Monitoring_Unit**										
BH405	IT3D	25/02/2011	Normal		3088.8	25	158	25.7	19.6	12.8		12.4	<10	<10
BH405	IT3D FILTRATE	25/02/2011	Normal		562.85	2.1	10.2	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
BH405	IT3M	25/02/2011	Normal		15.5	<1	<1	<1	<1	<0.5		<1	<1	<1
BH405	IT3M FILTRATE	25/02/2011	Normal		1.65	<0.1	<0.1	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
BH405	IT3S	25/02/2011	Normal		33.3	<1	<1	<1	2.2	3.8		4.8	3	2.5
BH405	IT3S FILTRATE	25/02/2011	Normal		1.95	<0.1	<0.1	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1
MW10_Coffey	MW10	26/03/2008	Normal		34,451	369	1140	1680	1150	709		944	260	192
MW10_Coffey	QC2	26/03/2008	Field_D		20,910	243	692	1010	701	448		512	152	164
MW10_Coffey	QC2A	26/03/2008	Normal		4195	28	46	88	50	36	45		15	
MW10_Coffey	QC3	1/05/2008	Field_D		304,419	3590	13,200	10,400	8060	6220		6840	3250	3670
MW15_Coffey	MW15	1/05/2008	Normal		383,602	3870	18,700	13,700	10,400	7750		8330	4220	2930
MW3	BH3	20/03/2010	Normal		1055	12	40	25	8	3	5		<2	
MW3	MW3	26/03/2008	Normal		2007.8	<0.2	68.7	14.1	5.3	4.1		4.2	2	1.8
MW6	BH6	20/03/2010	Normal		<28	<2	<2	<2	<2	<2	<4		<2	
MW6	MW6	26/03/2008	Normal		3.6	<0.2	<0.2	<0.2	<0.2	<0.2		<0.2	<0.2	<0.2
MW7	MW7PER	26/03/2008	Normal		9211.9	69.6	407	133	83.3	70.2		67.9	34	31.8
MW7	MW7POST	26/03/2008	Normal		5444.4	38.5	246	34.3	11.2	9.3		9.2	4.2	4.2
MW7	QC1	26/03/2008	Field_D		6441.1	51.5	331	44.4	18.6	15.8		17.5	6.3	4.4
Statistical Summary														
Number of Results					69	68	68	68	68	68	26	42	68	42
Number of Detects					63	39	50	30	24	23	5	15	17	13
Minimum Concentration					1.65	<0.1	<0.1	<0.1	<0.1	<0.05	<2	<0.1	<0.1	<0.1
Minimum Detect					1.65	1	0.3	1	1	0.7	5	2.2	2	1.8
Maximum Concentration					530,568	4480	43,200	15,400	12,600	9260	9860	8330	4220	3670
Maximum Detect					530,568	4480	43,200	15,400	12,600	9260	9860	8330	4220	3670
Average Concentration					20,977	205	1211	651	505	372	398	410	150	173
Median Concentration					295.7	5.5	16	2.1	1	1	2	0.7	1	0.7
Standard Deviation					85,284	823	5853	2756	2174	1620	1931	1641	676	714
Number of Guideline Exceedances					0	3	8	4	68	68	26	42	7	31
Number of Guideline Exceedances(Detects Only)					0	3	8	4	24	23	5	15	6	13

Notes;
ND = Not detected above the laboratory limit of reporting
CPAH (SUM) = Sum of carcinogenic PAHs (see text for details)
CPAH (TEF) = Sum of carcinogenic PAHs taking into consideration Toxic Equivalency Factors (as presented in Appendix D).

Table T3
Human Health Groundwater Screen and Selection of COPC

Location_Code	Field_ID	Sampled_ Date_Time	Sample _Type	Monitoring_Unit	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	CPAH (SUM)	CPAH (TEF)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
EQL					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Scenario 1 and Scenario 2 VMP July 2012					2.9	0.0029	630	220	0.029	0.14	1300	87		
AECOM_BH40	MW40	20/03/2010	Normal		<0.9	<0.9	2	12	<0.9	244	14	2	ND	ND
AECOM_BH45	MW45	19/03/2010	Normal		<2	<2	<2	<2	<2	8	<2	<2	ND	ND
AECOM_BH52	MW52	19/03/2010	Normal		<2	<2	4	<2	<2	4	<2	4	ND	ND
AECOM_BH54	MW54	19/03/2010	Normal		2	<2	19	92	<2	8640	98	14	5	0.05
AECOM_BH58	MW58	17/03/2010	Normal		<2	<2	<2	<2	<2	<2	<2	<2	ND	ND
AECOM_BH58	QC237	17/03/2010	Field_D		<2	<2	<2	<2	<2	<2	<2	<2	ND	ND
AECOM_BH58	QC328	17/03/2010	Interlab_D							<7				
AECOM_BH61	MW61	20/03/2010	Normal		12	<2	48	26	3	150	79	44	54	9.81
AECOM_BH62	MW62	17/03/2010	Normal		<0.9	<0.9	2	1	<0.9	7	4	2	0.7	0.7
AECOM_BH62	MW62	24/02/2011	Normal		<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
AECOM_BH62	MW62_FILTRATE	24/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	ND	ND
AECOM_BH64	MW64	20/03/2010	Normal		<2	<2	2	10	<2	11	15	3	ND	ND
AECOM_BH68	MW68	18/03/2010	Normal		<0.9	<0.9	<0.9	<0.9	<0.9	3	1	<0.9	ND	ND
AECOM_BH68	MW68	24/02/2011	Normal		<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
AECOM_BH68	MW68_FILTRATE	24/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	<0.1	0.8	0.2	<0.1	ND	ND
BH087	D1408-9	14/08/2006	Interlab_D	Fill	<1	<1	2	6	<1	12	10	2	ND	ND
BH087	MW015	25/07/2006	Normal	Fill	47.7	4.9	135	236	13.3	21,700	367	130	231.6	54.192
BH087	MW15	25/07/2006	Normal	Fill										
BH087	MW15	14/08/2006	Normal	Fill	97.3	8.4	480	491	35	11,400	932	451	563.5	120.628
BH087	MW15	15/08/2007	Normal	Fill	42.8	5.2	116	150	19.8	3930	242	110	250.8	60.135
BH087	MW15	12/05/2008	Normal	Fill	<18.3	<18.3	<18.3	25	<18.3	2430	19.2	<18.3	64	18.64
BH087	MW15	5/12/2008	Normal	Fill										
BH087	MW15	15/03/2010	Normal	Fill	<9	<9	18	83	<9	7800	87	16	9	0.9
BH198	D01	9/05/2008	Interlab_D	Fill and Clayey Sand	<1	<1	<1	1	<1	7	2	1	ND	ND
BH198	MW198	9/05/2008	Normal	Fill and Clayey Sand	<1	<1	1.1	1.6	<1	6.5	2.1	1.3	ND	ND
BH198	MW198	5/09/2008	Normal	Fill and Clayey Sand										
BH198	MW198	16/03/2010	Normal	Fill and Clayey Sand	<2	<2	<2	<2	<2	<2	<2	<2	ND	ND
BH198	MW198	25/02/2011	Normal	Fill and Clayey Sand	<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
BH198	MW198 FILTRATE	25/02/2011	Normal	Fill and Clayey Sand	<0.1	<0.1	<0.1	<0.1	<0.1	0.7	<0.1	<0.1	ND	ND
BH198	QC323	16/03/2010	Field_D	Fill and Clayey Sand	<2	<2	<2	<2	<2	<2	<2	<2	ND	ND
BH198	QC324	16/03/2010	Interlab_D	Fill and Clayey Sand	<2	<2	<2	<2	<2	<2	<2	<2	ND	ND
BH198	QC618	25/02/2011	Field_D	Fill and Clayey Sand	<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
BH198	QC618 FILTRATE	25/02/2011	Field_D	Fill and Clayey Sand	<0.1	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	ND	ND
BH200	MW200	13/05/2008	Normal	Sandstone Bedrock	<19.2	<19.2	<19.2	21.8	<19.2	2290	<19.2	<19.2	72	20.97
BH200	MW200	16/03/2010	Normal	Sandstone Bedrock	<9	<9	<9	11	<9	7950	12	<9	9	0.9
BH200	MW200	28/02/2011	Normal	Sandstone Bedrock	<98	<98	<98	<98	<98	5450	<98	<98	64	18.64
BH200	MW200 FILTRATE	28/02/2011	Normal	Sandstone Bedrock	<1	<1	<1	<1	<1	2970	<1	<1	ND	ND
BH204	MW204 FILTRATE	25/02/2011	Normal	Sandstone Bedrock	<0.1	<0.1	<0.1	0.8	<0.1	1100	<0.1	<0.1	ND	ND
BH204	MW204S	15/03/2010	Normal	Sandstone Bedrock	<9	<9	<9	92	<9	6740	97	<9	9	0.9
BH204	MW204S	25/02/2011	Normal	Sandstone Bedrock	<10	<10	<10	80.6	<10	8580	54.6	<10	ND	ND
BH204D	MW204D	13/05/2008	Normal	Fill and Clayey Sand	210	<39	767	508	53	5920	1390	732	991.7	182.168
BH205	MW205	9/05/2008	Normal	Sandstone Bedrock	<19.1	<19.1	<19.1	<19.1	<19.1	1590	<19.1	<19.1	72	20.97
BH205	MW205	5/09/2008	Normal	Sandstone Bedrock										
BH205	MW205	17/03/2010	Normal	Sandstone Bedrock	9780	728	25,200	21,100	1910	283,000	74,100	27,900	46,048	11,408
BH206	MW206	12/05/2008	Normal	Clayey Sand	<1	<1	1.2	11.6	<1	870	10	1.2	ND	ND
BH206	MW206	5/12/2008	Normal	Clayey Sand										
BH206	MW206	19/03/2010	Normal	Clayey Sand	462	<47	1250	1030	81	10,600	2840	1520	1892	361.73
BH209	D01_120508	12/05/2008	Interlab_D	Fill	<10	<10	<10	17	<10	108	15	<10	ND	ND
BH209	MW209	12/05/2008	Normal	Fill	<1.8	<1.8	3.2	18.9	<1.8	175	17	3.5	8	2.33
BH209	MW209	5/12/2008	Normal	Fill										
BH209	MW209	16/03/2010	Normal	Fill	<2	<2	4	10	<2	677	14	6	5	3.02
BH209	MW209	28/02/2011	Normal	Fill	<1	<1	1.2	<1	<1	10.8	2	1.8	1.8	0.81
BH209	MW209 FILTRATE	28/02/2011	Normal	Fill	<0.1	<0.1	<0.1	<0.1	<0.1	2	<0.1	<0.1	ND	ND
BH210	MW210	8/05/2008	Normal	Sandstone Bedrock	2.4	<2	15.6	73.8	<2	1220	63.8	12.6	8.1	0.279
BH210	MW210	5/08/2008	Normal	Sandstone Bedrock										
BH210	MW210	16/03/2010	Normal	Sandstone Bedrock	<2	<2	6	<2	<2	6	5	4	ND	ND
BH210	MW210	24/02/2011	Normal	Sandstone Bedrock	<1	<1	2.6	<1	<1	<1	<1	4.2	2	0.911
BH210	MW210 FILTRATE	24/02/2011	Normal	Sandstone Bedrock	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	<0.1	<0.1	ND	ND

Table T3
Human Health Groundwater Screen and Selection of COPC

					Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	CPAH (SUM)	CPAH (TEF)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
EQL					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Scenario 1 and Scenario 2 VMP July 2012					2.9	0.0029	630	220	0.029	0.14	1300	87		
Location_Code	**Field_ID**	**Sampled_ Date_Time**	**Sample _Type**	**Monitoring_Unit**										
BH405	IT3D	25/02/2011	Normal		11.3	<10	28.6	75.9	<10	2560	77.7	41.8	56.1	14.349
BH405	IT3D FILTRATE	25/02/2011	Normal		<0.1	<0.1	<0.1	0.4	<0.1	549	<0.1	<0.1	ND	ND
BH405	IT3M	25/02/2011	Normal		<1	<1	<1	<1	<1	<1	<1	1	ND	ND
BH405	IT3M FILTRATE	25/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	ND	ND
BH405	IT3S	25/02/2011	Normal		1.4	<1	1.9	<1	2.2	<1	<1	4.5	19.9	4.816
BH405	IT3S FILTRATE	25/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	<0.1	0.5	<0.1	<0.1	ND	ND
MW10_Coffey	MW10	26/03/2008	Normal		829	80.4	2420	1670	258	15,800	4390	2560	4422.4	951.19
MW10_Coffey	QC2	26/03/2008	Field_D		501	49.6	1450	1160	157	9360	2770	1540	2684.6	594.44
MW10_Coffey	QC2A	26/03/2008	Normal		34	<5	120	110	13	3300	230	120	193	42.79
MW10_Coffey	QC3	1/05/2008	Field_D		6120	659	19,200	21,400	2610	149,000	33,300	16,900	37,429	8,365
MW15_Coffey	MW15	1/05/2008	Normal		7630	822	25,900	19,100	3050	192,000	42,000	23,200	45,132	10,226
MW3	BH3	20/03/2010	Normal		8	<2	38	57	<2	699	125	34	24	3.66
MW3	MW3	26/03/2008	Normal		4.1	0.5	18.5	82.6	1.8	1680	103	16.9	23.8	5.494
MW6	BH6	20/03/2010	Normal		<2	<2	<2	<2	<2	<2	<2	<2	ND	ND
MW6	MW6	26/03/2008	Normal		<0.2	<0.2	<0.2	<0.2	<0.2	0.6	<0.2	0.2	ND	ND
MW7	MW7PER	26/03/2008	Normal		68.9	7.6	216	190	29.6	7200	388	215	393.3	92.592
MW7	MW7POST	26/03/2008	Normal		9.2	<1.9	39.8	86.5	3.7	4800	110	36.4	52	12.256
MW7	QC1	26/03/2008	Field_D		15.5	<1.9	63.6	121	5.7	5530	154	59.9	84.8	19.964
Statistical Summary														
Number of Results					68	68	68	68	68	69	68	68	68	68
Number of Detects					21	10	34	38	17	55	39	37	33	33
Minimum Concentration					<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	52	12.256
Minimum Detect					1.4	0.5	1.1	0.4	1.8	0.2	0.2	0.2	0.7	0.05
Maximum Concentration					9780	822	25,900	21,400	3050	283,000	74,100	27,900	46,048	11,408
Maximum Detect					9780	822	25,900	21,400	3050	283,000	74,100	27,900	46,048	11,408
Average Concentration					382	37	1142	1003	123	11,422	2415	1115	2072	480
Median Concentration					1	1	2.3	7.775	1	150	9.575	3.75	0	0
Standard Deviation					1651	152	4881	4242	530	44,018	10,931	4778	8893	2082
Number of Guideline Exceedances					27	68	7	9	68	69	7	13	0	0
Number of Guideline Exceedances(Detects Only)					18	10	7	9	17	55	7	12	0	0

Notes;
ND = Not detected above the laboratory limit of reporting
CPAH (SUM) = Sum of carcinogenic PAHs (see text for details)
CPAH (TEF) = Sum of carcinogenic PAHs taking into consideration Toxic Equivalency Factors (as pr

Table T3
Human Health Groundwater Screen and Selection of COPC

					TPH				BTEX						Phenols	Cyanide			Ammonia		pH
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Weak Acid Dissociable Cyanide	Cyanide (Free)	Cyanide Total	Ammonia	Ammonia as N	pH (Lab)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH_Units
EQL					20	50	100	50	1	1	1	10	1		0.1	0.004	0.004	0.004	0.01	0.01	0.01
Scenario 1 and Scenario 2 VMP July 2012					20	50	100	50	1	300	800	190	190	600	4500	0.08	0.08	0.08	0.5	0.5	
Location_Code	**Field_ID**	**Sampled_ Date_Time**	**Sample _Type**	**Monitoring_Unit**																	
AECOM_BH40	MW40	20/03/2010	Normal						52	2	46	26	12	38	2					9.7	
AECOM_BH45	MW45	19/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			<0.1	6.25
AECOM_BH52	MW52	19/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	0.008	0.007			<0.1	6.9
AECOM_BH54	MW54	19/03/2010	Normal		3730	28,000	10,900	400	621	206	502	626	328	954	6	<0.004	<0.004			10.8	6.39
AECOM_BH58	MW58	17/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			13.6	5.95
AECOM_BH58	QC237	17/03/2010	Field_D		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			13.8	5.81
AECOM_BH58	QC328	17/03/2010	Interlab_D		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4							
AECOM_BH61	MW61	20/03/2010	Normal		520	860	1420	370	16	20	102	66	30	96	<2	0.007	<0.004			0.12	
AECOM_BH62	MW62	17/03/2010	Normal		<20	<50	1260	200	<1	<2	<5	<2	<2	<4	<0.9	0.008	<0.004			8.47	8.16
AECOM_BH62	MW62	24/02/2011	Normal		<20	<50	390	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
AECOM_BH62	MW62_FILTRATE	24/02/2011	Normal												0.3						
AECOM_BH64	MW64	20/03/2010	Normal		<20	270	1850	540	4	3	6	6	4	10	<2	<0.004	<0.004			2.66	
AECOM_BH68	MW68	18/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<0.9	<0.004	<0.004			5.46	6.88
AECOM_BH68	MW68	24/02/2011	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
AECOM_BH68	MW68_FILTRATE	24/02/2011	Normal												0.9						
BH087	D1408-9	14/08/2006	Interlab_D	Fill	29,200	690	1060	<50	11,400	1850	4390	3440	2240	5680				<0.009			
BH087	MW015	25/07/2006	Normal	Fill	31,500	46,000	19,600	760	14,400	3020	5740	4490	2210	6700				0.346			
BH087	MW15	25/07/2006	Normal	Fill													<0.004				
BH087	MW15	14/08/2006	Normal	Fill	23,200	50,500	22,700	1340	8890	2590	3980	3670	1840	5510			<0.004				
BH087	MW15	15/08/2007	Normal	Fill	14,500	48,200	23,800	2190	7270	1470	2330	1990	1150	3140	58.2		<0.004			42.8	
BH087	MW15	12/05/2008	Normal	Fill	10,100	104,000	15,500	150	4140	68	1760	443	224	667	2240			2.47		5.72	
BH087	MW15	5/12/2008	Normal	Fill																	
BH087	MW15	15/03/2010	Normal	Fill	46,200	41,000	14,400	470	13,100	3010	5030	3920	2180	6100	24	0.011	0.005			37.2	7.09
BH198	D01	9/05/2008	Interlab_D	Fill and Clayey Sand	170	290	470	<50	115	32	3	6	10	16	<2			19	130		
BH198	MW198	9/05/2008	Normal	Fill and Clayey Sand	190	550	1200	70	85	30	<5	3	8	11	1			18.6		110	
BH198	MW198	5/09/2008	Normal	Fill and Clayey Sand																	
BH198	MW198	16/03/2010	Normal	Fill and Clayey Sand	<20	120	590	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			27.4	6.13
BH198	MW198	25/02/2011	Normal	Fill and Clayey Sand	<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
BH198	MW198 FILTRATE	25/02/2011	Normal	Fill and Clayey Sand											0.3						
BH198	QC323	16/03/2010	Field_D	Fill and Clayey Sand	<20	160	690	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			28.2	
BH198	QC324	16/03/2010	Interlab_D	Fill and Clayey Sand	<50	170	580	<50	<5	<5	<5	<10	<5	<15	<2	0.02	<0.004		20		
BH198	QC618	25/02/2011	Field_D	Fill and Clayey Sand	<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
BH198	QC618 FILTRATE	25/02/2011	Field_D	Fill and Clayey Sand											0.5						
BH200	MW200	13/05/2008	Normal	Sandstone Bedrock	28,500	97,200	22,000	120	12,900	473	1620	1380	607	1987	1200			2.43		103	
BH200	MW200	16/03/2010	Normal	Sandstone Bedrock	22,400	100,000	22,500	150	16,200	686	1820	1800	536	2336	300	0.004	0.007			<0.01	6.55
BH200	MW200	28/02/2011	Normal	Sandstone Bedrock	37,600	47,400	17,200	<50	17,900	659	1660	1350	560	1910	836	<0.004	<0.004				
BH200	MW200 FILTRATE	28/02/2011	Normal	Sandstone Bedrock											472						
BH204	MW204 FILTRATE	25/02/2011	Normal	Sandstone Bedrock											2.2						
BH204	MW204S	15/03/2010	Normal	Sandstone Bedrock	890	19,600	7400	450	92	60	180	172	82	254	<9	<0.004	<0.004			5.36	7.04
BH204	MW204S	25/02/2011	Normal	Sandstone Bedrock	2380	8430	2690	130	237	169	440	466	229	695	<10	<0.004	<0.004				
BH204D	MW204D	13/05/2008	Normal	Fill and Clayey Sand	27,900	422,000	75,800	9840	7700	411	3650	2030	914	2944	21,300			3.21		87	
BH205	MW205	9/05/2008	Normal	Sandstone Bedrock	73,600	72,800	8100	80	27,800	745	17,600	3140	2000	5140	21			0.0348		6.7	
BH205	MW205	5/09/2008	Normal	Sandstone Bedrock																	
BH205	MW205	17/03/2010	Normal	Sandstone Bedrock		1,730,000	1,520,000	332,000							503						
BH206	MW206	12/05/2008	Normal	Clayey Sand	8380	6940	1500	<50	2960	306	430	807	612	1419	<1			<0.004		3.84	
BH206	MW206	5/12/2008	Normal	Clayey Sand																	
BH206	MW206	19/03/2010	Normal	Clayey Sand	13,300	68,000	70,600	14,800	5450	1250	101	1230	1540	2770	<47						
BH209	D01_120508	12/05/2008	Interlab_D	Fill	5400	5390	1000	700	2780	123	1520	372	657	1029	234			0.8	13.1		
BH209	MW209	12/05/2008	Normal	Fill	8150	7980	1900	<50	2370	118	1700	380	275	655	115			0.469		12	
BH209	MW209	5/12/2008	Normal	Fill																	
BH209	MW209	16/03/2010	Normal	Fill	1380	2230	1000	160	772	149	48	76	104	180	<2	<0.004	<0.004			7.48	7.1
BH209	MW209	28/02/2011	Normal	Fill	100	100	220	<50	56	15	5	8	10	18	<1	<0.004	<0.004				
BH209	MW209 FILTRATE	28/02/2011	Normal	Fill											1.1						
BH210	MW210	8/05/2008	Normal	Sandstone Bedrock	2650	14,800	4400	210	511	69	617	401	218	619	7.3			<0.004		6.56	
BH210	MW210	5/08/2008	Normal	Sandstone Bedrock																	
BH210	MW210	16/03/2010	Normal	Sandstone Bedrock	30	210	730	<50	12	8	<5	3	3	6	<2					5.24	6.5
BH210	MW210	24/02/2011	Normal	Sandstone Bedrock	<20	80	730	70	2	3	<5	<2	<2	<4	<1	<0.004	<0.004				
BH210	MW210 FILTRATE	24/02/2011	Normal	Sandstone Bedrock											0.4						

Table T3
Human Health Groundwater Screen and Selection of COPC

					TPH				BTEX						Phenols	Cyanide			Ammonia		pH
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Weak Acid Dissociable Cyanide	Cyanide (Free)	Cyanide Total	Ammonia	Ammonia as N	pH (Lab)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH_Units
EQL					20	50	100	50	1	1	1	10	1		0.1	0.004	0.004	0.004	0.01	0.01	0.01
Scenario 1 and Scenario 2 VMP July 2012					20	50	100	50	1	300	800	190	190	600	4500	0.08	0.08	0.08	0.5	0.5	
Location_Code	Field_ID	Sampled_ Date_Time	Sample _Type	Monitoring_Unit																	
BH405	IT3D	25/02/2011	Normal		2120	5590	2970	260	595	51	465	325	136	461	<10	<0.004	<0.004				
BH405	IT3D FILTRATE	25/02/2011	Normal												6.9						
BH405	IT3M	25/02/2011	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
BH405	IT3M FILTRATE	25/02/2011	Normal												0.2						
BH405	IT3S	25/02/2011	Normal		<20	<50	410	240	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
BH405	IT3S FILTRATE	25/02/2011	Normal												1						
MW10_Coffey	MW10	26/03/2008	Normal		9690	528,000	152,000	30,600	5450	52	2140	331	280	611	249,000					348	
MW10_Coffey	QC2	26/03/2008	Field_D		40,000	492,000	89,400	14,700	18,300	373	8060	2220	1160	3380	392,000					312	
MW10_Coffey	QC2A	26/03/2008	Normal						24,000	360	12,000			3774	140,000					4.2	
MW10_Coffey	QC3	1/05/2008	Field_D		54,700	654,000	1,050,000	305,000	41,000	<500	8150	1960	817	2777	1620		<0.004	0.572		23.7	
MW15_Coffey	MW15	1/05/2008	Normal		55,800	494,000	754,000	205,000	40,200	<500	7890	2000	841	2841	1880		0.0115	0.75		23.3	
MW3	BH3	20/03/2010	Normal		40	2900	2780	260	11	5	<5	7	5	12	<2	0.02	0.013			1.81	
MW3	MW3	26/03/2008	Normal		120	5050	2900	300	14	35	15	29	23	52	<2					0.934	
MW6	BH6	20/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			<0.1	
MW6	MW6	26/03/2008	Normal		<20	<50	<100	<50	<1	<2	<2	<2	<2	<4	10					0.163	
MW7	MW7PER	26/03/2008	Normal		27,000	771,000	42,500	1330	21,100	151	5750	1080	538	1618	227,000					239	
MW7	MW7POST	26/03/2008	Normal		30,300	830,000	46,900	670	25,200	159	6440	1150	592	1742	134,000					294	
MW7	QC1	26/03/2008	Field_D		28,900	831,000	46,400	660	19,900	161	4630	1180	601	1781	168,000					281	
Statistical Summary																					
Number of Results					55	56	56	56	57	57	57	56	56	57	65	29	34	14	3	38	13
Number of Detects					35	41	44	33	39	37	35	37	37	38	35	7	5	11	3	34	13
Minimum Concentration					<20	<50	<100	<50	<1	<2	<2	<2	<2	<4	0.2	<0.004	<0.004	<0.004	13.1	<0.01	5.81
Minimum Detect					30	80	220	70	2	2	3	3	3	6	0.2	0.004	0.005	0.0348	13.1	0.12	5.81
Maximum Concentration					73,600	1,730,000	1,520,000	332,000	41,000	3020	17,600	4490	2240	6700	392,000	0.02	0.013	19	130	348	8.16
Maximum Detect					73,600	1,730,000	1,520,000	332,000	41,000	3020	17,600	4490	2240	6700	392,000	0.02	0.013	19	130	348	8.16
Average Concentration					11,652	134,605	72,590	16,514	6204	341	1945	761	421	1228	20,629	0.0042	0.003	3.5	54	55	6.7
Median Concentration					890	3975	1675	140	115	51	101	71	56	180	1	0.002	0.002	0.661	20	9.085	6.55
Standard Deviation					17,714	312,632	260,692	64,875	10,188	707	3440	1157	641	1799	69,122	0.005	0.0027	6.6	66	99	0.62
Number of Guideline Exceedances					36	41	44	33	40	16	21	26	25	26	7	0	0	10	3	32	0
Number of Guideline Exceedances(Detects Only)					35	41	44	33	39	14	21	26	25	26	7	0	0	10	3	32	0

Notes;
ND = Not detected above the laboratory limit of reporting
CPAH (SUM) = Sum of carcinogenic PAHs (see text for details)
CPAH (TEF) = Sum of carcinogenic PAHs taking into consideration Toxic Equivalency Factors (as pr

Table T4
Adopted Toxicity Criteria

Chemical	Oral CSF		PAH TEF (Oral)		IUR		PAH TEF (Inhal)		Oral RfD		RfC		Background Air Conc (urban)		Background Corrected RfC	GI Abs		Derm RfD		Derm Slope Factor	
	(mg/kg/day)-1	source	unitless	source	(ug/m3)-1	source	unitless	source	mg/kg/day	source	mg/m3	source	mg/m3	source	mg/m3	unitless	source	mg/kg/day	source	(mg/kg/day)-1	source
Acenaphthene	-	-	-	-	-	-	-	-	6.00E-02	IRIS	2.10E-01	IRIS (r)	4.50E-06	DEC (2004)	2.10E-01	1.00E+00	RAIS (2010)	6.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
Acenaphthylene	-	-	-	-	-	-	-	-	6.00E-02	Surrogate	2.10E-01	Surrogate (r)	-	-	-	1.00E+00	RAIS (2010)	6.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
Ammonia	-	-	-	-	-	-	-	-	-	-	6.95E-02	ATSDR (2009)	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	-	=CSF/GI Abs
Anthracene	-	-	-	-	-	-	-	-	3.00E-01	IRIS	1.05E+00	IRIS (r)	4.50E-06	DEC (2004)	3.50E+00	1.00E+00	RAIS (2010)	3.00E-01	=RfD*GI Abs	-	=CSF/GI Abs
Benz(a)anthracene	4.30E-02	NHMRC (2004)/TEF	1.00E-01	CCME (2008)	8.70E-03	WHO (2000a)	1.00E-01	CCME (2008)	-	-	-	-	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	4.30E-02	=CSF/GI Abs
Benzene	3.50E-02	NHMRC (2004)	--	--	6.00E-06	WHO (2000a)	--	--	5.00E-04	ATSDR (2009)	9.60E-03	ATSDR (2009)	4.00E-03	EA (2003)	5.60E-03	1.00E+00	RAIS (2010)	5.00E-04	=RfD*GI Abs	3.50E-02	=CSF/GI Abs
Benzo(a)pyrene	4.30E-01	NHMRC (2004)	1.00E+00	CCME (2008)	8.70E-02	WHO (2000a)	1.00E+00	CCME (2008)	-	-	-	-	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	4.30E-01	=CSF/GI Abs
Benzo(b)fluoranthene	4.30E-02	NHMRC (2004)/TEF	0.1	CCME (2008)	8.70E-03	WHO (2000a)	0.1	CCME (2008)	-	-	-	-	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	4.30E-02	=CSF/GI Abs
Benzo(e)pyrene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00E+00	Default	-	=RfD*GI Abs	-	=CSF/GI Abs
Benzo(g,h,i)perylene	4.30E-03	NHMRC (2004)/TEF	1.00E-02	CCME (2008)	8.70E-04	WHO (2000a)	1.00E-02	CCME (2008)	-	-	-	-	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	4.30E-03	=CSF/GI Abs
Benzo(k)fluoranthene	4.30E-02	NHMRC (2004)/TEF	1.00E-01	CCME (2008)	8.70E-03	WHO (2000a)	1.00E-01	CCME (2008)	-	-	-	-	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	4.30E-02	=CSF/GI Abs
Chrysene	4.30E-03	NHMRC (2004)/TEF	1.00E-02	CCME (2008)	8.70E-04	WHO (2000a)	1.00E-02	CCME (2008)	-	-	-	-	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	4.30E-03	=CSF/GI Abs
Cyanide (CN-)	-	-	-	-	-	-	-	-	1.20E-02	NHMRC (2004)	4.20E-02	NHMRC (2004) (r)	-	-	-	1.00E+00	RAIS (2010)	1.20E-02	=RfD*GI Abs	-	=CSF/GI Abs
Dibenz(a,h)anthracene	4.30E-01	NHMRC (2004)/TEF	1.00E+00	CCME (2008)	8.70E-02	WHO (2000a)	1.00E+00	CCME (2008)	-	-	-	-	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	4.30E-01	=CSF/GI Abs
Ethylbenzene	-	-	-	-	-	-	-	-	9.71E-02	NHMRC (2004)	1.30E+00	ATSDR(2007)	4.00E-03	EA (2003)	2.20E+01	1.00E+00	RAIS (2010)	9.71E-02	=RfD*GI Abs	-	=CSF/GI Abs
Fluoranthene	-	-	-	-	-	-	-	-	4.00E-02	IRIS	1.40E-01	IRIS (r)	4.50E-06	DEC (2004)	1.40E-01	1.00E+00	RAIS (2010)	4.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
Fluorene	-	-	-	-	-	-	-	-	4.00E-02	IRIS	1.40E-01	IRIS (r)	4.50E-06	DEC (2004)	1.40E-01	1.00E+00	RAIS (2010)	4.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
Indeno(1,2,3-cd)pyrene	4.30E-02	NHMRC (2004)/TEF	1.00E-01	CCME (2008)	8.70E-03	WHO (2000a)	1.00E-01	CCME (2008)	-	-	-	-	-	-	-	1.00E+00	RAIS (2010)	-	=RfD*GI Abs	4.30E-02	=CSF/GI Abs
Naphthalene	-	-	-	-	-	-	-	-	2.00E-02	IRIS	3.00E-03	ATSDR (2009)	4.50E-06	DEC (2004)	3.00E-03	1.00E+00	RAIS (2010)	2.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
Phenanthrene	-	-	-	-	-	-	-	-	6.00E-02	Surrogate	2.10E-01	Surrogate (r)	-	-	-	1.00E+00	RAIS (2010)	6.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
Phenol	-	-	-	-	-	-	-	-	3.00E-01	IRIS	2.00E-01	alEPA (USEPA RSL	-	-	-	1.00E+00	RAIS (2010)	3.00E-01	=RfD*GI Abs	-	=CSF/GI Abs
Pyrene	-	-	-	-	-	-	-	-	3.00E-02	IRIS	1.05E-01	IRIS (r)	4.50E-06	DEC (2004)	1.05E-01	1.00E+00	RAIS (2010)	3.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
Toluene	-	-	-	-	-	-	-	-	2.23E-01	NHMRC (2004)	5.00E+00	IRIS	2.50E-02	EA (2003)	3.55E-01	1.00E+00	RAIS (2010)	2.23E-01	=RfD*GI Abs	-	=CSF/GI Abs
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-	5.00E+00	TPHCWG 97a	1.84E+01	TPHCWG (1997a)	4.40E-01	Hawas (2002)	1.80E+01	1.00E+00	Default	5.00E+00	=RfD*GI Abs	-	=CSF/GI Abs
TPH C10-C14 aliphatic	-	-	-	-	-	-	-	-	1.00E-01	TPHCWG 97a	1.00E+00	TPHCWG (1997a)	2.20E-01	Hawas (2002)	7.80E-01	1.00E+00	Default	1.00E-01	=RfD*GI Abs	-	=CSF/GI Abs
TPH C10-C14 aromatic	-	-	-	-	-	-	-	-	4.00E-02	TPHCWG 97a	2.00E-01	TPHCWG (1997a)	6.00E-03	Hawas (2002)	1.94E-01	1.00E+00	Default	4.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
TPH C15-C28 aliphatic	-	-	-	-	-	-	-	-	2.00E+00	TPHCWG 97a	7.00E+00	TPHCWG (1997a)	-	-	-	1.00E+00	Default	2.00E+00	=RfD*GI Abs	-	=CSF/GI Abs
TPH C15-C28 aromatic	-	-	-	-	-	-	-	-	3.00E-02	TPHCWG 97a	1.05E-01	TPHCWG (1997a)	-	-	-	1.00E+00	Default	3.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	2.00E+00	TPHCWG 97a	7.00E+00	TPHCWG (1997a)	-	-	-	1.00E+00	Default	2.00E+00	=RfD*GI Abs	-	=CSF/GI Abs
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-	3.00E-02	TPHCWG 97a	1.05E-01	TPHCWG (1997a)	-	-	-	1.00E+00	Default	3.00E-02	=RfD*GI Abs	-	=CSF/GI Abs
Xylenes (total)	-	-	-	-	-	-	-	-	1.79E-01	NHMRC (2004)	2.20E-01	ATSDR(2007)	2.30E-02	EA (2003)	8.47E-01	1.00E+00	RAIS (2010)	1.79E-01	=RfD*GI Abs	-	=CSF/GI Abs

Notes

BG > 50% RfC

* Default for semivolatiles
** See note 7 below
*** Upper limit of log Kow for TPH fractions has been set to 6 as values higher than this are not considered to be realistic - see TPHCWG 1997b
NOTE ALL TPHCWG 1997b physical property values are fraction-weighted averages of values reported for differently grouped fractions.

1 International Agency for Research on Cancer (www.iarc.fr).
2 Based on recommended criteria for TPH C6 to C8
3 Based on recommended criteria for TPH C9 to C16
4 Inhalation toxicity criteria for this TPH fraction have not been derived by TPHCWG. The oral RfD has therefore been converted to an inhalation reference concentration assuming a body weight of 70 kg and a daily inhalation rate of 20 m3/day.
5 Based on recommended criteria for TPH C17 to C35
6 Inhalation toxicity criteria for this TPH fraction have not been derived by TPHCWG as it is not considered volatile. However, in order to evaluate potential exposures via the dust inhalation pathway, the oral RfD has been converted to an inhalation reference concentration assuming a body weight of 70 kg and a daily inhalation rate of 20 m3/day.
7 USEPA (2004) considers that, where specific dermal absorption factors are not published for volatile organic compounds, VOCs would tend to volatilise quickly from the skin and exposure would therefore be accounted for via the volatilisation/inhalation exposure routes.
8 Based on recommended dermal absorption factor for semivolatile organic compounds (SVOCs).
9 Incorporating Toxic Equivalency Factors (TEFs). See text for discussion.
References are included in main document text.

ATSDR = Minimal risk level published by the Agency for Toxic Substances and Disease Registry; see toxicity profiles for further details.
CalEPA = California Environmental Protection Agency value adopted by USEPA for derivation of Regional Screening Levels (only used in absence of other published criteria).
IRIS = Integrated Risk Information System (www.epa.gov/iris). Accessed March 2010.
RAIS = Risk Assessment Information System (University of Tennessee, 2010).
Pennsylvania DEP = Pennsylvania Department of Environmental Protection
(r) = Value converted from oral criterion based on route to route extrapolation (oral to inhalation), in absence of other published inhalation criterion. Oral to inhalation conversions were undertaken assuming and adult body weight of 70 kg, and a daily inhalation volume of 20 m3.
Surrogate = Adopted criteria based on on surrogate chemical considered to be of similar toxicity, in absence of other published criteria. See chemical-specific toxicity profiles in Appendix J.
* USEPA (2004b) default for semivolatiles
** USEPA Region III (1995) considers that, where specific dermal absorption factors are not published for volatile organic compounds, VOCs would tend to volatilise quickly from the skin and exposure would therefore be accounted for via the volatilisation/inhalation exposure routes. http://www.epa.gov/reg3hwmd/risk/human/info/solabsg2.htm

Table T4
Adopted Toxicity Criteria

Chemical	Oral Abs Factor		Dermal Abs Factor		Dermal Perm Constant (kp)		Soil-Water Partition Coefficient		Log of Octanol-Water Partition Coefficient		Organic Carbon Partition Coefficient		Diffusivity in Air		Diffusivity in Water		Henry's Law Constant		Aqueous Solubility		Vapour Pressure		Volatile?
	unitless	source	unitless	source	cm/hr	source	cm3/g	source	cm3/g	source	L/kg (=cm3/g)	source	cm2/s	source	cm2/s	source	unitless	source	mg/L	source	mm Hg	source	Y/N
Acenaphthene	1.00E+00	Default	1.30E-01	RAIS (2010)	8.60E-02	RAIS	-	-	3.92E+00	RAIS	5.03E+03	RAIS	5.06E-02	RAIS	8.33E-06	RAIS	7.52E-03	RAIS	3.90E+00	RAIS	2.15E-03	RAIS	Y
Acenaphthylene	1.00E+00	Default	1.30E-01	RAIS (2010)	9.11E-02	RAIS	-	-	3.94E+00	RAIS	5.03E+03	RAIS	4.50E-02	RAIS	6.98E-06	RAIS	4.66E-03	RAIS	1.61E+01	RAIS	6.68E-03	RAIS	Y
Ammonia	1.00E+00	Default	-	USEPA (1995)**	1.00E-03	RAIS	-	-	-	-	3.10E+00	Pennsylvania DEP	2.28E-01	Spiller (1989)	1.10E-05	Pennsylvania DEP	6.58E-04	RAIS	4.82E+05	RAIS	-	RAIS	Y
Anthracene	1.00E+00	Default	1.30E-01	RAIS (2010)	1.42E-01	RAIS	-	-	4.45E+00	RAIS	1.64E+04	RAIS	3.90E-02	RAIS	7.85E-06	RAIS	2.27E-03	RAIS	4.34E-02	RAIS	6.53E-06	RAIS	Y
Benz(a)anthracene	1.00E+00	Default	1.30E-01	RAIS (2010)	5.52E-01	RAIS	-	-	5.76E+00	RAIS	1.77E+05	RAIS	5.10E-02	TPHCWG V3	9.00E-06	TPHCWG V3	1.37E-04	RAIS	9.40E-03	RAIS	2.10E-07	RAIS	N
Benzene	1.00E+00	Default	-	USEPA (1995)**	1.49E-02	RAIS	-	-	2.13E+00	RAIS	1.46E+02	RAIS	8.95E-02	RAIS	1.03E-05	RAIS	2.27E-01	RAIS	1.79E+03	RAIS	9.48E+01	RAIS	Y
Benzo(a)pyrene	1.00E+00	Default	1.30E-01	RAIS (2010)	7.13E-01	RAIS	-	-	6.13E+00	RAIS	5.87E+05	RAIS	4.30E-02	TPHCWG V3	9.00E-06	TPHCWG V3	1.87E-05	RAIS	1.62E-03	RAIS	5.49E-09	RAIS	N
Benzo(b)fluoranthene	1.00E+00	Default	1.30E-01	RAIS (2010)	4.17E-01	RAIS	-	-	5.78E+00	RAIS	5.99E+05	RAIS	2.26E-02	TPHCWG V3	5.56E-06	TPHCWG V3	2.69E-05	RAIS	1.50E-03	RAIS	5.00E-07	RAIS	N
Benzo(e)pyrene			-																				NA
Benzo(g,h,i)perylene	1.00E+00	Default	1.30E-01	RAIS (2010)	1.12E+00	RAIS	-	-	6.63E+00	RAIS	1.95E+06	RAIS	4.90E-02	TPHCWG V3	5.56E-06	TPHCWG V3	1.35E-05	RAIS	2.60E-04	RAIS	1.00E-10	RAIS	N
Benzo(k)fluoranthene	1.00E+00	Default	1.30E-01	RAIS (2010)	6.91E-01	RAIS	-	-	6.11E+00	RAIS	5.87E+05	RAIS	2.26E-02	TPHCWG V3	5.56E-06	TPHCWG V3	2.39E-05	RAIS	8.00E-04	RAIS	9.65E-10	RAIS	N
Chrysene	1.00E+00	Default	1.30E-01	RAIS (2010)	5.96E-01	RAIS	-	-	5.81E+00	RAIS	1.81E+05	RAIS	2.48E-02	TPHCWG V3	6.21E-06	TPHCWG V3	2.14E-04	RAIS	2.00E-03	RAIS	6.23E-09	RAIS	N
Cyanide (CN-)	1.00E+00	Default	-	USEPA (1995)**	7.54E-04	RAIS	9.90E+00	RAIS	-2.50E-01	RAIS	2.84E+00	RAIS	2.11E-01	RAIS	2.46E-05	RAIS	5.44E-03	RAIS	1.00E+06	RAIS	7.42E+02	RAIS	Y
Dibenz(a,h)anthracene	1.00E+00	Default	1.30E-01	RAIS (2010)	9.53E-01	RAIS	-	-	6.75E+00	RAIS	1.91E+06	RAIS	2.00E-02	TPHCWG V3	5.24E-06	TPHCWG V3	5.76E-06	RAIS	2.49E-03	RAIS	9.55E-10	RAIS	N
Ethylbenzene	1.00E+00	Default	-	USEPA (1995)**	4.93E-02	RAIS	-	-	3.15E+00	RAIS	4.46E+02	RAIS	6.85E-02	RAIS	8.46E-06	RAIS	3.22E-01	RAIS	1.69E+02	RAIS	9.60E+00	RAIS	Y
Fluoranthene	1.00E+00	Default	1.30E-01	RAIS (2010)	3.08E-01	RAIS	-	-	5.16E+00	RAIS	5.55E+04	RAIS	3.02E-02	TPHCWG V3	6.35E-06	TPHCWG V3	3.62E-04	RAIS	2.60E-01	RAIS	9.22E-06	RAIS	N
Fluorene	1.00E+00	Default	1.30E-01	RAIS (2010)	1.10E-01	RAIS	-	-	4.18E+00	RAIS	9.16E+03	RAIS	4.40E-02	RAIS	7.89E-06	RAIS	3.93E-03	RAIS	1.69E+00	RAIS	6.00E-04	RAIS	Y
Indeno(1,2,3-cd)pyrene	1.00E+00	Default	1.30E-01	RAIS (2010)	1.24E+00	RAIS	-	-	6.70E+00	RAIS	1.95E+06	RAIS	2.30E-02	TPHCWG V3	4.41E-06	TPHCWG V3	1.42E-05	RAIS	1.90E-04	RAIS	1.25E-10	RAIS	N
Naphthalene	1.00E+00	Default	1.30E-01	RAIS (2010)	4.66E-02	RAIS	-	-	3.30E+00	RAIS	1.54E+03	RAIS	6.05E-02	RAIS	8.38E-06	RAIS	1.80E-02	RAIS	3.10E+01	RAIS	8.50E-02	RAIS	Y
Phenanthrene	1.00E+00	Default	1.30E-01	RAIS (2010)	1.44E-01	RAIS	-	-	4.46E+00	RAIS	1.67E+04	RAIS	3.45E-02	RAIS	6.69E-06	RAIS	1.73E-03	RAIS	1.15E+00	RAIS	1.21E-04	RAIS	Y
Phenol	1.00E+00	Default	1.00E-01	RAIS (2010)	4.34E-03	RAIS	-	-	1.46E+00	RAIS	1.87E+02	RAIS	8.34E-02	RAIS	1.03E-05	RAIS	1.36E-05	RAIS	8.28E+04	RAIS	3.50E-01	RAIS	N
Pyrene	1.00E+00	Default	1.30E-01	RAIS (2010)	2.01E-01	RAIS	-	-	4.88E+00	RAIS	5.43E+04	RAIS	2.78E-02	RAIS	7.25E-06	RAIS	4.87E-04	RAIS	1.35E-01	RAIS	4.50E-06	RAIS	Y
Toluene	1.00E+00	Default	-	USEPA (1995)**	3.11E-02	RAIS	-	-	2.73E+00	RAIS	2.34E+02	RAIS	7.78E-02	RAIS	9.20E-06	RAIS	2.71E-01	RAIS	5.26E+02	RAIS	2.84E+01	RAIS	Y
TPH C06-C09 aliphatic	1.00E+00	Default	-	USEPA (1995)**	1.96E-01	TPHCWG 97b	-	-	4.17E+00	TPHCWG 97b	4.47E+03	TPHCWG 97b	1.00E-01	TPHCWG 97b	1.00E-05	TPHCWG 97b	5.05E+01	TPHCWG 97b	1.18E+01	TPHCWG 97b	9.16E+01	TPHCWG 97b	Y
TPH C10-C14 aliphatic	1.00E+00	Default	-	USEPA (1995)**	1.29E+00	TPHCWG 97b	-	-	5.86E+00	TPHCWG 97b	5.50E+05	TPHCWG 97b	1.00E-01	TPHCWG 97b	1.00E-05	TPHCWG 97b	6.26E+01	TPHCWG 97b	9.99E-02	TPHCWG 97b	1.16E+00	TPHCWG 97b	Y
TPH C10-C14 aromatic	1.00E+00	Default	-	USEPA (1995)**	1.28E-01	TPHCWG 97b	-	-	4.06E+00	TPHCWG 97b	3.02E+03	TPHCWG 97b	1.00E-01	TPHCWG 97b	1.00E-05	TPHCWG 97b	1.41E-01	TPHCWG 97b	2.53E+01	TPHCWG 97b	1.16E+00	TPHCWG 97b	Y
TPH C15-C28 aliphatic	1.00E+00	Default	1.00E-01	USEPA (1995)**	5.06E-01	TPHCWG 97b	-	-	6.00E+00	TPHCWG 97b***	3.16E+08	TPHCWG 97b	1.00E-01	TPHCWG 97b	1.00E-05	TPHCWG 97b	8.27E+01	TPHCWG 97b	1.11E-04	TPHCWG 97b	5.93E-03	TPHCWG 97b	N
TPH C15-C28 aromatic	1.00E+00	Default	1.00E-01	USEPA (1995)**	3.56E-01	TPHCWG 97b	-	-	5.38E+00	TPHCWG 97b	3.79E+04	TPHCWG 97b	1.00E-01	TPHCWG 97b	1.00E-05	TPHCWG 97b	4.90E-03	TPHCWG 97b	1.06E+00	TPHCWG 97b	5.51E-03	TPHCWG 97b	N
TPH C29-C36 aliphatic	1.00E+00	Default	1.00E-01	USEPA (1995)**	4.44E-01	TPHCWG 97b	-	-	6.00E+00	TPHCWG 97b***	6.31E+08	TPHCWG 97b	1.00E-01	TPHCWG 97b	1.00E-05	TPHCWG 97b	8.50E+01	TPHCWG 97b	2.50E-06	TPHCWG 97b	8.36E-04	TPHCWG 97b	N
TPH C29-C36 aromatic	1.00E+00	Default	1.00E-01	USEPA (1995)**	6.55E-01	TPHCWG 97b	-	-	6.00E+00	TPHCWG 97b***	1.26E+05	TPHCWG 97b	1.00E-01	TPHCWG 97b	1.00E-05	TPHCWG 97b	1.70E-05	TPHCWG 97b	6.60E-03	TPHCWG 97b	3.34E-07	TPHCWG 97b	N
Xylenes (total)	1.00E+00	Default	-	USEPA (1995)**	4.71E-02	RAIS	-	-	3.12E+00	RAIS	3.83E+02	RAIS	8.47E-02	RAIS	9.90E-06	RAIS	2.12E-01	RAIS	1.06E+01	RAIS	7.99E+00	RAIS	Y

Table T5
Odour Thresholds
VMP Remediation Works Area

Chemical Name	Odour Threshold (mg/m3)	Reference	Comment
Acenaphthene	0.50	ATSDR (Converted from 0.08 ppm)	ATSDR adopted this threshold from the Hazardous Substances Data Bank (HSDB) published by the National Library of Medicine.
Acenaphthylene	-	ATSDR	**
Ammonia	18.00	ATSDR	ATSDR have adopted a range of odour thresholds from three peer reviewed sources. The lowest of these thresholds was adopted in the current HHERA.
Anthracene	-	ATSDR	**
Benz(a)anthracene	-	ATSDR	**
Benzene	108.61	ATSDR (Converted from 34 ppm)	ATSDR published a range of threshold set by the American Industrial Hygiene Association (AIHA). The lowest value in this range was adopted in the current HHERA.
Benzo(a)pyrene	-	ATSDR	**
Benzo(b)fluoranthene	-	ATSDR	**
Benzo(g,h,i)perylene	-	ATSDR	**
Benzo(k)fluoranthene	-	ATSDR	**
Chrysene	-	ATSDR	**
Cyanide (CN-)	0.64	ATSDR (Reported as 0.58 ppm Hydrogen Cyanide)	ATSDR published a range of odour thresholds from two sources (Amoore and Hautala (1983) and HSDB (2004). The lowest published value was adopted in the current HHERA.
Dibenz(a,h)anthracene	-	ATSDR	**
Ethylbenzene	2.00	ATSDR	ATSDR published a range of odour thresholds from two sources (Verschueren (1983) and Amoore and Hautala (1983). The lowest value in this range was adopted.
Fluoranthene	-	ATSDR	**
Fluorene	-	ATSDR	**
Indeno(1,2,3-cd)pyrene	-	ATSDR	**
Naphthalene	0.44	ATSDR	ATSDR published an odour threshold that was determined by Amoore and Hautala (1983) and Ruth (1986). This value was adopted in the current HHERA.
Phenol	0.15	ATSDR (Converted from 0.04 ppm)	ATSDR have published a value adopted from Amoore and Hautala (1983). This values has been adopted in the current HHERA.
Pyrene	-	ATSDR	**
Toluene	30.13	ATSDR (Converted from 8 ppm)	ATSDR have adopted a value published in the HSDB (1998). This value has been adopted in the current HHERA.
TPH C06-C09 aliphatic	-	ATSDR	**
TPH C10-C14 aliphatic	-	ATSDR	**
TPH C10-C14 aromatic	-	ATSDR	**
TPH C15-C28 aliphatic	-	ATSDR	**
TPH C15-C28 aromatic	-	ATSDR	**
TPH C29-C36 aliphatic	-	ATSDR	**
TPH C29-C36 aromatic	-	ATSDR	**
Xylenes (total)	4.34	ATSDR (Converted from 1 ppm)	ATSDR have adopted an odour theshold published by Carpenter et al. (1975). This value has been adopted in the current HHERA.

Note: All compounds with an odour threshold reported in ppm were converted assuming standard temperature (25^{o}C) and pressure (1 atm).

** ATSDR have not published an odour threshold for this compound thus it has been considered appropriate not to adopted an odour theshold in the current risk assessment.

The following references have been used as peer reviewed sources by ATSDR and IRIS:

Amoore, J.E., and Hautala, E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatilities for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, 3(6):272-290.

Carpenter, C.P., Kinkead, E.R., Geary, D.J., et al. 1975. Petroleum hydrocarbon toxicity studies: I. Methodology. Toxicol Appl Pharmacol. 32:246-262.

Verschueren, K. 1983. Handbook of Environmental Data on Organic Chemicals. 2nd Ed. New York, NY: Van Nostrand Reinhold Co., 628-630.

Table T6
MWQC Screen of Groundwater Analytical Results

					Low MW PAHs						High MW PAHs												
					Acenaphthene	Acenaphthylene	Anthracene	Fluorene	Naphthalene	Phenanthrene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Indeno(1,2,3-c,d)pyrene	Fluoranthene	Pyrene	cPAH (SUM)	cPAH (TEF)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
MWQC VMP July 2012					5.8	5.8	0.1	3	70	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1		
Location_Code	**Field_ID**	**Sampled_Date_Time**	**Sample_Type**	**Monitoring_Unit**																			
AECOM_BH40	MW40	20/03/2010	Normal		4	16	3	12	244	14	<0.9	<0.9	<2		<0.9		<0.9	<0.9	<0.9	2	2	0	0
AECOM_BH45	MW45	19/03/2010	Normal		<2	<2	<2	<2	8	<2	<2	<2	<4		<2		<2	<2	<2	<2	<2	ND	ND
AECOM_BH52	MW52	19/03/2010	Normal		<2	<2	<2	<2	4	<2	<2	<2	<4		<2		<2	<2	<2	4	4	ND	ND
AECOM_BH54	MW54	19/03/2010	Normal		72	113	19	92	8640	98	3	<2	<4		<2		2	<2	<2	19	14	5	0.05
AECOM_BH58	MW58	17/03/2010	Normal		<2	<2	<2	<2	<2	<2	<2	<2	<4		<2		<2	<2	<2	<2	<2	ND	ND
AECOM_BH58	QC237	17/03/2010	Field_D		<2	<2	<2	<2	<2	<2	<2	<2	<4		<2		<2	<2	<2	<2	<2	ND	ND
AECOM_BH58	QC328	17/03/2010	Interlab_D						<7													ND	ND
AECOM_BH61	MW61	20/03/2010	Normal		6	21	18	26	150	79	16	8	12		3		12	<2	3	48	44	54	9.81
AECOM_BH62	MW62	17/03/2010	Normal		1	<0.9	1	1	7	4	<0.9	0.7	<2		<0.9		<0.9	<0.9	<0.9	2	2	0.7	0.7
AECOM_BH62	MW62	24/02/2011	Normal		<1	<1	<1	<1	<1	<1	<1	<0.5		<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
AECOM_BH62	MW62_FILTRATE	24/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
AECOM_BH64	MW64	20/03/2010	Normal		3	11	2	10	11	15	<2	<2	<4		<2		<2	<2	<2	2	3	ND	ND
AECOM_BH68	MW68	18/03/2010	Normal		<0.9	<0.9	<0.9	<0.9	3	1	<0.9	<0.9	<2		<0.9		<0.9	<0.9	<0.9	<0.9	<0.9	ND	ND
AECOM_BH68	MW68	24/02/2011	Normal		<1	<1	<1	<1	<1	<1	<1	<0.5		<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
AECOM_BH68	MW68_FILTRATE	24/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	0.8	0.2	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH087	D1408-9	14/08/2006	Interlab_D	Fill	7	3	3	6	12	10	<1	<1	<2		<1		<1	<1	<1	2	2	ND	ND
BH087	MW015	25/07/2006	Normal	Fill	80.1	376	94.7	236	21,700	367	54.6	41.1		27.8	12.9	29.3	47.7	4.9	13.3	135	130	231.6	54.192
BH087	MW15	25/07/2006	Normal	Fill																		ND	ND
BH087	MW15	14/08/2006	Normal	Fill	112	696	161	491	11,400	932	145	91		118	37.5	31.3	97.3	8.4	35	480	451	563.5	120.63
BH087	MW15	15/08/2007	Normal	Fill	60.8	227	66.3	150	3930	242	53.5	45.4		37.1	20.2	26.8	42.8	5.2	19.8	116	110	250.8	60.135
BH087	MW15	12/05/2008	Normal	Fill	<18.3	51.5	<18.3	25	2430	19.2	<18.3	<18.3		<18.3	<18.3	<18.3	<18.3	<18.3	<18.3	<18.3	<18.3	66.4	19.339
BH087	MW15	5/12/2008	Normal	Fill																		ND	ND
BH087	MW15	15/03/2010	Normal	Fill	49	155	18	83	7800	87	<9	<9	<19		<9		<9	<9	<9	18	16	ND	ND
BH198	D01	9/05/2008	Interlab_D	Fill and Clayey Sand	2	7	<1	1	7	2	<1	<1	<2		<1		<1	<1	<1	<1	1	ND	ND
BH198	MW198	9/05/2008	Normal	Fill and Clayey Sand	2.2	9.7	<1	1.6	6.5	2.1	<1	<0.5		<1	<1	<1	<1	<1	<1	1.1	1.3	ND	ND
BH198	MW198	5/09/2008	Normal	Fill and Clayey Sand																		ND	ND
BH198	MW198	16/03/2010	Normal	Fill and Clayey Sand	2	12	<2	<2	<2	<2	<2	<2	<4		<2		<2	<2	<2	<2	<2	ND	ND
BH198	MW198	25/02/2011	Normal	Fill and Clayey Sand	<1	1.4	<1	<1	<1	<1	<1	<0.5		<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
BH198	MW198 FILTRATE	25/02/2011	Normal	Fill and Clayey Sand	<0.1	0.4	<0.1	<0.1	0.7	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH198	QC323	16/03/2010	Field_D	Fill and Clayey Sand	3	16	<2	<2	<2	<2	<2	<2	<4		<2		<2	<2	<2	<2	<2	ND	ND
BH198	QC324	16/03/2010	Interlab_D	Fill and Clayey Sand	<2	16	<2	<2	<2	<2	<2	<2	<4		<2		<2	<2	<2	<2	<2	ND	ND
BH198	QC618	25/02/2011	Field_D	Fill and Clayey Sand	<1	2.4	<1	<1	<1	<1	<1	<0.5		<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
BH198	QC618 FILTRATE	25/02/2011	Field_D	Fill and Clayey Sand	<0.1	0.4	<0.1	<0.1	0.6	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH200	MW200	13/05/2008	Normal	Sandstone Bedrock	<19.2	39.1	<19.2	21.8	2290	<19.2	<19.2	<19.2		<19.2	<19.2	<19.2	<19.2	<19.2	<19.2	<19.2	<19.2	ND	ND
BH200	MW200	16/03/2010	Normal	Sandstone Bedrock	15	40	<9	11	7950	12	<9	<9	<19		<9		<9	<9	<9	<9	<9	ND	ND
BH200	MW200	28/02/2011	Normal	Sandstone Bedrock	<98	<98	<98	<98	5450	<98	<98	<98		<98	<98	<98	<98	<98	<98	<98	<98	ND	ND
BH200	MW200 FILTRATE	28/02/2011	Normal	Sandstone Bedrock	6.4	20.2	<1	<1	2970	<1	<1	<0.5		<1	<1	<1	<1	<1	<1	<1	<1	ND	ND
BH204	MW204 FILTRATE	25/02/2011	Normal	Sandstone Bedrock	10.9	5.1	<0.1	0.8	1100	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH204	MW204S	15/03/2010	Normal	Sandstone Bedrock	96	55	<9	92	6740	97	<9	<9	<19		<9		<9	<9	<9	<9	<9	ND	ND
BH204	MW204S	25/02/2011	Normal	Sandstone Bedrock	85.5	45.4	<10	80.6	8580	54.6	<10	<10		<10	<10	<10	<10	<10	<10	<10	<10	ND	ND
BH204D	MW204D	13/05/2008	Normal	Fill and Clayey Sand	122	334	476	508	5920	1390	254	145		185	63.8	80.9	210	<39	53	767	732	991.7	182.17
BH205	MW205	9/05/2008	Normal	Sandstone Bedrock	<19.1	66.8	<19.1	<19.1	1590	<19.1	<19.1	<19.1		<19.1	<19.1	<19.1	<19.1	<19.1	<19.1	<19.1	<19.1	ND	ND
BH205	MW205	5/09/2008	Normal	Sandstone Bedrock																		ND	ND
BH205	MW205	17/03/2010	Normal	Sandstone Bedrock	4480	43,200	15,400	21,100	283,000	74,100	12,600	9260	9860		1910		9780	728	1910	25,200	27,900	46,048	11,408
BH206	MW206	12/05/2008	Normal	Clayey Sand	6.3	42.6	2.2	11.6	870	10	<1	<0.9		<1	<1	<1	<1	<1	<1	1.2	1.2	ND	ND
BH206	MW206	5/12/2008	Normal	Clayey Sand																		ND	ND
BH206	MW206	19/03/2010	Normal	Clayey Sand	274	1380	680	1030	10,600	2840	592	299	362		89		462	<47	81	1250	1520	1892	361.73
BH209	D01_120508	12/05/2008	Interlab_D	Fill	<10	37	<10	17	108	15	<10	<10	<20		<10		<10	<10	<10	<10	<10	ND	ND
BH209	MW209	12/05/2008	Normal	Fill	8.1	50	5.6	18.9	175	17	<1.8	<1.8		<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	3.2	3.5	ND	ND
BH209	MW209	5/12/2008	Normal	Fill																		ND	ND
BH209	MW209	16/03/2010	Normal	Fill	7	26	4	10	677	14	2	3	<4		<2		<2	<2	<2	4	6	5	3.02
BH209	MW209	28/02/2011	Normal	Fill	1.8	6.2	1	<1	10.8	2	1	0.8		<1	<1	<1	<1	<1	<1	1.2	1.8	1.8	0.81
BH209	MW209 FILTRATE	28/02/2011	Normal	Fill	<0.1	<0.1	<0.1	<0.1	2	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND

Table T6
MWQC Screen of Groundwater Analytical Results

					Low MW PAHs						High MW PAHs												
					Acenaphthene	Acenaphthylene	Anthracene	Fluorene	Naphthalene	Phenanthrene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Indeno(1,2,3-c,d)pyrene	Fluoranthene	Pyrene	cPAH (SUM)	cPAH (TEF)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
MWQC VMP July 2012					5.8	5.8	0.1	3	70	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1		
Location_Code	**Field_ID**	**Sampled_Date_Time**	**Sample_Type**	**Monitoring_Unit**																			
BH210	MW210	8/05/2008	Normal	Sandstone Bedrock	24.4	156	15.4	73.8	1220	63.8	3.5	<2		2.2	<2	<2	2.4	<2	<2	15.6	12.6	8.1	0.279
BH210	MW210	5/08/2008	Normal	Sandstone Bedrock																		ND	ND
BH210	MW210	16/03/2010	Normal	Sandstone Bedrock	7	12	2	<2	6	5	<2	<2	<4		<2		<2	<2	<2	6	4	ND	ND
BH210	MW210	24/02/2011	Normal	Sandstone Bedrock	<1	3.1	<1	<1	<1	<1	1.1	0.9		<1	<1	<1	<1	<1	<1	2.6	4.2	2	0.911
BH210	MW210 FILTRATE	24/02/2011	Normal	Sandstone Bedrock	<0.1	0.3	<0.1	<0.1	0.5	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH405	IT3D	25/02/2011	Normal		25	158	25.7	75.9	2560	77.7	19.6	12.8		12.4	<10	<10	11.3	<10	<10	28.6	41.8	56.1	14.349
BH405	IT3D FILTRATE	25/02/2011	Normal		2.1	10.2	<0.1	0.4	549	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH405	IT3M	25/02/2011	Normal		<1	<1	<1	<1	<1	<1	<1	<0.5		<1	<1	<1	<1	<1	<1	<1	1	ND	ND
BH405	IT3M FILTRATE	25/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH405	IT3S	25/02/2011	Normal		<1	<1	<1	<1	<1	<1	2.2	3.8		4.8	3	2.5	1.4	<1	2.2	1.9	4.5	19.9	4.816
BH405	IT3S FILTRATE	25/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	0.5	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
MW10_Coffey	MW10	26/03/2008	Normal		369	1140	1680	1670	15,800	4390	1150	709		944	260	192	829	80.4	258	2420	2560	4422.4	951.19
MW10_Coffey	QC2	26/03/2008	Field_D		243	692	1010	1160	9360	2770	701	448		512	152	164	501	49.6	157	1450	1540	2684.6	594.44
MW10_Coffey	QC2A	26/03/2008	Normal		28	46	88	110	3300	230	50	36	45		15		34	<5	13	120	120	193	42.79
MW10_Coffey	QC3	1/05/2008	Field_D		3590	13,200	10,400	21,400	149,000	33,300	8060	6220		6840	3250	3670	6120	659	2610	19,200	16,900	37,429	8,365
MW15_Coffey	MW15	1/05/2008	Normal		3870	18,700	13,700	19,100	192,000	42,000	10,400	7750		8330	4220	2930	7630	822	3050	25,900	23,200	45,132	10,226
MW3	BH3	20/03/2010	Normal		12	40	25	57	699	125	8	3	5		<2		8	<2	<2	38	34	24	3.66
MW3	MW3	26/03/2008	Normal		<0.2	68.7	14.1	82.6	1680	103	5.3	4.1		4.2	2	1.8	4.1	0.5	1.8	18.5	16.9	23.8	5.494
MW6	BH6	20/03/2010	Normal		<2	<2	<2	<2	<2	<2	<2	<2	<4		<2		<2	<2	<2	<2	<2	ND	ND
MW6	MW6	26/03/2008	Normal		<0.2	<0.2	<0.2	<0.2	0.6	<0.2	<0.2	<0.2		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	ND	ND
MW7	MW7PER	26/03/2008	Normal		69.6	407	133	190	7200	388	83.3	70.2		67.9	34	31.8	68.9	7.6	29.6	216	215	393.3	92.592
MW7	MW7POST	26/03/2008	Normal		38.5	246	34.3	86.5	4800	110	11.2	9.3		9.2	4.2	4.2	9.2	<1.9	3.7	39.8	36.4	51.9	12.156
MW7	QC1	26/03/2008	Field_D		51.5	331	44.4	121	5530	154	18.6	15.8		17.5	6.3	4.4	15.5	<1.9	5.7	63.6	59.9	84.7	19.864
Offsite Down-Gradient Wells Considered																							
AECOM_BH40	MW40	20/03/2010	Normal		4	16	3	12	244	14	<0.9	<0.9	<2		<0.9		<0.9	<0.9	<0.9	2	2	ND	ND
AECOM_BH69	MW 69 FILTRATE	25/02/2011	Normal		<0.1	<0.1	<0.1	<0.1	5	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
AECOM_BH69	MW69	19/03/2010	Normal		35	158	28	64	1920	126	14	6	6		<2		12	<2	<2	34	47	38	6.86
AECOM_BH69	MW69	25/02/2011	Normal		11.7	37.2	8.9	5.7	202	32	<5	<5		<5	<5	<5	<5	<5	<5	7.4	15.1	ND	ND
BH401	MW401	24/02/2011	Normal		10.5	12.8	<4.9	9.4	195	16.3	<4.9	<4.9		<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	5.2	ND	ND
BH401	MW401 FILTRATE	24/02/2011	Normal		1.2	1	<0.1	<0.1	47.7	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH401	QC615	24/02/2011	Field_D		10.5	12.1	<10	11.4	184	15	<10	<10		<10	<10	<10	<10	<10	<10	<10	<10	ND	ND
BH401	QC615 FILTRATE	24/02/2011	Field_D		1.4	1.2	0.1	<0.1	39.6	<0.1	<0.1	<0.05		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
BH401	QC616	24/02/2011	Interlab_D		11	10	2	11	270	15	<1	<1	<2		<1		<1	<1	<1	3	3	ND	ND
Statistical Summary																							
Number of Results					77	77	77	77	78	77	77	77	29	48	77	48	77	77	77	77	77	85	85
Number of Detects					47	58	35	44	64	45	25	24	6	15	17	13	22	10	17	38	42	28	28
Minimum Concentration					<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.05	<2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Minimum Detect					1	0.3	0.1	0.4	0.2	0.2	1	0.7	5	2.2	2	1.8	1.4	0.5	1.8	1.1	0.2	0.7	0.05
Maximum Concentration					4480	43,200	15,400	21,400	283,000	74,100	12,600	9260	9860	8330	4220	3670	9780	822	3050	25,900	27,900	46,048	11,408
Maximum Detect					4480	43,200	15,400	21,400	283,000	74,100	12,600	9260	9860	8330	4220	3670	9780	822	3050	25,900	27,900	46,048	11,408
Average Concentration					182	1073	575	888	10,144	2136	446	329	357	359	133	152	338	33	109	1010	985	1655	383
Median Concentration					6	16	2.2	9.4	179.5	10	1	1	2	0.7	1	0.7	1	1	1	2.45	3.5	0	0
Standard Deviation					776	5509	2596	3995	41,519	10,292	2048	1526	1829	1538	636	669	1555	144	499	4598	4501	7986	1870
Number of Guideline Exceedances					40	49	65	41	42	63	64	64	29	35	64	35	64	64	64	55	64	0	0
Number of Guideline Exceedances(Detects Only)					35	48	35	39	42	44	25	24	6	15	17	13	22	10	17	38	42	0	0

Notes;
ND = Not detected above the laboratory limit of reporting
cPAH (SUM) = Sum of carcinogenic PAHs (see text for details)
cPAH (TEF) = Sum of carcinogenic PAHs taking into consideration Toxic Equivalency Factors (as presented in Appendix D).

Table T6
MWQC Screen of Groundwater Analytical Results

					TPH				BTEX						Phenols	Cyanide			Ammonia		pH
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Weak Acid Dissociable Cyanide	Cyanide (Free)	Cyanide Total	Ammonia	Ammonia as N	pH (Lab)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH_Units
EQL					20	50	100	50	1	1	1	10	1		0.1	0.004	0.004	0.004	0.01	0.01	0.01
MWQC VMP July 2012					110	40	100	50	700	80	180	75	350		400	0.004	0.004	0.004	4.83	4.83	
Location_Code	**Field_ID**	**Sampled_Date_Time**	**Sample_Type**	**Monitoring_Unit**																	
AECOM_BH40	MW40	20/03/2010	Normal						52	2	46	26	12	38	2					9.7	
AECOM_BH45	MW45	19/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			<0.1	6.25
AECOM_BH52	MW52	19/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	0.008	0.007			<0.1	6.9
AECOM_BH54	MW54	19/03/2010	Normal		3730	28,000	10,900	400	621	206	502	626	328	954	6	<0.004	<0.004			10.8	6.39
AECOM_BH58	MW58	17/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			13.6	5.95
AECOM_BH58	QC237	17/03/2010	Field_D		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			13.8	5.81
AECOM_BH58	QC328	17/03/2010	Interlab_D		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4							
AECOM_BH61	MW61	20/03/2010	Normal		520	860	1420	370	16	20	102	66	30	96	<2	0.007	<0.004			0.12	
AECOM_BH62	MW62	17/03/2010	Normal		<20	<50	1260	200	<1	<2	<5	<2	<2	<4	<0.9	0.008	<0.004			8.47	8.16
AECOM_BH62	MW62	24/02/2011	Normal		<20	<50	390	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
AECOM_BH62	MW62_FILTRATE	24/02/2011	Normal												0.3						
AECOM_BH64	MW64	20/03/2010	Normal		<20	270	1850	540	4	3	6	6	4	10	<2	<0.004	<0.004			2.66	
AECOM_BH68	MW68	18/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<0.9	<0.004	<0.004			5.46	6.88
AECOM_BH68	MW68	24/02/2011	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
AECOM_BH68	MW68_FILTRATE	24/02/2011	Normal												0.9						
BH087	D1408-9	14/08/2006	Interlab_D	Fill	29,200	690	1060	<50	11,400	1850	4390	3440	2240	5680				<0.009			
BH087	MW015	25/07/2006	Normal	Fill	31,500	46,000	19,600	760	14,400	3020	5740	4490	2210	6700				0.346			
BH087	MW15	25/07/2006	Normal	Fill													<0.004				
BH087	MW15	14/08/2006	Normal	Fill	23,200	50,500	22,700	1340	8890	2590	3980	3670	1840	5510			<0.004				
BH087	MW15	15/08/2007	Normal	Fill	14,500	48,200	23,800	2190	7270	1470	2330	1990	1150	3140	58.2		<0.004			42.8	
BH087	MW15	12/05/2008	Normal	Fill	10,100	104,000	15,500	150	4140	68	1760	443	224	667	2240			2.47		5.72	
BH087	MW15	5/12/2008	Normal	Fill																	
BH087	MW15	15/03/2010	Normal	Fill	46,200	41,000	14,400	470	13,100	3010	5030	3920	2180	6100	24	0.011	0.005			37.2	7.09
BH198	D01	9/05/2008	Interlab_D	Fill and Clayey Sand	170	290	470	<50	115	32	3	6	10	16	<2			19	130		
BH198	MW198	9/05/2008	Normal	Fill and Clayey Sand	190	550	1200	70	85	30	<5	3	8	11	1			18.6		110	
BH198	MW198	5/09/2008	Normal	Fill and Clayey Sand																	
BH198	MW198	16/03/2010	Normal	Fill and Clayey Sand	<20	120	590	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			27.4	6.13
BH198	MW198	25/02/2011	Normal	Fill and Clayey Sand	<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
BH198	MW198 FILTRATE	25/02/2011	Normal	Fill and Clayey Sand											0.3						
BH198	QC323	16/03/2010	Field_D	Fill and Clayey Sand	<20	160	690	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			28.2	
BH198	QC324	16/03/2010	Interlab_D	Fill and Clayey Sand	<50	170	580	<50	<5	<5	<5	<10	<5	<15	<2	0.02	<0.004		20		
BH198	QC618	25/02/2011	Field_D	Fill and Clayey Sand	<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
BH198	QC618 FILTRATE	25/02/2011	Field_D	Fill and Clayey Sand											0.5						
BH200	MW200	13/05/2008	Normal	Sandstone Bedrock	28,500	97,200	22,000	120	12,900	473	1620	1380	607	1987	1200			2.43		103	
BH200	MW200	16/03/2010	Normal	Sandstone Bedrock	22,400	100,000	22,500	150	16,200	686	1820	1800	536	2336	300	0.004	0.007			<0.01	6.55
BH200	MW200	28/02/2011	Normal	Sandstone Bedrock	37,600	47,400	17,200	<50	17,900	659	1660	1350	560	1910	836	<0.004	<0.004				
BH200	MW200 FILTRATE	28/02/2011	Normal	Sandstone Bedrock											472						
BH204	MW204 FILTRATE	25/02/2011	Normal	Sandstone Bedrock											2.2						
BH204	MW204S	15/03/2010	Normal	Sandstone Bedrock	890	19,600	7400	450	92	60	180	172	82	254	<9	<0.004	<0.004			5.36	7.04
BH204	MW204S	25/02/2011	Normal	Sandstone Bedrock	2380	8430	2690	130	237	169	440	466	229	695	<10	<0.004	<0.004				
BH204D	MW204D	13/05/2008	Normal	Fill and Clayey Sand	27,900	422,000	75,800	9840	7700	411	3650	2030	914	2944	21,300			3.21		87	
BH205	MW205	9/05/2008	Normal	Sandstone Bedrock	73,600	72,800	8100	80	27,800	745	17,600	3140	2000	5140	21			0.0348		6.7	
BH205	MW205	5/09/2008	Normal	Sandstone Bedrock																	
BH205	MW205	17/03/2010	Normal	Sandstone Bedrock		1,730,000	1,520,000	332,000							503						
BH206	MW206	12/05/2008	Normal	Clayey Sand	8380	6940	1500	<50	2960	306	430	807	612	1419	<1			<0.004		3.84	
BH206	MW206	5/12/2008	Normal	Clayey Sand																	
BH206	MW206	19/03/2010	Normal	Clayey Sand	13,300	68,000	70,600	14,800	5450	1250	101	1230	1540	2770	<47						
BH209	D01_120508	12/05/2008	Interlab_D	Fill	5400	5390	1000	700	2780	123	1520	372	657	1029	234			0.8	13.1		
BH209	MW209	12/05/2008	Normal	Fill	8150	7980	1900	<50	2370	118	1700	380	275	655	115			0.469		12	
BH209	MW209	5/12/2008	Normal	Fill																	
BH209	MW209	16/03/2010	Normal	Fill	1380	2230	1000	160	772	149	48	76	104	180	<2	<0.004	<0.004			7.48	7.1
BH209	MW209	28/02/2011	Normal	Fill	100	100	220	<50	56	15	5	8	10	18	<1	<0.004	<0.004				
BH209	MW209 FILTRATE	28/02/2011	Normal	Fill											1.1						

Table T6
MWQC Screen of Groundwater Analytical Results

					TPH				BTEX						Phenols	Cyanide			Ammonia		pH
					TPH C6 - C9	TPH C10 - C14	TPH C15-C28	TPH C29-C36	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Total Xylene (ESDAT)	Phenol	Weak Acid Dissociable Cyanide	Cyanide (Free)	Cyanide Total	Ammonia	Ammonia as N	pH (Lab)
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH_Units
EQL					20	50	100	50	1	1	1	10	1		0.1	0.004	0.004	0.004	0.01	0.01	0.01
MWQC VMP July 2012					110	40	100	50	700	80	180	75	350		400	0.004	0.004	0.004	4.83	4.83	
Location_Code	**Field_ID**	**Sampled_Date_Time**	**Sample_Type**	**Monitoring_Unit**																	
BH210	MW210	8/05/2008	Normal	Sandstone Bedrock	2650	14,800	4400	210	511	69	617	401	218	619	7.3			<0.004		6.56	
BH210	MW210	5/08/2008	Normal	Sandstone Bedrock																	
BH210	MW210	16/03/2010	Normal	Sandstone Bedrock	30	210	730	<50	12	8	<5	3	3	6	<2					5.24	6.5
BH210	MW210	24/02/2011	Normal	Sandstone Bedrock	<20	80	730	70	2	3	<5	<2	<2	<4	<1	<0.004	<0.004				
BH210	MW210 FILTRATE	24/02/2011	Normal	Sandstone Bedrock											0.4						
BH405	IT3D	25/02/2011	Normal		2120	5590	2970	260	595	51	465	325	136	461	<10	<0.004	<0.004				
BH405	IT3D FILTRATE	25/02/2011	Normal												6.9						
BH405	IT3M	25/02/2011	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
BH405	IT3M FILTRATE	25/02/2011	Normal												0.2						
BH405	IT3S	25/02/2011	Normal		<20	<50	410	240	<1	<2	<5	<2	<2	<4	<1	<0.004	<0.004				
BH405	IT3S FILTRATE	25/02/2011	Normal												1						
MW10_Coffey	MW10	26/03/2008	Normal		9690	528,000	152,000	30,600	5450	52	2140	331	280	611	249,000					348	
MW10_Coffey	QC2	26/03/2008	Field_D		40,000	492,000	89,400	14,700	18,300	373	8060	2220	1160	3380	392,000					312	
MW10_Coffey	QC2A	26/03/2008	Normal						24,000	360	12,000			3774	140,000					4.2	
MW10_Coffey	QC3	1/05/2008	Field_D		54,700	654,000	1,050,000	305,000	41,000	<500	8150	1960	817	2777	1620		<0.004	0.572		23.7	
MW15_Coffey	MW15	1/05/2008	Normal		55,800	494,000	754,000	205,000	40,200	<500	7890	2000	841	2841	1880		0.0115	0.75		23.3	
MW3	BH3	20/03/2010	Normal		40	2900	2780	260	11	5	<5	7	5	12	<2	0.02	0.013			1.81	
MW3	MW3	26/03/2008	Normal		120	5050	2900	300	14	35	15	29	23	52	<2					0.934	
MW6	BH6	20/03/2010	Normal		<20	<50	<100	<50	<1	<2	<5	<2	<2	<4	<2	<0.004	<0.004			<0.1	
MW6	MW6	26/03/2008	Normal		<20	<50	<100	<50	<1	<2	<2	<2	<2	<4	10					0.163	
MW7	MW7PER	26/03/2008	Normal		27,000	771,000	42,500	1330	21,100	151	5750	1080	538	1618	227,000					239	
MW7	MW7POST	26/03/2008	Normal		30,300	830,000	46,900	670	25,200	159	6440	1150	592	1742	134,000					294	
MW7	QC1	26/03/2008	Field_D		28,900	831,000	46,400	660	19,900	161	4630	1180	601	1781	168,000					281	
Offsite Down-Gradient Wells Considered																					
AECOM_BH40	MW40	20/03/2010	Normal						52	2	46	26	12	38	2					9.7	
AECOM_BH69	MW 69 FILTRATE	25/02/2011	Normal												0.5						
AECOM_BH69	MW69	19/03/2010	Normal		3400	7200	3900	360	868	77	804	240	144	384	2	0.01	0.004			90.4	
AECOM_BH69	MW69	25/02/2011	Normal		210	530	330	<50	52	16	9	13	13	26	<5	<0.004	<0.004				
BH401	MW401	24/02/2011	Normal		350	790	1070	<50	127	<5	108	27	15	42	15	<0.004	<0.004				
BH401	MW401 FILTRATE	24/02/2011	Normal												6.6						
BH401	QC615	24/02/2011	Field_D		400	800	1050	<50	138	<5	112	30	14	44	15.4	<0.004	<0.004				
BH401	QC615 FILTRATE	24/02/2011	Field_D												9.4						
BH401	QC616	24/02/2011	Interlab_D		330	1000	1300	220	140	4	120	31	15	46	<50	0.01	0.007				
Statistical Summary																					
Number of Results					60	61	61	61	63	63	63	62	62	63	74	34	39	14	3	40	13
Number of Detects					40	46	49	35	45	41	41	43	43	44	42	9	7	11	3	36	13
Minimum Concentration					<20	<50	<100	<50	<1	<2	<2	<2	<2	<4	0.2	<0.004	<0.004	<0.004	13.1	<0.01	5.81
Minimum Detect					30	80	220	70	2	2	3	3	3	6	0.2	0.004	0.004	0.0348	13.1	0.12	5.81
Maximum Concentration					73,600	1,730,000	1,520,000	332,000	41,000	3020	17,600	4490	2240	6700	392,000	0.02	0.013	19	130	348	8.16
Maximum Detect					73,600	1,730,000	1,520,000	332,000	41,000	3020	17,600	4490	2240	6700	392,000	0.02	0.013	19	130	348	8.16
Average Concentration					10,759	123,741	66,765	15,171	5635	310	1779	693	384	1120	18,121	0.0044	0.003	3.5	54	55	6.7
Median Concentration					460	2230	1420	130	127	32	102	30.5	19	52	2	0.002	0.002	0.661	20	9.7	6.55
Standard Deviation					17,212	301,560	250,367	62,278	9843	679	3311	1119	619	1742	65,075	0.0048	0.0026	6.6	66	97	0.62
Number of Guideline Exceedances					37	61	49	35	25	24	28	29	19	0	14	9	7	12	3	29	0
Number of Guideline Exceedances(Detects Only)					37	46	49	35	25	22	28	29	19	0	14	9	7	11	3	29	0

Notes;
ND = Not detected above the laboratory limit of reporting
cPAH (SUM) = Sum of carcinogenic PAHs (see text for details)
cPAH (TEF) = Sum of carcinogenic PAHs taking into consideration Toxic Equivalency Factors (as presented in Appenc

Table T7
Filtered Groundwater Results

			Field_ID	IT3D	IT3D FILTRATE	IT3D FP1	IT3D FP2	IT3M	IT3M FILTRATE	IT3M FP1	IT3M FP2	IT3S	IT3S FILTRATE	IT3S FP1	IT3S FP2
			SDG	ES1104161	ES1104161	ES1104161	ES1104161	ES1104161	ES1104161	ES1104161	ES1104161	ES1104161	ES1104161	ES1104161	ES1104161
			SampleCode	ES1104161005	ES1104161029	ES1104161017	ES1104161018	ES1104161004	ES1104161028	ES1104161015	ES1104161016	ES1104161003	ES1104161027	ES1104161027	ES1104161027
			Monitoring_Zone	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4
			Location_Code	BH405	BH405	BH405	BH405	BH405	BH405	BH405	BH405	BH405	BH405	BH405	BH405
			Well	IT3D	IT3D	IT3D	IT3D	IT3M	IT3M	IT3M	IT3M	IT3S	IT3S	IT3S	IT3S
			Sampled_Date_Time	25/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011
			SampleComments	Unfiltered	Filtrate	Filtercake	Filtercake	Unfiltered	Filtrate	Filtercake	Filtercake	Unfiltered	Filtrate	Filtercake	Filtercake
ChemName	**Filtrate output unit**	**EQL**	**MWQC**												
Phenols															
Phenol	µg/L	0.1	400	<10	6.9			<1	0.2			<1	1		
PAH															
Acenaphthene	µg/L	0.1	5.8	25	2.1	280	20	<1	<0.1	30	<20	<1	<0.1	<20	<20
Acenaphthylene	µg/L	0.1	5.8	158	10.2	1090	100	<1	<0.1	70	<20	<1	<0.1	<20	<20
Anthracene	µg/L	0.1	0.01	25.7	<0.1	720	<20	<1	<0.1	160	<20	<1	<0.1	40	<20
Benz(a)anthracene	µg/L	0.1	0.1	19.6	<0.1	690	<20	<1	<0.1	690	<20	2.2	<0.1	270	<20
Benzo(a) pyrene	µg/L	0.05	0.1	12.8	<0.05	700	<20	<0.5	<0.05	1000	<20	3.8	<0.05	630	<20
Benzo(b)fluoranthene	µg/L	0.1	1	12.4	<0.1	700	<20	<1	<0.1	1040	<20	4.8	<0.1	590	<20
Benzo(g,h,i)perylene	µg/L	0.1	0.1	<10	<0.1	180	<20	<1	<0.1	280	<20	3	<0.1	230	<20
Benzo(k)fluoranthene	µg/L	0.1	0.1	<10	<0.1	360	<20	<1	<0.1	530	<20	2.5	<0.1	300	<20
Chrysene	µg/L	0.1	0.1	11.3	<0.1	540	<20	<1	<0.1	660	<20	1.4	<0.1	230	<20
Dibenz(a,h)anthracene	µg/L	0.1	0.1	<10	<0.1	30	<20	<1	<0.1	30	<20	<1	<0.1	20	<20
Fluoranthene	µg/L	0.1	1	28.6	<0.1	1090	<20	<1	<0.1	890	<20	1.9	<0.1	270	<20
Fluorene	µg/L	0.1	3	75.9	<0.4	1080	<20	<1	<0.1	60	<20	<1	<0.1	<20	<20
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	0.1	<10	<0.1	160	<20	<1	<0.1	210	<20	2.2	<0.1	180	<20
Naphthalene	µg/L	0.1	70	2560	549	15800	2140	<1	0.2	90	<20	<1	0.5	40	<20
Phenanthrene	µg/L	0.1	0.6	77.7	<0.1	2550	30	<1	<0.1	560	<20	<1	<0.1	120	<20
Pyrene	µg/L	0.1	0.025	41.8	<0.1	960	<20	<1	<0.1	1110	<20	4.5	<0.1	510	<20
High MW PAHs	µg/L	0.1	0.1	28.2	<LOR	928.2	<LOR	<LOR	<LOR	1286	<LOR	6	<LOR	789	<LOR

Notes:
MWQC = Marine Water Quality Criteria
Sources for the MWQC are provided in Table 28 in Section 7.4 in the main report.

Table T7
Filtered Groundwater Results

			Field_ID	MW198	MW198 FILTRATE	MW198 FP1	MW198 FP2	MW200	MW200 FILTRATE	MW200 FP1	MW200 FP2	MW204S	MW204 FILTRATE	MW204SFP1	MW204S FP2
			SDG	ES1104161	ES1104161	ES1104161	ES1104161	ES1104220	ES1104220	ES1104220	ES1104220	ES1104220	ES1104220	ES1104220	ES1104220
			SampleCode	ES1104161006	ES1104161030	ES1104161030	ES1104161030	ES1104220004	ES1104220018	ES1104220013	ES1104220014	ES1104220001	ES1104220015	ES1104220007	ES1104220008
			Monitoring_Zone	VMP & PDA - Block 5	VMP & PDA - Block 5	VMP & PDA - Block 5	VMP & PDA - Block 5	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4
			Location_Code	BH198	BH198	BH198	BH198	BH200	BH200	BH200	BH200	BH204	BH204	BH204	BH204
			Well	MW198	MW198	MW198	MW198	MW200	MW200	MW200	MW200	MW204S	MW204S	MW204S	MW204S
			Sampled_Date_Time	25/02/2011	25/02/2011	25/02/2011	25/02/2011	28/02/2011	28/02/2011	28/02/2011	28/02/2011	25/02/2011	25/02/2011	25/02/2011	25/02/2011
			SampleComments	Unfiltered	Filtrate	Filtercake	Filtercake	Unfiltered	Filtrate	Filtercake	Filtercake	Unfiltered	Filtrate	Filtercake	Filtercake
ChemName	**Filtrate output unit**	**EQL**	**MWQC**												
Phenols															
Phenol	µg/L	0.1	400	<1	0.3			836	472			<10	2.2		
PAH															
Acenaphthene	µg/L	0.1	5.8	<1	<0.1	<20	<20	<98	6.4	40	<10	85.5	10.9	330	190
Acenaphthylene	µg/L	0.1	5.8	1.4	0.4	<20	<20	<98	20.2	140	30	45.4	5.1	140	90
Anthracene	µg/L	0.1	0.01	<1	<0.1	<20	<20	<98	<1	10	<10	<10	<0.1	40	<10
Benz(a)anthracene	µg/L	0.1	0.1	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	<10	<10
Benzo(a) pyrene	µg/L	0.05	0.1	<0.5	<0.05	<20	<20	<98	<0.5	<10	<10	<10	<0.05	<10	<10
Benzo(b)fluoranthene	µg/L	0.1	1	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	<10	<10
Benzo(g,h,i)perylene	µg/L	0.1	0.1	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	<10	<10
Benzo(k)fluoranthene	µg/L	0.1	0.1	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	<10	<10
Chrysene	µg/L	0.1	0.1	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	<10	<10
Dibenz(a,h)anthracene	µg/L	0.1	0.1	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	<10	<10
Fluoranthene	µg/L	0.1	1	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	40	<10
Fluorene	µg/L	0.1	3	<1	<0.1	<20	<20	<98	<1	120	<10	80.6	0.8	460	90
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	0.1	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	<10	<10
Naphthalene	µg/L	0.1	70	<1	0.7	20	<20	5450	2970	11200	1810	8580	1100	13400	14400
Phenanthrene	µg/L	0.1	0.6	<1	<0.1	<20	<20	<98	<1	80	<10	54.6	<0.1	610	30
Pyrene	µg/L	0.1	0.025	<1	<0.1	<20	<20	<98	<1	<10	<10	<10	<0.1	20	<10
High MW PAHs	µg/L	0.1	0.1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Notes:
MWQC = Marine Water Quality Criteria
Sources for the MWQC are provided in Table 28 in Section 7.4 in the main repor

Table T7
Filtered Groundwater Results

			Field_ID	MW209	MW209 FILTRATE	MW209 FP1	MW209 FP2	MW210	MW210 FILTRATE	MW210 FP1	MW210 FP2
			SDG	ES1104220	ES1104220	ES1104220	ES1104220	ES1104095	ES1104095	ES1104095	ES1104095
			SampleCode	ES1104220003	ES1104220017	ES1104220011	ES1104220012	ES1104095001	ES1104095013	ES1104094-007	ES1104094-007
			Monitoring_Zone	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Block 4	VMP & PDA - Proposed Southern Cove	VMP & PDA - Proposed Southern Cove	VMP & PDA - Proposed Southern Cove	VMP & PDA - Proposed Southern Cove
			Location_Code	BH209	BH209	BH209	BH209	BH210	BH210	BH210	BH210
			Well	MW209	MW209	MW209	MW209	MW210	MW210	MW210	MW210
			Sampled_Date_Time	28/02/2011	28/02/2011	28/02/2011	28/02/2011	24/02/2011	24/02/2011	24/02/2011	24/02/2011
			SampleComments	Unfiltered	Filtrate	Filtercake	Filtercake	Unfiltered	Filtrate	Filtercake	Filtercake
ChemName	**Filtrate output unit**	**EQL**	**MWQC**								
Phenols											
Phenol	µg/L	0.1	400	<1	1.1			<1	0.4	<10	<10
PAH											
Acenaphthene	µg/L	0.1	5.8	1.8	<0.1	80	<10	<1	<0.1	<10	<10
Acenaphthylene	µg/L	0.1	5.8	6.2	<0.1	460	<10	3.1	0.3	<10	<10
Anthracene	µg/L	0.1	0.01	1	<0.1	200	<10	<1	<0.1	<10	<10
Benz(a)anthracene	µg/L	0.1	0.1	1	<0.1	590	<10	1.1	<0.1	10	<10
Benzo(a) pyrene	µg/L	0.05	0.1	0.8	<0.05	720	<10	0.9	<0.05	10	<10
Benzo(b)fluoranthene	µg/L	0.1	1	<1	<0.1	500	<10	<1	<0.1	<10	<10
Benzo(g,h,i)perylene	µg/L	0.1	0.1	<1	<0.1	190	<10	<1	<0.1	<10	<10
Benzo(k)fluoranthene	µg/L	0.1	0.1	<1	<0.1	260	<10	<1	<0.1	<10	<10
Chrysene	µg/L	0.1	0.1	<1	<0.1	420	<10	<1	<0.1	<10	<10
Dibenz(a,h)anthracene	µg/L	0.1	0.1	<1	<0.1	40	<10	<1	<0.1	<10	<10
Fluoranthene	µg/L	0.1	1	1.2	<0.1	400	<10	2.6	<0.1	20	<10
Fluorene	µg/L	0.1	3	<1	<0.1	100	<10	<1	<0.1	<10	<10
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	0.1	<1	<0.1	150	<10	<1	<0.1	<10	<10
Naphthalene	µg/L	0.1	70	10.8	2	210	<10	<1	0.5	<10	<10
Phenanthrene	µg/L	0.1	0.6	2	<0.1	290	<10	<1	<0.1	<10	<10
Pyrene	µg/L	0.1	0.025	1.8	<0.1	540	<10	4.2	<0.1	20	<10
High MW PAHs	µg/L	0.1	0.1	2	<LOR	916	<LOR	2	<LOR	<LOR	<LOR

Notes:
MWQC = Marine Water Quality Criteria
Sources for the MWQC are provided in Table 28 in Section 7.4 in the main repor

Table T7
Filtered Groundwater Results

			Field_ID	MW62	MW62_FILTRATE	MW62_FP1	MW62_FP2	MW62	MW68	MW68_FILTRATE
			SDG	ES1104095	ES1104095	ES1104095	ES1104095	ES1104095	ES1104095	ES1104095
			SampleCode	ES1104095002	ES1104095014	ES1104095014	ES1104095014	ES1104095014	ES1104095003	ES1104095015
			Monitoring_Zone	VMP & PDA - Block 5	VMP & PDA - Block 5	VMP & PDA - Block 5	VMP & PDA - Block 5	VMP & PDA - Block 5	VMP & PDA - Block 5	VMP & PDA - Block 5
			Location_Code	AECOM_BH62	AECOM_BH62	AECOM_BH62	AECOM_BH62	AECOM_BH62	AECOM_BH68	AECOM_BH68
			Well	MW62	MW62	MW62	MW62	MW62	MW68	MW68
			Sampled_Date_Time	24/02/2011	24/02/2011	24/02/2011	24/02/2011	24/02/2011	24/02/2011	24/02/2011
			SampleComments	Unfiltered	Filtrate	Filtercake	Filtercake		Unfiltered	Filtrate
ChemName	**Filtrate output unit**	**EQL**	**MWQC**							
Phenols										
Phenol	µg/L	0.1	400	<1	0.3	<10	<10		<1	0.9
PAH										
Acenaphthene	µg/L	0.1	5.8	<1	<0.1	<10	<10	<1	<1	<0.1
Acenaphthylene	µg/L	0.1	5.8	<1	<0.1	<10	<10	<1	<1	<0.1
Anthracene	µg/L	0.1	0.01	<1	<0.1	<10	<10	<1	<1	<0.1
Benz(a)anthracene	µg/L	0.1	0.1	<1	<0.1	<10	<10	<1	<1	<0.1
Benzo(a) pyrene	µg/L	0.05	0.1	<0.5	<0.05	<10	<10	<0.5	<0.5	<0.05
Benzo(b)fluoranthene	µg/L	0.1	1	<1	<0.1	<10	<10	<1	<1	<0.1
Benzo(g,h,i)perylene	µg/L	0.1	0.1	<1	<0.1	<10	<10	<1	<1	<0.1
Benzo(k)fluoranthene	µg/L	0.1	0.1	<1	<0.1	<10	<10	<1	<1	<0.1
Chrysene	µg/L	0.1	0.1	<1	<0.1	<10	<10	<1	<1	<0.1
Dibenz(a,h)anthracene	µg/L	0.1	0.1	<1	<0.1	<10	<10	<1	<1	<0.1
Fluoranthene	µg/L	0.1	1	<1	<0.1	<10	<10	<1	<1	<0.1
Fluorene	µg/L	0.1	3	<1	<0.1	<10	<10	<1	<1	<0.1
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	0.1	<1	<0.1	<10	<10	<1	<1	<0.1
Naphthalene	µg/L	0.1	70	<1	0.4	<10	<10	<1	<1	0.8
Phenanthrene	µg/L	0.1	0.6	<1	<0.1	<10	<10	<1	<1	0.2
Pyrene	µg/L	0.1	0.025	<1	<0.1	<10	<10	<1	<1	<0.1
High MW PAHs	µg/L	0.1	0.1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Notes:
MWQC = Marine Water Quality Criteria
Sources for the MWQC are provided in Table 28 in Section 7.4 in the main repor

Table T8
Soil Leachate Data
VMP Remediation Works Area, HHERA

Field_ID	Location Code	Sampled Date	Area	Acenaphthene - soil	Acenaphthene - leached	Acenaphthylene - soil	Acenaphthylene - leached	Anthracene - soil	Anthracene - leached	Benz(a)anthracene - soil	Benz(a)anthracene - leached	Benzo(a) pyrene - soil	Benzo(a) pyrene - leached	Benzo(b)fluoranthene - soil	Benzo(b)fluoranthene - leached	Benzo(g,h,i)perylene - soil	Benzo(g,h,i)perylene - leached	Benzo(k)fluoranthene - soil	Benzo(k)fluoranthene - leached	Chrysene - soil	Chrysene - leached	Dibenz(a,h)anthracene - soil	Dibenz(a,h)anthracene - leached	Fluoranthene - soil	Fluoranthene - leached	Fluorene - soil	Fluorene - leached	Indeno(1,2,3-c,d)pyrene - soil	Indeno(1,2,3-c,d)pyrene - leached	High MW PAHs (B(a)P TEF) - leached	Naphthalene - soil	Naphthalene - leached	Phenanthrene - soil	Phenanthrene - leached	Pyrene - soil	Pyrene - leached
				mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL				0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5			0.5		0.5		0.5	
MWQC					5.8		5.8		0.01				0.1												1		3			0.1		70		0.6		0.025
Field_ID	**Location Code**	**Sampled Date**	**Area**																																	
BH21_12.0-12.2	AECOM_BH21	11/02/2010	Block 1	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	-	-	<0.5	-	<0.5	-	0.6	-	<0.5	-	<0.5	-		<0.5	-	<0.5	-	0.7	-
BH15_2.0-2.2	AECOM_BH15	9/02/2010	Block 2	<0.5	<1	<0.5	<1	<0.5	<1	1	<1	1.3	<0.5	1.6	<1	2.2	<1	0.7	<1	0.9	<1	<0.5	<1	1.6	<1	<0.5	<1	1.7	<1	<LOR	<0.5	<1	1.5	<1	1.5	<1
BH20_11.0-11.2	AECOM_BH20	11/02/2010	Block 2	<0.5	<1	0.6	<1	1.2	<1	2.8	<1	2.6	<0.5	-	<1	1	<1	-	<1	2.3	<1	<0.5	<1	4.7	<1	<0.5	<1	1	<1	<LOR	<0.5	<1 - 1.3	2.4	1.7	6.2	<1
BH32_14.5-14.7	AECOM_BH32	12/02/2010	Block 2	<0.5	<1	2.2	<1	2.8	<1	5.3	<1	4.8	<0.5	6.6	<1	2.5	<1	2.4	<1	4.2	<1	0.6	<1	11.1	1.1	0.9	<1	2.1	<1	<LOR	0.7	1.2	4.4	1.9	13.8	1.4
BH101 3.0_3.25	BH101	15/06/2006	Block 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH195/9.9	BH195	31/03/2008	Block 2	<0.5	2.5	0.5	<1	1.2	<1	2.1	<1	1.4	<0.5	1.9	<1	0.9	<1	0.7	<1	1.6	<1	<0.5	<1	4.1	<1	0.6	1.6	0.6	<1	<LOR	<0.5	<1	4.4	1.9	3.9	<1
BH196/1.0	BH196	27/03/2008	Block 2	2.4	11.9	<0.5	<1	1.4	<1	1.6	<1	1.2	<0.5	1.5	<1	0.6	<1	<0.5	<1	1.3	<1	<0.5	<1	4.6	<1	<0.5	2.3	0.6	<1	<LOR	<0.5	1.6	3.7	2.3	4.2	<1
BH07_7.4-7.56	AECOM_BH07	8/12/2009	Block 3	10.7	-	0.9	-	18.6	-	12.5	-	9.3	-	9.4	-	4.4	-	5.5	-	10.8	-	0.8	-	35.4	-	13	-	3.5	-	-	13.6	-	64.6	-	38.3	-
BH11_2.6-2.7	AECOM_BH11	5/02/2010	Block 3	-	2.4	-	<1 - 1.1	-	<1	-	<1	-	<0.5	-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	<LOR	-	<1	-	1	-	<1
BH13_2.4-2.6	AECOM_BH13	5/02/2010	Block 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13_7.2-7.4	AECOM_BH13	5/02/2010	Block 3	<0.5	<1	0.9	<1	0.8	<1	2.8	<1	2.8	<0.5	4.6	<1	1.5	<1	2.1	<1	1.8	<1	<0.5	<1	0.6	3.7	<0.5	<1	1.1	<1	<LOR	<0.5	<1	0.6	3.3	13.7	2.6
BH37_5.5-5.7	AECOM_BH37	18/02/2010	Block 3	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<0.5	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	1.7	<0.5	<1	<LOR	<0.5	3.6	<0.5	3	<0.5	<1
BH57_7.0-7.2	AECOM_BH57	25/02/2010	Block 4	<0.5	1.3	2.7	2	7.3	2.4	10.5	<1	6.8	<0.5	10	<1	2.9	<1	3.2	<1	8.1	<1	0.7	<1	26.6	3.2	1.5	3.7	2.7	<1	<LOR	0.5	3.2	20.9	12.2	22.7	2.3
BH70_2.5-2.7	AECOM_BH70	8/03/2010	Block 5	<0.5	1.6	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<0.5	-	<1	<0.5	<1	-	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<LOR	4.3	55.5	<0.5	1.2	<0.5	<1
BH001	BH001	1/05/2006	Block 5	1.1	-	14.4	-	19.2	-	65.9	-	33.4	-	98.6	-	25.5	-	29.6	-	70.5	-	10.4	-	104	-	3.6	-	28.6	-	-	11.5	-	84.4	-	98.4	-
BH136 3.0_3.45	BH136	6/07/2006	Block 5	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-
BH197/11.5	BH197	9/04/2008	Block 5	1.7	22.3	9.9	99.6	3.6	17.4	2.7	<1	1.2	<0.5	1	<1	<0.5	<1	<0.5	<1	1.7	<1	<0.5	<1	3.8	7.6	9.2	78.4	<0.5	<1	<LOR	31.1	473	19.3	124	6.1	9.6
BH36_1.0-1.2	AECOM_BH36	3/03/2010	Declaration Area (Block 3)	<0.5	<1	<0.5	<1	<0.5	1.2	<0.5	<1	<0.5	<0.5	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	1.3	<0.5	1.8	<0.5	<1	<LOR	<0.5	7.6	<0.5	5	<0.5	1.2
BH42_3.2-3.3	AECOM_BH42	23/02/2010	Declaration Area (Block 4)	35	51.8	250	283	217	28.9	157	<3.8	113	<3.8	-	<3.8	22.9	<3.8	-	<3.8	122	<3.8	7.9	<3.8	369	15.3	243	169	23.8	<3.8	<LOR	926	5210	660	134	351	12.4
BH48-14.5-14.7	AECOM_BH48	23/02/2010	Declaration Area (Block 4)	12.9	77.5	113	508	54	45.5	39.2	<3.7	31	<3.7	-	<3.7	8.5	<3.7	-	<3.7	30.8	<3.7	2.9	<3.7	124	18.2	94.3	232	8.9	<3.7	<LOR	517	8890	215	148	101	12.5
BH52_2.2-2.6	AECOM_BH52	22/02/2010	Declaration Area (Block 4)	<0.5	1.1	1	4.5	1	1.8	2.4	<1	1.6	<0.5	2.4	<1	0.9	<1	1	<1	1.9	<1	<0.5	<1	4.1	2.5	<0.5	5.6	0.8	<1	<LOR	<0.5	32.4	2.3	8	3.9	1.8
BH54_1.0-1.4	AECOM_BH54	23/02/2010	Declaration Area (Block 4)	273	98	1000	220	1070	41.8	912	<3.8	533	<3.8	824	<3.8	248	<3.8	324	<3.8	549	<3.8	72.5	<3.8	2130	23.1	1290	196	231	<3.8	<LOR	6370	8550	3130	160	1670	15.6
BH55_2.2-2.4	AECOM_BH55	25/02/2010	Declaration Area (Block 4)	25.3	49.5	149	287	119	26	107	<3.7	84	<3.7	-	<3.7	17.2	<3.7	-	<3.7	87	<3.7	5.4	<3.7	274	17.1	151	166	17.5	<3.7	<LOR	1740	8760	463	134	237	11.8
BH59_3.4-3.5	AECOM_BH59	22/02/2010	Declaration Area (Block 4)	104	55.15	404	277.5	368	31.35	271	<3.8	189	<3.8	-	<3.8	44.5	<3.8	-	<3.8	214	<3.8	21.7	<3.8	669	16.75	462	176	52.2	<3.8	<LOR	3560	6945	1400	156.5	603	12.8
BH133 1.5_1.95	BH133	6/07/2006	Declaration Area (Block 4)	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-
BH141 1.5_1.95	BH141	7/07/2006	Declaration Area (Block 4)	1.8	-	11.8	-	14.6	-	28.2	-	24.6	-	25.2	-	12.2	-	10.6	-	24.1	-	2.5	-	72.2	-	4.5	-	9.6	-	-	2.3	-	38.4	-	67.9	-
BH146-1.5-1.95	BH146	11/07/2006	Declaration Area (Block 4)	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-
BH146-4.1-4.6	BH146	11/07/2006	Declaration Area (Block 4)	16	-	78.8	-	58.6	-	43.5	-	32.9	-	37.2	-	16.2	-	14.8	-	34.7	-	4.1	-	107	-	71.6	-	14.2	-	-	454	-	186	-	105	-
BH202/2.3	BH202	10/03/2008	Declaration Area (Block 4)	<0.5	<1	1	<1	1.6	<1	6.5	<1	6.5	<0.5	6.4	<1	3.9	<1	3	<1	5.5	<1	0.9	<1	11.4	<1	<0.5	<1	3.9	<1	<LOR	1	<1	3.4	<1	11.6	<1
BH204/1.0	BH204	2/04/2008	Declaration Area (Block 4)	45.2	74.6	194	287	187	39.1	128	<3.9	78.6	<3.9	68.8	<3.9	39.8	<3.9	59	<3.9	83.5	<3.9	9.9	<3.9	373	27.7	295	256	41.3	<3.9	<LOR	1180	5820	673	205	246	17
BH204D/1.5	BH204D	11/04/2008	Declaration Area (Block 4)	222	29.1	605	34.3	1200	30.8	823	<3.9	652	<3.9	587	<3.9	305	<3.9	231	<3.9	631	<3.9	71.4	<3.9	1550	9.7	1190	94.1	247	<3.9	<LOR	8410	7350	2700	97.6	1510	7.8
BH205/9.3	BH205	1/04/2008	Declaration Area (Block 4)	11	37.2	57.6	419	30.7	20	25.2	<4	15.5	<4	14.3	<4	5.6	<4	6.7	<4	20.8	<4	1.6	<4	42.4	11.2	42.9	116	5	<4	<LOR	291	6400	117	94.7	50.8	11.3
BH205/13.8	BH205	7/04/2008	Declaration Area (Block 4)	<0.5	<1	<0.5	2.2	<0.5	<1	<0.5	<1	<0.5	<0.5	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	1.4	<0.5	<1	<LOR	<0.5	17.2	<0.5	2.3	<0.5	<1
BH206/7.1	BH206	17/04/2008	Declaration Area (Block 4)	1.4	20.8	10	156	5.6	12.4	4.1	<2	2.1	<2	1.9	<2	0.7	<2	0.7	<2	2.5	<2	<0.5	<2	6.7	4.5	8.3	60.6	0.6	<2	<LOR	39.8	1500	16.9	61.6	8.8	5.3
BH206/10.7	BH206	29/04/2008	Declaration Area (Block 4)	<0.5	16.1	1.9	105	1.6	17.7	1.2	<1	0.7	<0.5	0.8	<1	<0.5	<1	<0.5	<1	0.9	<1	<0.5	<1	2.1	9.3	1.4	66.3	<0.5	<1	<LOR	3.5	725	5.1	73.4	2.5	8
BH208/2.25	BH208	9/04/2008	Declaration Area (Block 4)	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<0.5	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<LOR	<0.5	<1	<0.5	<1	<0.5	<1
BH209/9.4	BH209	23/04/2008	Declaration Area (Block 4)	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<0.5	<2	<LOR	<0.5	<2	<0.5	<2	<0.5	<2
BH209/4.5	BH209	29/04/2008	Declaration Area (Block 4)	5.9	21.5	33.8	157	19.1	10	17.7	<3.7	11.2	<3.7	11.4	<3.7	4.5	<3.7	2.7	<3.7	12.9	<3.7	1.2	<3.7	28.3	4.4	24.8	55.9	3.4	<3.7	<LOR	203	2710	75.5	52.3	41.6	4.8
BH209/6.1	BH209	29/04/2008	Declaration Area (Block 4)	6.8	16.8	54.9	214	22.3	8.5	15.4	<3.7	9.1	<3.7	7	<3.7	3.2	<3.7	2.9	<3.7	11	<3.7	1	<3.7	24.6	<3.7	27	42.1	2.2	<3.7	<LOR	498	4000	86.5	39.2	42.1	<3.7
BH211/15.5	BH211	31/03/2008	Declaration Area (Block 4)	<0.5	7.2	1.9	50.6	1.4	11.4	0.8	<1	<0.5	<0.5	<0.5	<1	<0.5	<1	<0.5	<1	0.6	<1	<0.5	<1	1.2	5.2	1.2	29.9	<0.5	<1	<LOR	5.2	301	3.6	69.6	1.8	6.2
BH62_5.4-5.6	AECOM_BH62	26/02/2010	Declaration Area (Block 5)	<0.5	5.1	0.6	3	2.2	4	5.1	<1	2.9	<0.5	4.3	<1	1.7	<1	2.2	<1	4	<1	<0.5	<1	10.8	5.2	0.5	7.2	1.3	<1	<LOR	0.5	41.7	6.1	17	10.3	4.4
BH64_2.5-2.7	AECOM_BH64	1/03/2010	Declaration Area (Block 5)	-	<1	-	<1	-	<1	-	<1	-	<0.5	-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	<LOR	-	3.8	-	<1	-	<1
BH69_1.0-1.15	AECOM_BH69	26/02/2010	Declaration Area (Block 5)	<0.5	5.7	2.3	11.5	3.3	6	5.8	<1	3.4	<0.5	5.8	<1	1.9	<1	1.7	<1	4.8	<1	<0.5	<1	11.6	6.5	1.8	16.3	1.4	<1	<LOR	2.9	45	11.3	26.8	10.8	5
D1107-1	BH145	11/07/2006	Declaration Area (Block 5)	1.5	-	24.2	-	26.2	-	85.7	-	78.1	-	96.1	-	48.8	-	37.1	-	76	-	13.1	-	132	-	6.3	-	38.9	-	-	11.6	-	65.6	-	152	-
BH198/3.0	BH198	12/03/2008	Declaration Area (Block 5)	3.4	-	16.3	-	12.7	-	13.3	-	26.3	<0.5	26.5	-	12.7	-	10.5	-	12.7	-	4.3	-	26.6	-	4.7	-	11.8	-	-	17.2	-	21	-	54.8	-
BH199/3.7	BH199	11/03/2008	Declaration Area (Block 5)	14.2	45.4	47.2	123	44.7	19.2	39.8	<3.7	27.4	<3.7	29.8	<3.7	10.3	<3.7	11.9	<3.7	28	<3.7	2.5	<3.7	122	14.1	69	144	10.4	<3.7	<LOR	439	4520	164	115	98.7	10.4
BH 199/6.0	BH199	17/03/2008	Declaration Area (Block 5)	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<0.5	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<LOR	<0.5	<1	<0.5	<1	<0.5	<1
BH199/6.0	BH199	27/03/2008	Declaration Area (Block 5)	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<0.5	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<LOR	<0.5	<1	<0.5	<1	<0.5	<1
BH201/10.3	BH201	23/03/2008	Declaration Area (Block 5)	1.5	2.8	6.5	<1	5.5	<1	13.1	<1	15.6	<0.5	16.7	<1	6.7	<1	4.7	<1	11	<1	1.9	<1	21.9	<1	4.3	1.9	6.2	<1	<LOR	5	1.1	16.2	2.2	23.6	<1
BH53_4.0-4.4	AECOM_BH53	6/03/2010	Declaration Area (Hickson Road)	108	<37.4	657	189	343	<37.4	275	<37.4	291	<37.4	-	<37.4	53.5	<37.4	-	<37.4	257	<37.4	12.1	<37.4	747	<37.4	344	50.4	49	<37.4	<LOR	4330	3600	1390	52.4	710	<37.4
BH40_17.8-18.0	AECOM_BH40	18/02/2010	Declaration Area (Proposed Southern Cove)	<0.5	28.4	<0.5	142	<0.5	25.6	<0.5	<1	<0.5	<0.5	-	<1	<0.5	<1	-	<1	<0.5	<1	<0.5	<1	<0.5	14.1	<0.5	146	<0.5	<1	<LOR	1.4	2540	0.8	134	<0.5	10.4
BH132_1.5-1.95	BH132	6/07/2006	Declaration Area (Proposed Southern Cove)	0.9	-	3.5	-	5.4	-	19.5	-	17.1	-	21.9	-	8.8	-	9	-	14.8	-	2.3	-	29.5	-	2	-	7.1	-	-	3.8	-	16.1	-	27.5	-
BH207/13.1	BH207	8/04/2008	Declaration Area (Proposed Southern Cove)	<0.5	11.7	2.4	37.2	2	12.6	1.8	<1	1.2	<0.5	1.3	<1	<0.5	<1	<0.5	<1	1.5	<1	<0.5	<1	3.5	8.9	2.4	35.8	<0.5	<1	<LOR	6.1	187	6.5	44.9	4.3	8.4
BH210/15.9	BH210	1/04/2008	Declaration Area (Proposed Southern Cove)	<0.5	<1	<0.5	2	<0.5	<1	<0.5	<1	<0.5	<0.5	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	1.8	<0.5	<1	<LOR	<0.5	9.6	<0.5	4.6	<0.5	<1
BH56_7.0-7.2	AECOM_BH56	4/03/2010	Declaration Area (Public Domain Blocks 4&5)	2.7	21.2	<0.5	<1	7.5	14.7	4.8	<1	3.2	<0.5	-	<1	1.3	<1	-	<1	4.2	<1	<0.5	<1	19.8	10	3.4	21.4	1.2	<1	<LOR	4.6	52.4	25.2	41.8	18	7.3
BH60_20.5-20.9	AECOM_BH60	2/03/2010	Declaration Area (Public Domain Blocks 4&5)	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<0.5	-	<1	<0.5	<1	-	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<0.5	<1	<LOR	<0.5	3.1	<0.5	2.2	<0.5	<1
BH73_17.5-17.7	AECOM_BH73	2/03/2010	Declaration Area (Public Domain Blocks 4&5)	-	14.1	-	51.6	-	19.3	-	<1.9	-	<1.9	-	<1.9	-	<1.9	-	<1.9	-	<1.9	-	<1.9	-	10.4	-	77.7	-	<1.9	<LOR	-	412	-	74.1	-	7.4

Notes:
MWQC = Marine Water Quality Criteria
Sources for the MWQC are provided in Table 27, Section 7.4 in the main report.
The leachate results presented for Chromium are screened against criteria for Chromium III as this analyte is determined to be the dominant species (of III and VI) based on groundwater results (see Section 7.4 of the main report for further discussion)

Field ID	Location Code	Sample Depth	Sampled Date	Monitoring Zone		Benzene	Benzene	Ethylbenzene	Ethylbenzene	Toluene	Toluene	Total Xylene	Total Xylene	Xylene (m & p)	Xylene (m & p)	Xylene (o)	Xylene (o)	Ammonia as N	Ammonia as N	Cyanide Total	Cyanide Total	Acenaphthene	Acenaphthene	Acenaphthylene	Acenaphthylene	Anthracene	Anthracene	Benz(a)anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(b)fluoranthene	Benzo(b)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzo(k)fluoranthene	Chrysene	Chrysene	Dibenz(a,h)anthracene	Dibenz(a,h)anthracene	Dibenzofuran	Dibenzofuran	Fluoranthene	Fluoranthene	Fluorene	Fluorene	Hexachlorophene	Indeno(1,2,3-c,d)pyrene	Indeno(1,2,3-c,d)pyrene	High MW PAHs (B(a)P TEF)	Naphthalene	Naphthalene
						Soil	Leach	Soil	Leach	Soil	Leach	Leach	Soil	Soil	Leach	Soil	Leach	Soil	Leach	Soil	Leach	Leach	Soil	Leach	Soil	Leach	Soil	Leach	Soil	Leach	Soil	Soil	Leach	Soil	Leach	Leach	Soil	Leach	Soil	Leach	Soil	Leach	Soil	Soil	Leach	Leach	Soil	Leach	Soil	Leach	Leach	Soil	Leach	Leach	Soil
						mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	µg/L	mg/kg	mg/kg	µg/L	mg/kg	µg/L	mg/kg	mg/L	mg/kg	mg/L	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	mg/kg	µg/L	mg/kg	µg/L	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	mg/kg	µg/L	µg/L	mg/kg	µg/L	mg/kg	µg/L	µg/L	mg/kg	µg/L	µg/L	mg/kg
EQL						0.2	1	0.5	2	0.5	2		0.15	0.5	2	0.5	2	20	0.01	1	0.004	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.05	0.5	1	0.1	0.5	0.1	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.5	2	0.1	0.5	0.1	0.5	0.1	0.1	0.5		0.1	0.5
MWQC							700		80		180	75			75		75		0.91		0.004	5.8		5.8		0.01				0.1															3.7	1		3					0.1	70	
BH406_10.0-10.3	BH406	10-10.3	8/02/2011	Block 4	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	0.9	-	<0.5	-	1	-	1.3	-	1.1	-	-	1.1	-	-	0.5	-	<0.5	-	1.1	-	<0.5	-	-	-	3.4	-	0.6	-	-	<0.5	-	-	<0.5
BH406_14.0-14.4	BH406	14-14.4	8/02/2011	Block 4	soil	3.8	-	2.6	-	1.6	-	-	6.7	4.4	-	2.3	-	-	-	-	-	-	31.3	-	33.5	-	68.2	-	77.5	-	50.8	-	-	49	-	-	19.1	-	22.9	-	55.4	-	5.1	-	-	-	200	-	57.2	-	-	17.9	-	-	76.7
BH406_15.0-15.4	BH406	15-15.4	8/02/2011	Block 4	soil	15.1	-	3.2	-	31	-	-	50	36.9	-	13.1	-	-	-	-	-	-	10	-	65.3	-	50.3	-	39.8	-	24.2	-	-	24.5	-	-	9.5	-	12.2	-	28.6	-	<4	-	-	-	94.8	-	58	-	-	8.4	-	-	401
QC602	BH406	15-15.4	8/02/2011	Block 4	soil	35.8	-	6.8	-	68.6	-	-	105.4	76.6	-	28.8	-	-	-	-	-	-	6.2	-	33.2	-	32.3	-	25.5	-	15.8	-	-	15	-	-	6.1	-	4.6	-	16.8	-	<4	-	-	-	61.2	-	30.3	-	-	5.2	-	-	236
BH406_16.0-16.5	BH406	16.000-16.500	9/02/2011	Block 4	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.9	-	456	-	29.7	-	<10	-	<5	-	-	<10	-	<10	<10	-	<10	-	<10	-	<10	-	-	-	13	-	163	-	<10	<10	-	<LOR	17,700	-
BH406_16.0-16.5	BH406	16-16.5	9/02/2011	Block 4	soil	85	-	10.9	-	140	-	-	171.8	126	-	45.8	-	-	-	-	-	-	34.3	-	231	-	162	-	114	-	78.1	-	-	92	-	-	29.4	-	26.5	-	93.7	-	7.5	-	-	-	323	-	220	-	-	26.6	-	-	1170
BH406_16.0-16.5	BH406	16-16.5	9/02/2011	Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH406_16.0-16.5	BH406	16-16.5	9/02/2011	Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH406_4.0-4.2	BH406	4-4.2	8/02/2011	Block 4	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	0.6	-	1.2	-	1.7	-	-	2.1	-	-	0.9	-	0.7	-	0.9	-	<0.5	-	-	-	2.7	-	<0.5	-	-	0.7	-	-	<0.5
BH406_7.0-7.4	BH406	7.000-7.400	8/02/2011	Block 4	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	139	-	<10	-	36.5	-	<10	-	<5	-	-	<10	-	<10	<10	-	<10	-	<10	-	<10	-	-	-	19	-	109	-	<10	<10	-	<LOR	2510	-
BH406_7.0-7.2	BH406	7-7.2	8/02/2011	Block 4	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	1.1	-	0.9	-	-	0.9	-	-	<0.5	-	<0.5	-	0.9	-	<0.5	-	-	-	2.6	-	<0.5	-	-	<0.5	-	-	<0.5
BH406_7.0-7.4	BH406	7-7.4	8/02/2011	Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH400_12.0-12.4	BH400	12-12.4	14/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	1.2	-	2.3	-	1.9	-	-	2.4	-	-	1	-	0.8	-	1.9	-	<0.5	-	-	-	5.4	-	<0.5	-	-	0.8	-	-	<0.5
BH400_13.2-13.4	BH400	13.2-13.4	14/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	0.9	-	<0.5	-	-	<0.5	-	-	<0.5
BH400_14.0-14.2	BH400	14-14.2	14/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	1.3	-	1.2	-	0.8	-	<0.5	-	-	0.6	-	-	<0.5	-	<0.5	-	0.6	-	<0.5	-	-	-	2	-	1.3	-	-	<0.5	-	-	6
BH400_15-15.4	BH400	15.000-15.400	14/02/2011	Block 5	ASLP	-	<1	-	<2	-	<5	<4	-	-	<2	-	<2	-	0.5	-	<0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-
BH400_15-15.4	BH400	15-15.4	14/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-
BH400_16.0-16.4	BH400	16-16.4	14/02/2011	Block 5	soil	40.3	-	11.2	-	99.4	-	-	116.1	78.2	-	37.9	-	-	-	-	-	-	26.2	-	215	-	78.4	-	46.1	-	26	-	-	26.7	-	-	7.6	-	8	-	35.3	-	2.2	-	-	-	111	-	156	-	-	6.8	-	-	734
BH400_6.0-6.4	BH400	6-6.4	11/02/2011	Block 5	soil	0.3	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	0.8	-	<0.5	-	-	<0.5	-	-	6.1
BH400_9.0-9.4	BH400	9-9.4	14/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	0.6	-	0.8	-	3.2	-	2.5	-	-	3.2	-	-	1.3	-	1.2	-	2.5	-	<0.5	-	-	-	10.3	-	<0.5	-	-	1	-	-	<0.5
BH401_10-10.4	BH401	10.000-10.400	10/02/2011	Block 5	ASLP	-	<1	-	<2	-	<5	<4	-	-	<2	-	<2	-	-	-	<0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH401_10-10.4	BH401	10-10.4	10/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-
BH401_11-11.4	BH401	11-11.4	10/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	1.2	-	1.8	-	1.6	-	-	1.8	-	-	1.2	-	0.7	-	1.5	-	<0.5	-	-	-	4.7	-	0.6	-	-	0.9	-	-	0.8
BH401_13-13.4	BH401	13-13.4	10/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	0.6	-	0.7	-	1.8	-	3.1	-	2.8	-	-	3.7	-	-	1.5	-	1.3	-	2.5	-	<0.5	-	-	-	7.5	-	1	-	-	1.2	-	-	<0.5
BH401_14-14.2	BH401	14-14.2	10/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	0.8	-	5.4	-	5.1	-	14.6	-	13.5	-	-	16.7	-	-	5.8	-	7.6	-	11	-	1.3	-	-	-	27.1	-	1.3	-	-	5.2	-	-	1.3
BH401_14-17.4	BH401	14-17.4	10/02/2011	Block 5	soil	0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH401_19.2-19.4	BH401	19.2-19.4	11/02/2011	Block 5	soil	1.4	-	0.7	-	5.9	-	-	10.1	7.2	-	2.9	-	-	-	-	-	-	5	-	30.9	-	19.5	-	12.9	-	8.5	-	-	10	-	-	2.8	-	3.5	-	9.8	-	0.7	-	-	-	28.4	-	26	-	-	2.6	-	-	120
BH401_20-20.15	BH401	20.000-20.150	11/02/2011	Block 5	ASLP	-	<1	-	<2	-	<5	<4	-	-	<2	-	<2	-	-	-	<0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH401_20-20.15	BH401	20-20.15	11/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-
BH401_3.0-3.4	BH401	3-3.4	10/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH401_5.0-5.4	BH401	5-5.4	10/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	0.8	-	1.3	-	1.2	-	-	1.6	-	-	0.6	-	0.5	-	1.1	-	<0.5	-	-	-	3.2	-	<0.5	-	-	<0.5	-	-	<0.5
BH401_9.0-9.4	BH401	9-9.4	10/02/2011	Block 5	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH402_11.0-11.2	BH402	11-11.2	9/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	0.9	-	<0.5	-	-	<0.5	-	-	<0.5
BH402_14.0-14.5	BH402	14-14.5	9/02/2011	Block 5	soil	6.2	-	1.5	-	15.7	-	-	27.8	20.4	-	7.4	-	-	-	-	-	-	4.3	-	28.4	-	24.8	-	16.7	-	11	-	-	10.5	-	-	4.6	-	4.3	-	11.9	-	<4	-	-	-	43.1	-	28.5	-	-	<4	-	-	168
BH402_15-15.5	BH402	15.000-15.500	9/02/2011	Block 5	ASLP	-	43	-	18	-	156	318	-	-	226	-	92	-	0.12	-	<0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	101	-	-	-	-	-	-	-	-	-	-
BH402_15-15.5	BH402	15-15.5	9/02/2011	Block 5	soil	3.7	-	2	-	8	-	-	29	19	-	10	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.1	-	-	-	-	-	-	-	-	-	-	-
BH402_16-16.3	BH402	16.000-16.300	10/02/2011	Block 5	ASLP	-	2	-	2	-	19	46	-	-	32	-	14	-	0.15	-	<0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	91	-	-	-	-	-	-	-	-	-	-
BH402_16-16.3	BH402	16-16.3	10/02/2011	Block 5	soil	0.8	-	1	-	6.4	-	-	14.9	10	-	4.9	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.3	-	-	-	-	-	-	-	-	-	-	-
QC607	BH402	17-17.4	10/02/2011	Block 5	soil	40	-	<5	-	87	-	-	116 - 120	80	-	36	-	-	-	-	-	-	13	-	110	-	84	-	61	-	55	77	-	-	-	-	23	-	-	-	48	-	2.4	-	-	-	160	-	120	-	-	19	-	-	1300
BH402_17.0-17.4	BH402	17-17.4	10/02/2011	Block 5	soil	63.4	-	9	-	127	-	-	174.1	128	-	46.1	-	-	-	-	-	-	27.7	-	220	-	158	-	93.3	-	69.6	-	-	65.2	-	-	30.4	-	23	-	73.8	-	7.4	-	-	-	278	-	169	-	-	24.8	-	-	957
QC606	BH402	17-17.4	10/02/2011	Block 5	soil	32	-	4.1	-	57.9	-	-	81.5	60	-	21.5	-	-	-	-	-	-	14.3	-	115	-	78.8	-	53.9	-	36.6	-	-	34.7	-	-	15.8	-	17	-	40.4	-	<4	-	-	-	145	-	89.2	-	-	12.8	-	-	457
BH402_19.1-19.4	BH402	19.1-19.4	10/02/2011	Block 5	soil	2.9	-	<0.5	-	3.3	-	-	3.6	2.6	-	1	-	-	-	-	-	-	<4	-	6.2	-	4.4	-	<4	-	<4	-	-	<4	-	-	<4	-	<4	-	<4	-	<4	-	-	-	7.7	-	5.1	-	-	<4	-	-	27.6
BH402_4.0-4.2	BH402	4-4.2	9/02/2011	Block 5	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH402_9.0-9.3	BH402	9-9.3	9/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	0.6	-	1.1	-	2.7	-	2.3	-	-	2.6	-	-	1.5	-	1.2	-	2.1	-	<0.5	-	-	-	4.6	-	<0.5	-	-	1.2	-	-	<0.5
BH403_10-10.4	BH403	10.000-10.400	9/02/2011	Block 5	ASLP	-	3500	-	166	-	4220	2699	-	-	1920	-	779	-	0.78	-	<0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	144	-	-	-	-	-	-	-	-	-	-
BH403_10-10.4	BH403	10-10.4	9/02/2011	Block 5	soil	83.7	-	20.6	-	202	-	-	411.3	318	-	93.3	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	222	-	-	-	-	-	-	-	-	-	-	-
BH403_12.0-12.4	BH403	12.000-12.400	9/02/2011	Block 5	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38.2	-	404	-	32.2	-	<1	-	<0.5	-	-	<1	-	<1	<1	-	<1	-	<1	-	<1	-	-	-	11.2	-	114	-	<1	<1	-	<LOR	11,300	-
BH403_12-12.4	BH403	12-12.4	9/02/2011	Block 5	soil	124	-	10.2	-	145	-	-	179.2	131	-	48.2	-	-	-	-	-	-	31.4	-	214	-	157	-	120	-	60.9	-	-	87.6	-	-	26.6	-	40	-	91.2	-	6.2	-	-	-	253	-	251	-	-	22.1	-	-	1160
BH403_12.0-12.4	BH403	12-12.4	9/02/2011	Block 5	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH403_12.0-12.4	BH403	12-12.4	9/02/2011	Block 5	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH403_15-15.4	BH403	15.000-15.400	9/02/2011	Block 5	ASLP	-	641	-	165	-	2180	2705	-	-	1900	-	805	-	0.14	-	<0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	139	-	-	-	-	-	-	-	-	-	-
BH403_15-15.4	BH403	15-15.4	9/02/2011	Block 5	soil	7	-	2.4	-	29.8	-	-	50	38.4	-	11.6	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	130	-	-	-	-	-	-	-	-	-	-	-
BH403_16-16.4	BH403	16-16.4	9/02/2011	Block 5	soil	60	-	8.7	-	117	-	-	157.3	116	-	41.3	-	-	-	-	-	-	31.9	-	200	-	170	-	115	-	68.4	-	-	93	-	-	25.5	-	34.2	-	86.4	-	6.8	-	-	-	280	-	192	-	-	22.6	-	-	941
BH403_17-17.3	BH403	17-17.3	9/02/2011	Block 5	soil	1.5	-	<0.5	-	2.9	-	-	4.4	3.3	-	1.1	-	-	-	-	-	-	12	-	57	-	58.6	-	39.7	-	27.2	-	-	30.6	-	-	9.7	-	13.6	-	29.1	-	<4	-	-	-	114	-	80.9	-	-	8.9	-	-	441
BH403_2.0-2.4	BH403	2-2.4	9/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	0.8	-	1.5	-	1	-	-	1	-	-	0.6	-	<0.5	-	1.3	-	<0.5	-	-	-	3.2	-	<0.5	-	-	<0.5	-	-	<0.5
BH403_4.0-4.4	BH403	4-4.4	9/02/2011	Block 5	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	6	-	<4	-	<4	-	<4	-	<4	-	-	<4	-	-	<4	-	<4	-	<4	-	<4	-	-	-	4.9	-	<4	-	-	<4	-	-	23.7
BH403_8.0-8.4	BH403	8.000-8.400	9/02/2011	Block 5	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18.4	-	10	-	5.4	-	0.6	-	0.35	-	-	0.3	-	0.2	0.2	-	0.2	-	0.6	-	<0.1	-	-	-	7.4	-	19.3	-	<0.1	0.1	-	0.578	46.1	-
BH403_8.0-8.4	BH403	8-8.4	9/02/2011	Block 5	soil	4.2	-	4.3	-	5	-	-	10.2	6.6	-	3.6	-	-	-	-	-	-	37.4	-	48.2	-	98	-	112	-	70.5	-	-	84.9	-	-	27.5	-	34.4	-	77.6	-	7.3	-	-	-	227	-	95	-	-	24.4	-	-	146
QC656	BH403	8-8.4	9/02/2011	Block 5	soil	3.5	-	2.4	-	0.9	-	-	3.1	1.9	-	1.2	-	-	-	-	-	-	6.6	-	20.2	-	19.8	-	46.8	-	36.8	-	-	41.7	-	-	18.6	-	18	-	34.3	-	4.1	-	-	-	96.9	-	8.7	-	-	14.6	-	-	8.3
BH403_8.0-8.4	BH403	8-8.4	9/02/2011	Block 5	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH403_8.0-8.4	BH403	8-8.4	9/02/2011	Block 5	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH407_12.0-12.18	BH407	12-12.18	14/02/2011	Proposed Southern Cove	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH407_14.0-14.5	BH407	14-14.5	14/02/2011	Proposed Southern Cove	soil	0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
QC610	BH407	14-14.5	14/02/2011	Proposed Southern Cove	soil	0.3	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH407_15.1-15.45	BH407	15.100-15.450	14/02/2011	Proposed Southern Cove	ASLP	-	<1	-	<2	-	<5	4	-	-	2	-	<2	-	0.2	-	<0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
BH407_15.1-15.45	BH407	15.1-15.45	14/02/2011	Proposed Southern Cove	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-
BH407_16.3-16.5	BH407	16.3-16.5	14/02/2011	Proposed Southern Cove	soil	0.4	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH407_17.4-17.6	BH407	17.4-17.6	14/02/2011	Proposed Southern Cove	soil	0.4	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH407_18.0-18.3	BH407	18-18.3	14/02/2011	Proposed Southern Cove	soil	1.2	-	<0.5	-	1.1	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH407_8.0-8.1	BH407	8-8.1	14/02/2011	Proposed Southern Cove	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH405_12.0-12.2	BH405	12-12.2	11/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH405_13.0-13.2	BH405	13-13.2	11/02/2011	VMP & PDA - Block 4	soil	0.7	-	0.6	-	0.6	-	-	4.3	3	-	1.3	-	-	-	-	-	-	11.2	-	45.2	-	40.9	-	30.2	-	21.6	-	-	25.7	-	-	7.5	-	14.3	-	23.6	-	2	-	-	-	72.9	-	46.5	-	-	7.6	-	-	208
BH405_14.0-14.4	BH405	14.000-14.400	11/02/2011	VMP & PDA - Block 4	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.2	-	381	-	29.7	-	<10	-	<5	-	-	<10	-	<10	<10	-	<10	-	<10	-	<10	-	-	-	13.1	-	157	-	<10	<10	-	<LOR	10,800	-
BH405_14.0-14.4	BH405	14-14.4	11/02/2011	VMP & PDA - Block 4	soil	5.9	-	4	-	33	-	-	76.6	57.2	-	19.4	-	-	-	-	-	-	44.9	-	221	-	182	-	130	-	86.2	-	-	96.3	-	-	49.1	-	44.5	-	93	-	10.3	-	-	-	301	-	236	-	-	42	-	-	1040
QC609	BH405	14-14.4	11/02/2011	VMP & PDA - Block 4	soil	0.6	-	<0.5	-	2.7	-	-	5.4	4	-	1.4	-	-	-	-	-	-	43.2	-	213	-	168	-	129	-	84.8	-	-	94.3	-	-	47.7	-	45.1	-	90.2	-	10.4	-	-	-	290	-	208	-	-	41.6	-	-	1010
BH405_14.0-14.4	BH405	14-14.4	11/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH405_4.0-4.3	BH405	4-4.3	10/02/2011	VMP & PDA - Block 4	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	0.9	-	1.2	-	5	-	5.9	-	-	8	-	-	2.6	-	2.4	-	5	-	<0.5	-	-	-	6.8	-	<0.5	-	-	2.2	-	-	<0.5
BH405_7.0-7.3	BH405	7.000-7.300	10/02/2011	VMP & PDA - Block 4	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	1.9	-	0.7	-	<0.1	-	<0.05	-	-	<0.1	-	<0.1	<0.1	-	<0.1	-	<0.1	-	<0.1	-	-	-	0.8	-	2	-	<0.1	<0.1	-	<LOR	13.9	-
BH405_7.0-7.3	BH405	7-7.3	10/02/2011	VMP & PDA - Block 4	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH405_7.0-7.3	BH405	7-7.3	10/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH405_7.0-7.3	BH405	7-7.3	10/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH408_2.0-2.4	BH408	2.000-2.400	14/02/2011	VMP & PDA - Block 4	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	3	-	0.8	-	<0.1	-	<0.05	-	-	<0.1	-	<0.1	<0.1	-	<0.1	-	<0.1	-	<0.1	-	-	-	1	-	2.1	-	<0.1	<0.1	-	<LOR	36.7	-
BH408_2.0-2.4	BH408	2-2.4	14/02/2011	VMP & PDA - Block 4	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	2.2	-	3.5	-	6.2	-	6.3	-	-	7.1	-	-	4.5	-	3.1	-	5.2	-	0.7	-	-	-	12.6	-	<0.5	-	-	3.6	-	-	<0.5
BH408_2.0-2.4	BH408	2-2.4	14/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH408_8.0-8.3	BH408	8-8.3	15/02/2011	VMP & PDA - Block 4	soil	0.6	-	0.7	-	<0.5	-	-	1.3	0.7	-	0.6	-	-	-	-	-	-	1.8	-	6.1	-	6.2	-	2.6	-	1.3	-	-	1.1	-	-	0.6	-	<0.5	-	1.9	-	<0.5	-	-	-	4.3	-	7	-	-	<0.5	-	-	13
BH408_9.0-9.4	BH408	9.000-9.400	15/02/2011	VMP & PDA - Block 4	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	2.9	-	0.2	-	<0.1	-	<0.05	-	-	<0.1	-	<0.1	<0.1	-	<0.1	-	<0.1	-	<0.1	-	-	-	<0.1	-	1.1	-	<0.1	<0.1	-	<LOR	23.7	-
BH408_9.0-9.4	BH408	9-9.4	15/02/2011	VMP & PDA - Block 4	soil	2.1	-	4.6	-	<0.5	-	-	8.9	5.1	-	3.8	-	-	-	-	-	-	4.2	-	22.9	-	12.5	-	9.7	-	5.6	-	-	4.6	-	-	2.6	-	2.3	-	7.6	-	0.6	-	-	-	14.5	-	16.6	-	-	2	-	-	89.8
QC613	BH408	9-9.4	15/02/2011	VMP & PDA - Block 4	soil	0.5	-	1	-	<0.5	-	-	2.2	1.2	-	1	-	-	-	-	-	-	1.1	-	6.6	-	3.9	-	2.5	-	1.4	-	-	1.1	-	-	0.6	-	0.5	-	1.9	-	<0.5	-	-	-	4.2	-	4.8	-	-	<0.5	-	-	23.8
BH408_9.0-9.4	BH408	9-9.4	15/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH409_3.7-4.0	BH409	3.700-4.000	14/02/2011	VMP & PDA - Block 4	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	-	1.4	-	1.2	-	0.1	-	<0.05	-	-	<0.1	-	<0.1	<0.1	-	<0.1	-	0.1	-	<0.1	-	-	-	1.2	-	3	-	<0.1	<0.1	-	<LOR	16.3	-
BH409_3.7-4.0	BH409	3.7-4	14/02/2011	VMP & PDA - Block 4	soil	<0.2	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	-	-	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5
BH409_3.7-4.0	BH409	3.7-4	14/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH409_3.7-4.0	BH409	3.7-4	14/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH409_5.0-5.3	BH409	5-5.3	14/02/2011	VMP & PDA - Block 4	soil	1.8	-	3.5	-	<0.5	-	-	2.9	1.1	-	1.8	-	-	-	-	-	-	5.6	-	2.8	-	1.9	-	0.6	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	1.2	-	2.2	-	-	<0.5	-	-	33.8
BH409_6.0-6.4	BH409	6.000-6.400	15/02/2011	VMP & PDA - Block 4	ASLP	-	2	-	6	-	<5	12	-	-	6	-	6	-	0.28	-	<0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
BH409_6.0-6.4	BH409	6-6.4	15/02/2011	VMP & PDA - Block 4	soil	0.3	-	<0.5	-	<0.5	-	-	<1	<0.5	-	<0.5	-	<20	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-
BH409_7.0-7.3	BH409	7.000-7.300	15/02/2011	VMP & PDA - Block 4	ASLP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.6	-	90.4	-	11.7	-	0.6	-	<0.05	-	-	<0.1	-	<0.1	<0.1	-	<0.1	-	0.5	-	<0.1	-	-	-	6	-	45.8	-	<0.1	<0.1	-	0.246	862	-
BH409_7.0-7.3	BH409	7-7.3	15/02/2011	VMP & PDA - Block 4	soil	2.8	-	3.5	-	22.3	-	-	26.7	17.8	-	8.9	-	-	-	-	-	-	<0.5	-	0.7	-	<0.5	-	<0.5	-	<0.5	-	-	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	<0.5	-	<0.5	-	-	<0.5	-	-	2.8
BH409_7.0-7.3	BH409	7-7.3	15/02/2011	VMP & PDA - Block 4	soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
MWQC = Marine Water Quality Criteria
Sources for the MWQC are provided in Table 27 in the main report.
The leachate results presented for Chromium are screened against criteria for Chromium III as this analyte is determined to be the dominant species (of III and VI) based on groundwater results (see Section 7.4 of the main report for further discussion)

Data Entry: CH
Data Review: AKL
AECOM

Field ID	Location Code	Sample Depth	Sampled Date	Monitoring Zone		Phenanthrene	Phenanthrene	Phenol	Phenol	Pyrene	Pyrene	TPH C10 - C14	TPH C10 - C14	TPH C15-C28	TPH C15-C36	TPH C29-C36	TPH C6 - C9	TPH C6 - C9	TPH+C10 - C36 (Sum of total)	TPH+C10 - C36 (Sum of total)
						Leach	Soil	Leach	Soil	Leach	Soil	Soil	Leach	Soil	Soil	Soil	Soil	Leach	Soil	Leach
						µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	mg/kg	µg/L	mg/kg	mg/kg	mg/kg	mg/kg	µg/L	mg/kg	µg/L
EQL						0.1	0.5	0.1	0.01	0.1	0.5	50	50	100		100	10	20	100	
MWQC						0.6		400		0.025			40					110		
BH406_10.0-10.3	BH406	10-10.3	8/02/2011	Block 4	soil	-	3.1	-		-	3.3	<50	-	150	250	<100	<10	-	150 - 300	-
BH406_14.0-14.4	BH406	14-14.4	8/02/2011	Block 4	soil	-	200	-		-	168	90	-	920	1320	400	30	-	1410	-
BH406_15.0-15.4	BH406	15-15.4	8/02/2011	Block 4	soil	-	153	-		-	80.4	1340	-	2720	3490	770	190	-	4830	-
QC602	BH406	15-15.4	8/02/2011	Block 4	soil	-	89.6	-		-	48.9	850	-	2020	2660	640	505	-	3510	-
BH406_16.0-16.5	BH406	16.000-16.500	9/02/2011	Block 4	ASLP	126	-	196		<10	-	-	-	-	-	-	-	-	-	-
BH406_16.0-16.5	BH406	16-16.5	9/02/2011	Block 4	soil	-	529	-	20.9	-	266	1940	-	3000	3900	900	861	-	5840	-
BH406_16.0-16.5	BH406	16-16.5	9/02/2011	Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH406_16.0-16.5	BH406	16-16.5	9/02/2011	Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH406_4.0-4.2	BH406	4-4.2	8/02/2011	Block 4	soil	-	1.5	-		-	7.2	<50	-	110	290	180	<10	-	290 - 340	-
BH406_7.0-7.4	BH406	7.000-7.400	8/02/2011	Block 4	ASLP	162	-	<10		17	-	-	-	-	-	-	-	-	-	-
BH406_7.0-7.2	BH406	7-7.2	8/02/2011	Block 4	soil	-	1	-		-	3	<50	-	140	240	<100	<10	-	140 - 290	-
BH406_7.0-7.4	BH406	7-7.4	8/02/2011	Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH400_12.0-12.4	BH400	12-12.4	14/02/2011	Block 5	soil	-	3.4	-		-	5.3	<50	-	<100	<200	<100	<10	-	<50	-
BH400_13.2-13.4	BH400	13.2-13.4	14/02/2011	Block 5	soil	-	0.5	-		-	0.9	<50	-	<100	<200	<100	<10	-	<50	-
BH400_14.0-14.2	BH400	14-14.2	14/02/2011	Block 5	soil	-	3.8	-		-	1.8	<50	-	<100	<200	<100	<10	-	<50	-
BH400_15-15.4	BH400	15.000-15.400	14/02/2011	Block 5	ASLP	-	-	-		-	-	-	360	-	-	-	-	<20	-	360
BH400_15-15.4	BH400	15-15.4	14/02/2011	Block 5	soil	-	-	-		-	-	<50	-	-	-	-	<10	-	<50	-
BH400_16.0-16.4	BH400	16-16.4	14/02/2011	Block 5	soil	-	363	-		-	150	3000	-	5600	6410	810	331	-	9410	-
BH400_6.0-6.4	BH400	6-6.4	11/02/2011	Block 5	soil	-	0.7	-		-	0.8	<50	-	<100	<200	<100	<10	-	<50	-
BH400_9.0-9.4	BH400	9-9.4	14/02/2011	Block 5	soil	-	1.4	-		-	9.4	<50	-	370	570	200	<10	-	570 - 620	-
BH401_10-10.4	BH401	10.000-10.400	10/02/2011	Block 5	ASLP	-	-	-		-	-	-	-	-	-	-	-	<20	-	-
BH401_10-10.4	BH401	10-10.4	10/02/2011	Block 5	soil	-	-	-		-	-	<50	-	-	-	-	<10	-	<50	-
BH401_11-11.4	BH401	11-11.4	10/02/2011	Block 5	soil	-	3.6	-		-	4.4	<50	-	<100	<200	<100	<10	-	<50	-
BH401_13-13.4	BH401	13-13.4	10/02/2011	Block 5	soil	-	6.3	-		-	7.1	<50	-	140	240	<100	<10	-	140 - 290	-
BH401_14-14.2	BH401	14-14.2	10/02/2011	Block 5	soil	-	9.5	-		-	30.2	<50	-	1720	2900	1180	<10	-	900 - 295	-
BH401_14-17.4	BH401	14-17.4	10/02/2011	Block 5	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH401_19.2-19.4	BH401	19.2-19.4	11/02/2011	Block 5	soil	-	61.3	-		-	28.5	470	-	970	1180	210	22	-	1650	-
BH401_20-20.15	BH401	20.000-20.150	11/02/2011	Block 5	ASLP	-	-	-		-	-	-	-	-	-	-	-	<20	-	-
BH401_20-20.15	BH401	20-20.15	11/02/2011	Block 5	soil	-	-	-		-	-	<50	-	-	-	-	<10	-	<50	-
BH401_3.0-3.4	BH401	3-3.4	10/02/2011	Block 5	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH401_5.0-5.4	BH401	5-5.4	10/02/2011	Block 5	soil	-	2.5	-		-	3	<50	-	130	250	120	<10	-	250 - 300	-
BH401_9.0-9.4	BH401	9-9.4	10/02/2011	Block 5	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH402_11.0-11.2	BH402	11-11.2	9/02/2011	Block 5	soil	-	0.5	-		-	0.9	<50	-	<100	<200	<100	<10	-	<50	-
BH402_14.0-14.5	BH402	14-14.5	9/02/2011	Block 5	soil	-	69.7	-		-	38.1	690	-	1560	2220	660	66	-	2910	-
BH402_15-15.5	BH402	15.000-15.500	9/02/2011	Block 5	ASLP	-	-	-		-	-	-	14,600	-	-	-	-	620	-	14,600
BH402_15-15.5	BH402	15-15.5	9/02/2011	Block 5	soil	-	-	-		-	-	740	-	-	-	-	67	-	740	-
BH402_16-16.3	BH402	16.000-16.300	10/02/2011	Block 5	ASLP	-	-	-		-	-	-	7620	-	-	-	-	70	-	7620
BH402_16-16.3	BH402	16-16.3	10/02/2011	Block 5	soil	-	-	-		-	-	150	-	-	-	-	35	-	150	-
QC607	BH402	17-17.4	10/02/2011	Block 5	soil	-	310	-		-	140	2000	-	3600	4600	1000	310	-	6600	-
BH402_17.0-17.4	BH402	17-17.4	10/02/2011	Block 5	soil	-	417	-		-	251	3060	-	4860	6330	1470	470	-	9390	-
QC606	BH402	17-17.4	10/02/2011	Block 5	soil	-	220	-		-	131	2350	-	4900	6400	1500	221	-	8750	-
BH402_19.1-19.4	BH402	19.1-19.4	10/02/2011	Block 5	soil	-	12.7	-		-	6.8	180	-	250	350	<100	15	-	430 - 530	-
BH402_4.0-4.2	BH402	4-4.2	9/02/2011	Block 5	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH402_9.0-9.3	BH402	9-9.3	9/02/2011	Block 5	soil	-	3.4	-		-	4.4	<50	-	650	860	210	<10	-	860 - 910	-
BH403_10-10.4	BH403	10.000-10.400	9/02/2011	Block 5	ASLP	-	-	-		-	-	-	113,000	-	-	-	-	13,900	-	113,000
BH403_10-10.4	BH403	10-10.4	9/02/2011	Block 5	soil	-	-	-		-	-	12,300	-	-	-	-	930	-	12,300	-
BH403_12.0-12.4	BH403	12.000-12.400	9/02/2011	Block 5	ASLP	117	-	3700		8.4	-	-	-	-	-	-	-	-	-	-
BH403_12-12.4	BH403	12-12.4	9/02/2011	Block 5	soil	-	480	-	616	-	214	7080	-	11,200	14,660	3460	651	-	700 - 21,7	-
BH403_12.0-12.4	BH403	12-12.4	9/02/2011	Block 5	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH403_12.0-12.4	BH403	12-12.4	9/02/2011	Block 5	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH403_15-15.4	BH403	15.000-15.400	9/02/2011	Block 5	ASLP	-	-	-		-	-	-	73,500	-	-	-	-	8620	-	73,500
BH403_15-15.4	BH403	15-15.4	9/02/2011	Block 5	soil	-	-	-		-	-	9340	-	-	-	-	95	-	9340	-
BH403_16-16.4	BH403	16-16.4	9/02/2011	Block 5	soil	-	420	-		-	248	5540	-	9740	12,640	2900	434	-	180 - 18,2	-
BH403_17-17.3	BH403	17-17.3	9/02/2011	Block 5	soil	-	160	-		-	92.4	1800	-	3290	4270	980	13	-	6070	-
BH403_2.0-2.4	BH403	2-2.4	9/02/2011	Block 5	soil	-	3	-		-	3.1	<50	-	<100	<200	<100	<10	-	<50	-
BH403_4.0-4.4	BH403	4-4.4	9/02/2011	Block 5	soil	-	7.8	-		-	<4	220	-	1340	3100	1760	<10	-	3320	-
BH403_8.0-8.4	BH403	8.000-8.400	9/02/2011	Block 5	ASLP	31.4	-	0.6		6.6	-	-	-	-	-	-	-	-	-	-
BH403_8.0-8.4	BH403	8-8.4	9/02/2011	Block 5	soil	-	267	-	2	-	186	1300	-	8870	12,470	3600	31	-	770 - 13,8	-
QC656	BH403	8-8.4	9/02/2011	Block 5	soil	-	49.9	-		-	114	320	-	5480	8400	2920	15	-	8720	-
BH403_8.0-8.4	BH403	8-8.4	9/02/2011	Block 5	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH403_8.0-8.4	BH403	8-8.4	9/02/2011	Block 5	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH407_12.0-12.18	BH407	12-12.18	14/02/2011	Proposed Southern Cove	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH407_14.0-14.5	BH407	14-14.5	14/02/2011	Proposed Southern Cove	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
QC610	BH407	14-14.5	14/02/2011	Proposed Southern Cove	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH407_15.1-15.45	BH407	15.100-15.450	14/02/2011	Proposed Southern Cove	ASLP	-	-	-		-	-	-	570	-	-	-	-	<20	-	570
BH407_15.1-15.45	BH407	15.1-15.45	14/02/2011	Proposed Southern Cove	soil	-	-	-		-	-	<50	-	-	-	-	<10	-	<50	-
BH407_16.3-16.5	BH407	16.3-16.5	14/02/2011	Proposed Southern Cove	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH407_17.4-17.6	BH407	17.4-17.6	14/02/2011	Proposed Southern Cove	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH407_18.0-18.3	BH407	18-18.3	14/02/2011	Proposed Southern Cove	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH407_8.0-8.1	BH407	8-8.1	14/02/2011	Proposed Southern Cove	soil	-	<0.5	-		-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH405_12.0-12.2	BH405	12-12.2	11/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH405_13.0-13.2	BH405	13-13.2	11/02/2011	VMP & PDA - Block 4	soil	-	130	-		-	63	510	-	1760	2320	560	<10	-	2830	-
BH405_14.0-14.4	BH405	14.000-14.400	11/02/2011	VMP & PDA - Block 4	ASLP	123	-	<10		<10	-	-	-	-	-	-	-	-	-	-
BH405_14.0-14.4	BH405	14-14.4	11/02/2011	VMP & PDA - Block 4	soil	-	470	-	<0.02	-	250	3390	-	7020	9030	2010	156	-	400 - 12,4	-
QC609	BH405	14-14.4	11/02/2011	VMP & PDA - Block 4	soil	-	456	-		-	239	3020	-	5950	7650	1700	10	-	670 - 10,7	-
BH405_14.0-14.4	BH405	14-14.4	11/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH405_4.0-4.3	BH405	4-4.3	10/02/2011	VMP & PDA - Block 4	soil	-	1.4	-		-	17.1	<50	-	400	1020	620	<10	-	020 - 107	-
BH405_7.0-7.3	BH405	7.000-7.300	10/02/2011	VMP & PDA - Block 4	ASLP	3.2	-	0.7		0.7	-	-	-	-	-	-	-	-	-	-
BH405_7.0-7.3	BH405	7-7.3	10/02/2011	VMP & PDA - Block 4	soil	-	<0.5	-	<0.01	-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH405_7.0-7.3	BH405	7-7.3	10/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH405_7.0-7.3	BH405	7-7.3	10/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH408_2.0-2.4	BH408	2.000-2.400	14/02/2011	VMP & PDA - Block 4	ASLP	3.2	-	0.8		0.9	-	-	-	-	-	-	-	-	-	-
BH408_2.0-2.4	BH408	2-2.4	14/02/2011	VMP & PDA - Block 4	soil	-	6.6	-	<0.01	-	12.9	<50	-	190	450	260	<10	-	450 - 500	-
BH408_2.0-2.4	BH408	2-2.4	14/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH408_8.0-8.3	BH408	8-8.3	15/02/2011	VMP & PDA - Block 4	soil	-	9.4	-		-	6.9	100	-	350	450	<100	<10	-	450 - 550	-
BH408_9.0-9.4	BH408	9.000-9.400	15/02/2011	VMP & PDA - Block 4	ASLP	1	-	<0.1		<0.1	-	-	-	-	-	-	-	-	-	-
BH408_9.0-9.4	BH408	9-9.4	15/02/2011	VMP & PDA - Block 4	soil	-	38.8	-	<0.05	-	18.3	360	-	710	860	150	24	-	1220	-
QC613	BH408	9-9.4	15/02/2011	VMP & PDA - Block 4	soil	-	11.7	-		-	5.2	110	-	260	360	<100	<10	-	370 - 470	-
BH408_9.0-9.4	BH408	9-9.4	15/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH409_3.7-4.0	BH409	3.700-4.000	14/02/2011	VMP & PDA - Block 4	ASLP	5.4	-	0.2		1.3	-	-	-	-	-	-	-	-	-	-
BH409_3.7-4.0	BH409	3.7-4	14/02/2011	VMP & PDA - Block 4	soil	-	<0.5	-	0.01	-	<0.5	<50	-	<100	<200	<100	<10	-	<50	-
BH409_3.7-4.0	BH409	3.7-4	14/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH409_3.7-4.0	BH409	3.7-4	14/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-
BH409_5.0-5.3	BH409	5-5.3	14/02/2011	VMP & PDA - Block 4	soil	-	6.8	-		-	1.8	150	-	180	280	<100	12	-	330 - 430	-
BH409_6.0-6.4	BH409	6.000-6.400	15/02/2011	VMP & PDA - Block 4	ASLP	-	-	-		-	-	-	370	-	-	-	-	<20	-	370
BH409_6.0-6.4	BH409	6-6.4	15/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	<50	-	-	-	-	<10	-	<50	-
BH409_7.0-7.3	BH409	7.000-7.300	15/02/2011	VMP & PDA - Block 4	ASLP	63	-	1.2		8.3	-	-	-	-	-	-	-	-	-	-
BH409_7.0-7.3	BH409	7-7.3	15/02/2011	VMP & PDA - Block 4	soil	-	1.1	-	<0.01	-	0.6	<50	-	<100	<200	<100	106	-	<50	-
BH409_7.0-7.3	BH409	7-7.3	15/02/2011	VMP & PDA - Block 4	soil	-	-	-		-	-	-	-	-	-	-	-	-	-	-

Notes:
MWQC = Marine Water Quality Criteria
Sources for the MWQC are provided in Table 27 in the main report.
The leachate results presented for Chromium are screened against criteria for Chromium III as this analyte is determined to be the dominant species (of III and VI) based on groundwater results (see Section 7.4 of the main report for further discussion)

This page has been left blank intentionally.

Appendix B

Figures

This page has been left blank intentionally.

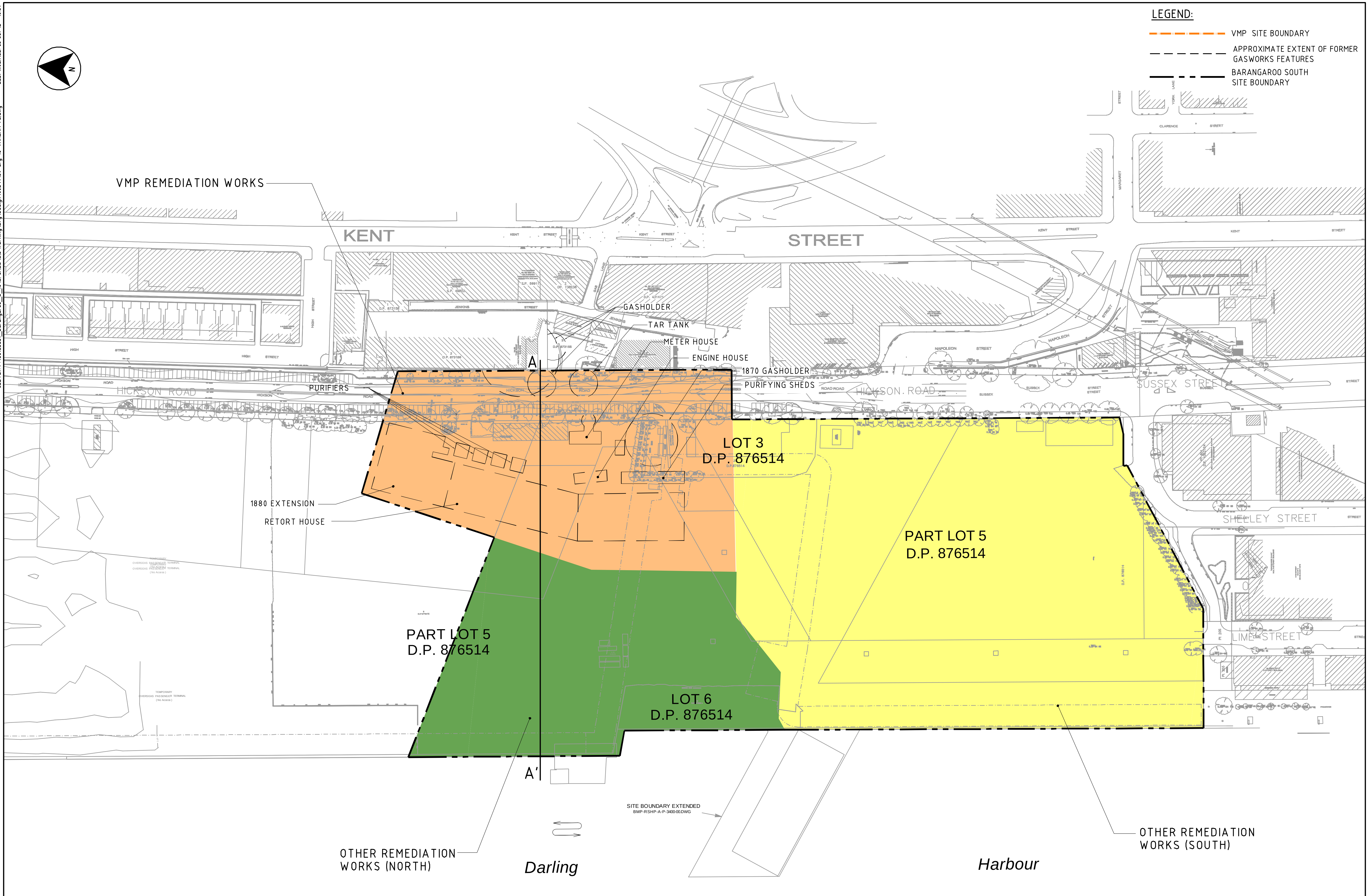
PROJECT ID:	60153531	AECOM
CREATED BY:	TO	
LAST MODIFIED:	TO 27 03 2012	www.aecom.com

0 600m

Site Location

Lend Lease (Millers Point) Pty Ltd
Human Health and Ecological Risk Assessment
Barangaroo
Hickson Road, Millers Point NSW

Figure
F1



Cad ref: P:\60153531_Barangaroo_S_JC\5. CADD\5.3 Working\Drg\Design\60247139-drg-10-VHHERA-F2.dwg

Last modified 03 Oct 12 - 16:51

This drawing is confidential and shall only be used for the purposes of this project.

REVISIONS

No.	BY	DATE	DESCRIPTION	APPD
01	SS	27.02.2012		GJS

SCALES:

10 0 10 20 30 40m

1 : 1000 FULL SIZE A1

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE AECOM QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	GW	CHECKED	CH/GJS
DRAWN	SS	CHECKED	JA
APPROVED	AKL	DATE	27.02.2012

DESIGNER:

AECOM

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

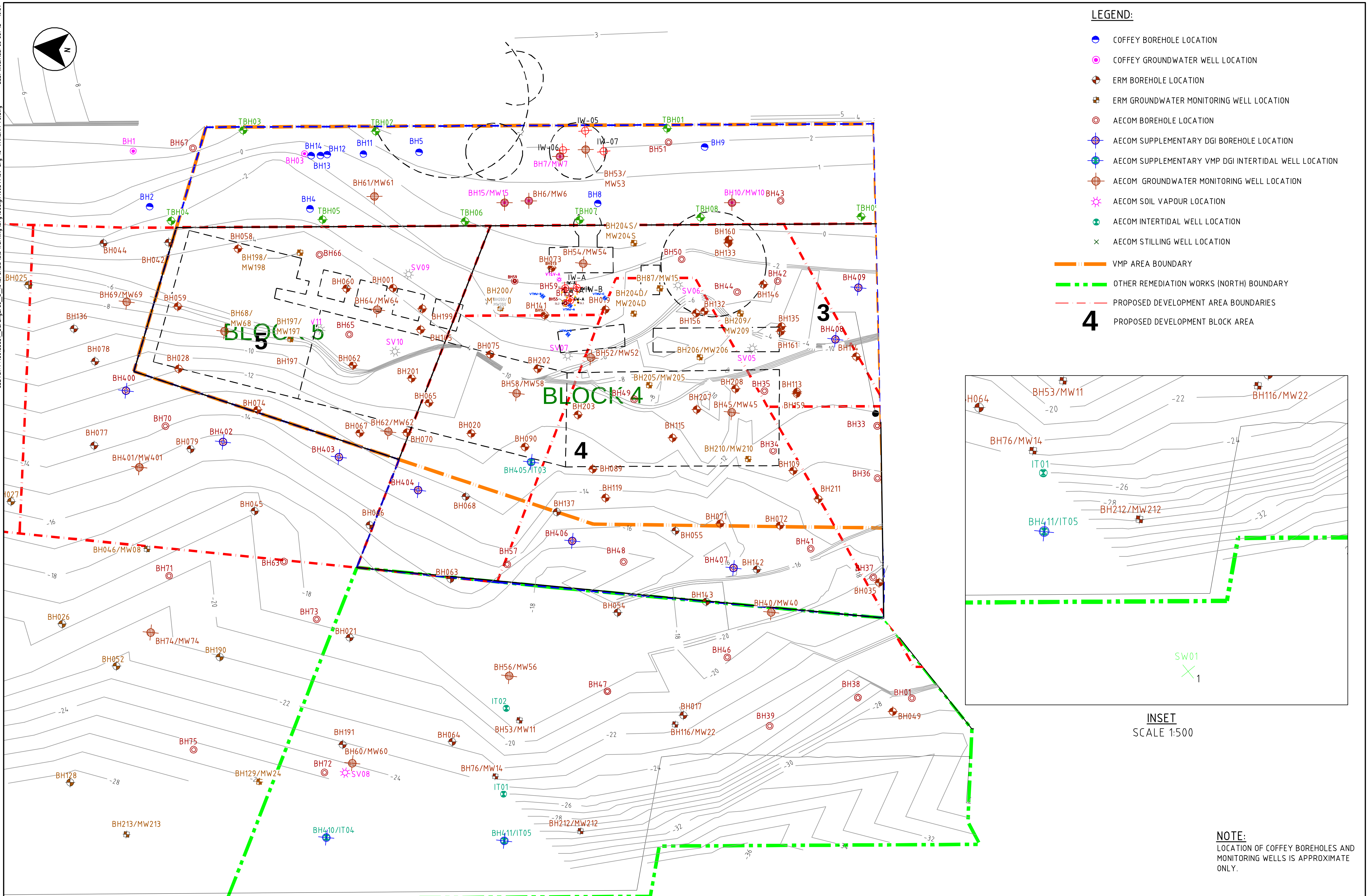
HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

FIGURE F2
SITE LAYOUT AND SURROUNDING AREA

STATUS: FINAL

DRAWING NO: 60247139-DRG-10-VHHERA-F2

REV: 01



Cad ref: P:\60153531_Barangaroo_S_IC\5. CADD\5.3 Working\Drg\Design\60247139-drg-10-VHHERA-F3.dwg Last modified: 03 Oct 12 - 16:51

This drawing is confidential and shall only be used for the purposes of this project.

REVISIONS				
01	SS	27.02.2012		AKL
No.	BY	DATE	DESCRIPTION	APPD

SCALES:
5000 0 5000 10000 15000mm
1:500 FULL SIZE A1

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE AECOM QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	GW	CHECKED	AKL
DRAWN	SS	CHECKED	JA
APPROVED	AKL	DATE	27.02.2012

DESIGNER:
AECOM
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

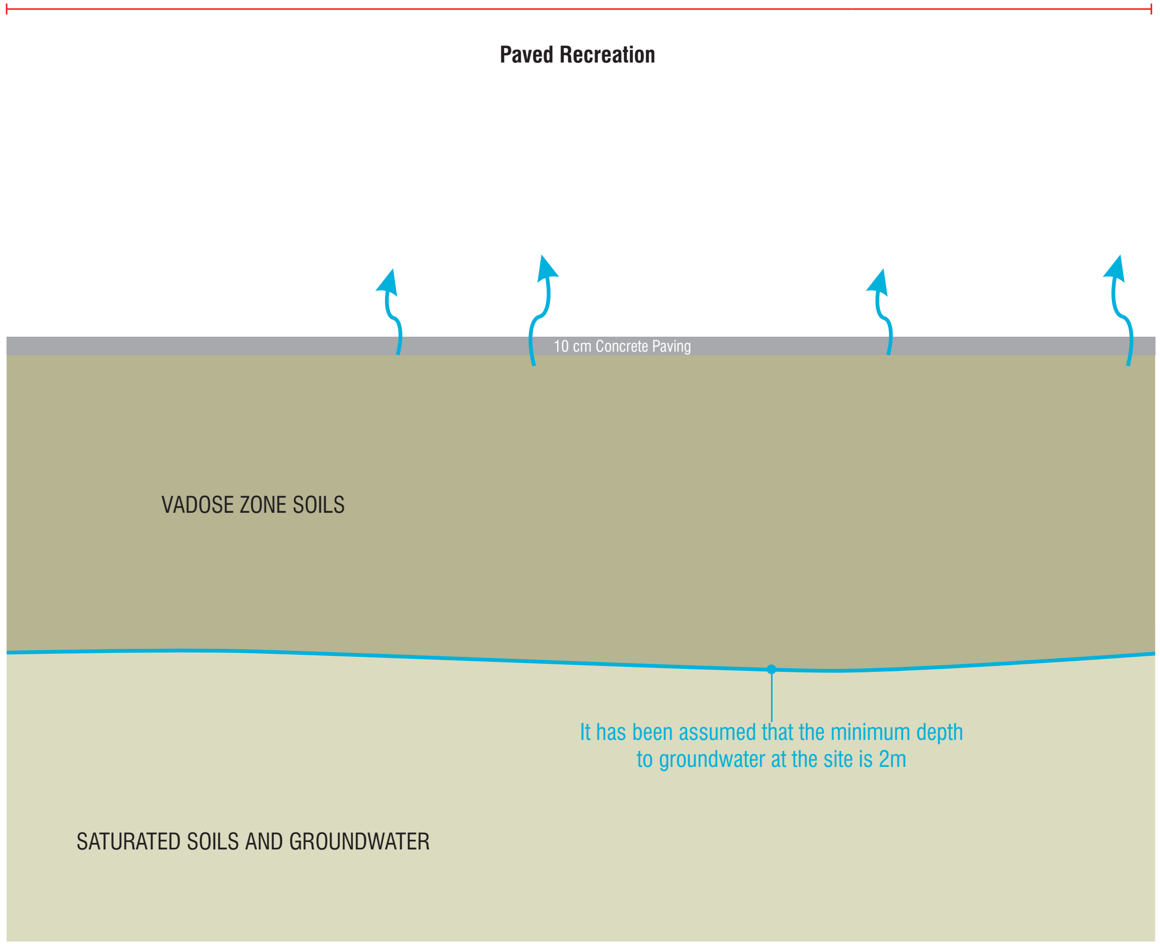
HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

FIGURE F3
SITE PLAN AND SAMPLING LOCATIONS

STATUS:	DRAWING No:	REV:
FINAL	60247139-DRG-10-VHHERA-F3	01

SCENARIO 1

Paved Recreation



PROJECT ID:	60153531
CREATED BY:	TO
LAST MODIFIED:	TO 27 03 2012

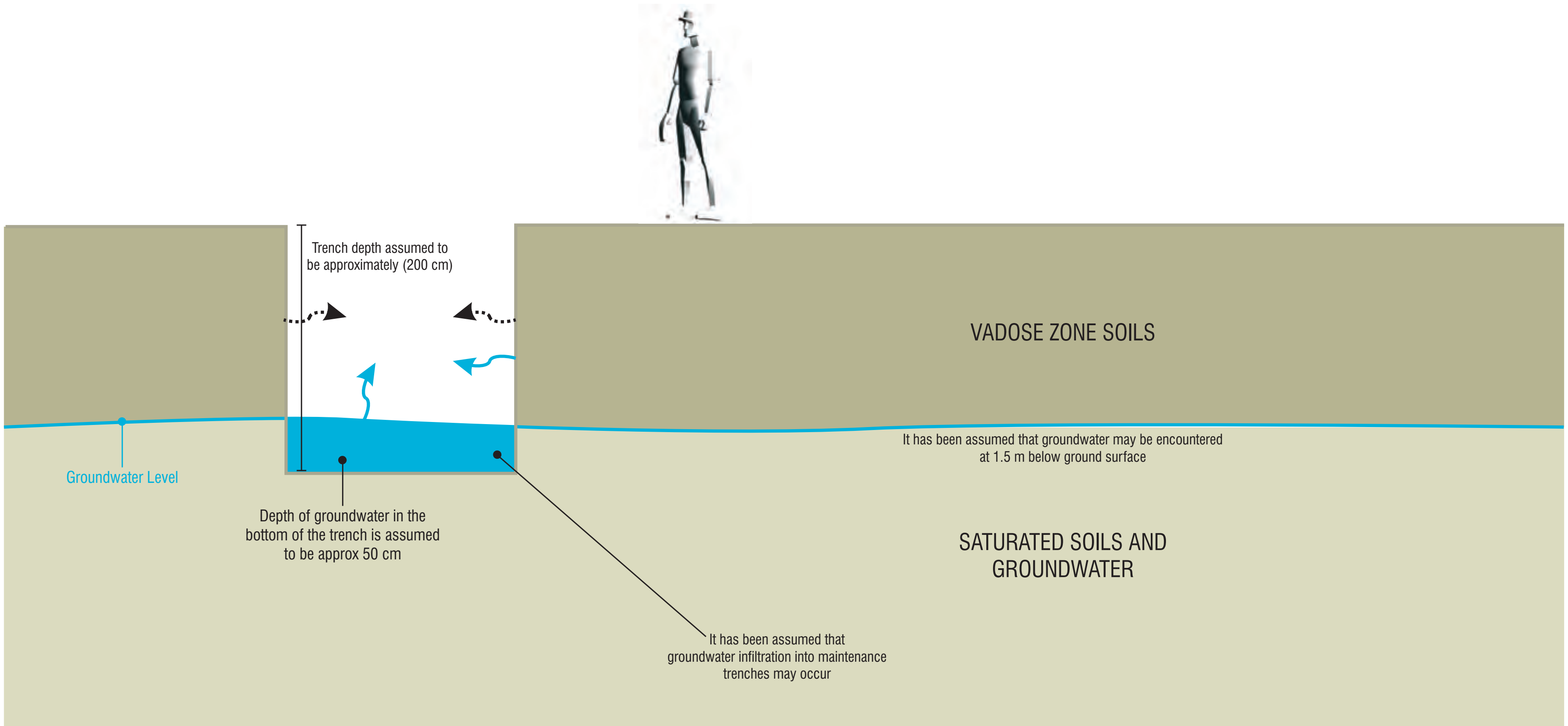
www.aecom.com

NOT TO SCALE

Conceptual Site Model - Scenario 1, (Paved Recreation)

Lend Lease (Millers Point) Pty Ltd
Human Health and Ecological Risk Assessment
Barangaroo
Hickson Road, Millers Point NSW

Figure
F4



PROJECT ID:	60153531
CREATED BY:	TO
LAST MODIFIED:	TO 27 03 2012

AECOM
www.aecom.com

NOT TO SCALE

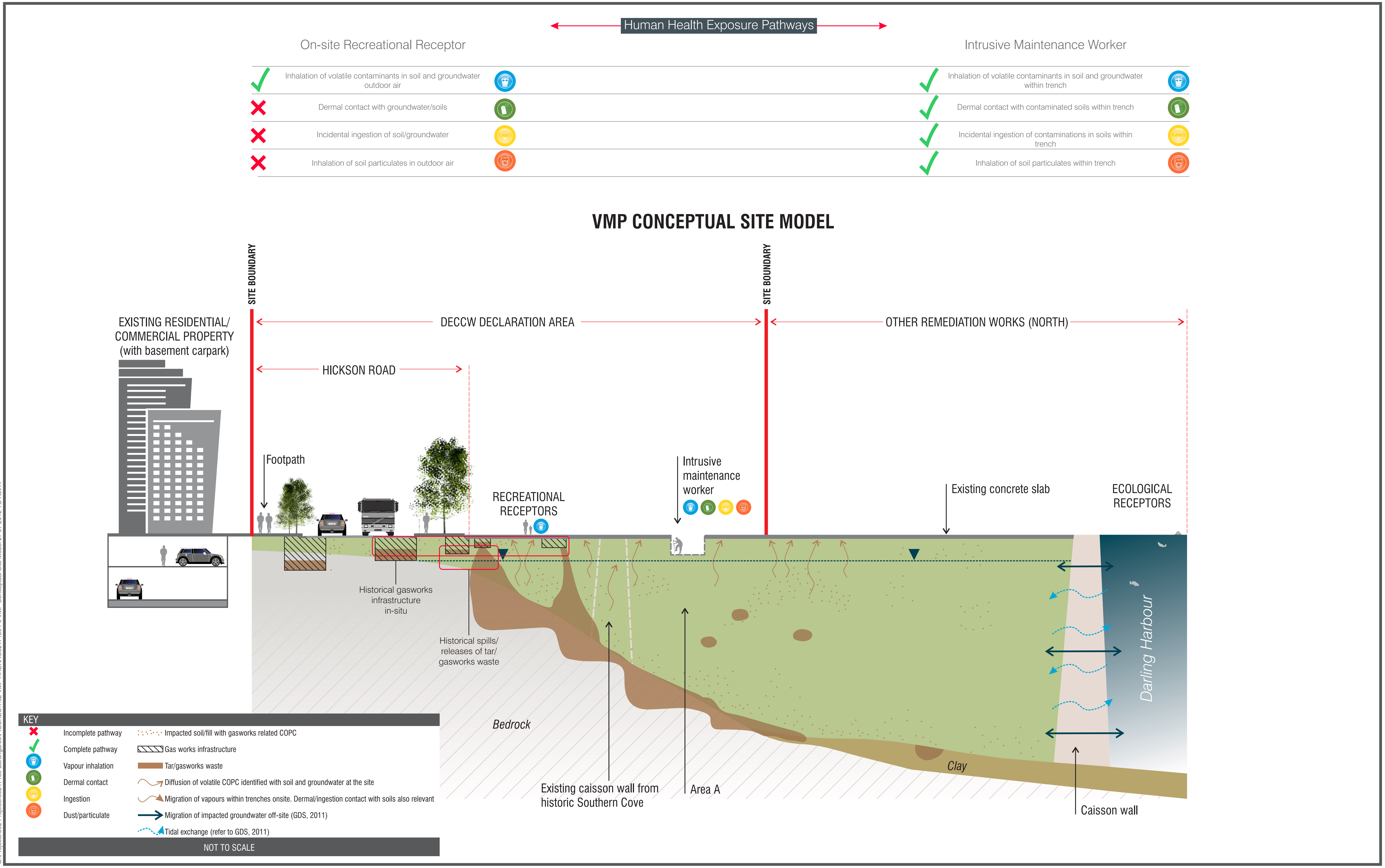
Dust generation during excavation

Vapour migration

Conceptual Site Model - Scenario 2 (Intrusive Maintenance)

Lend Lease (Millers Point) Pty Ltd
Human Health and Ecological Risk Assessment
Barangaroo
Hickson Road, Millers Point NSW

Figure
F5



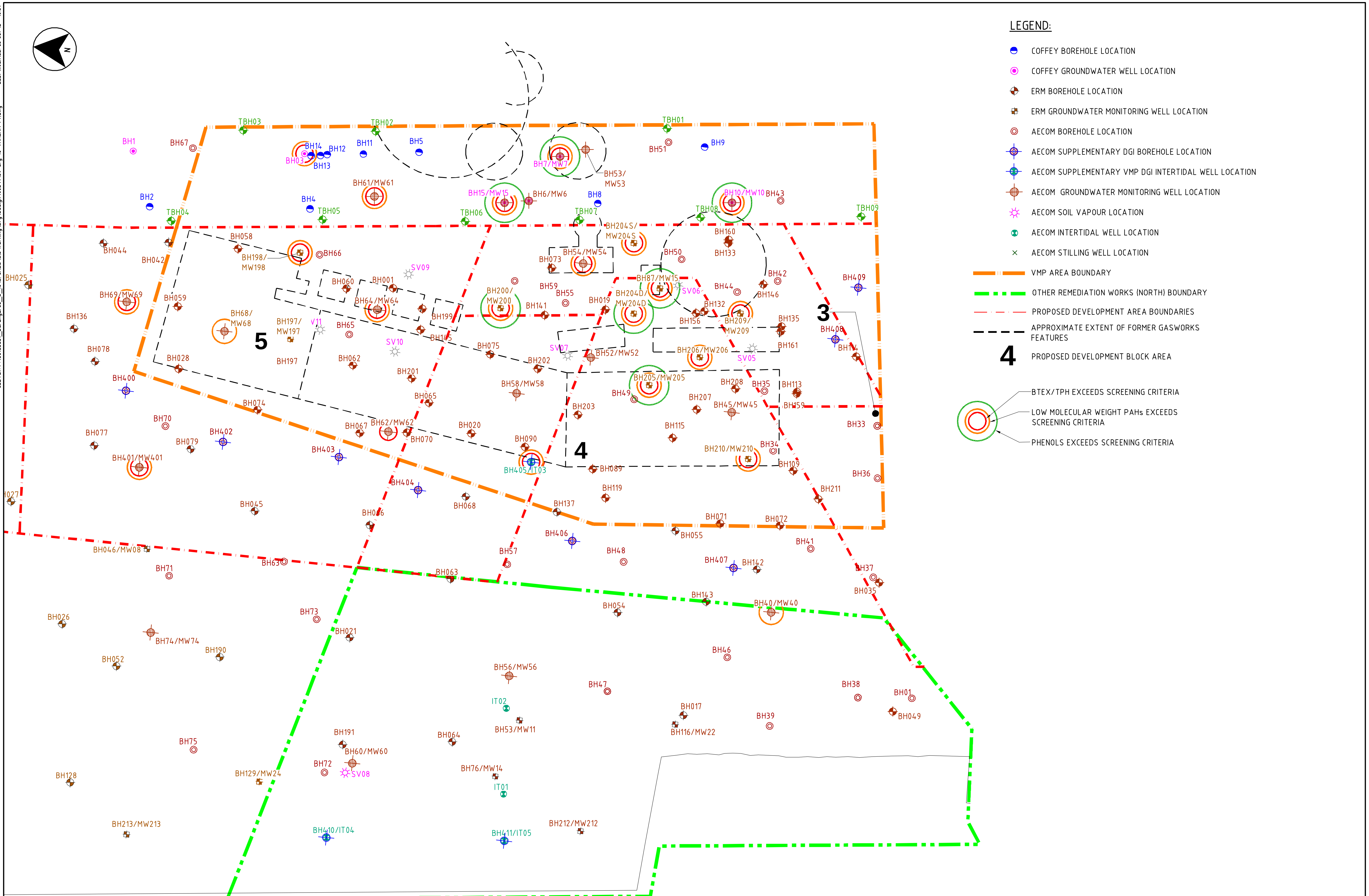
G:\Projects\602 Projects\60247139 Barangaroo\FIGURES\1.02 VMP HHERA\60247139 F6 VMP Conceptual Site Model 27 07 2012 TO Rev A

AECOM

CONCEPTUAL SITE MODEL

VMP Human Health and Ecological Risk Assessment
Barangaroo
Hickson Road, Millers Point NSW

FIGURE F6



This drawing is confidential and shall only be used for the purposes of this project.

No.	BY	DATE	DESCRIPTION	APPD
01	SS	27.07.2012		AKL

REVISIONS

SCALES: 5000 0 5000 10000 15000mm — 1:500 FULL SIZE A1

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE AECOM QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	GW	CHECKED	AKL
DRAWN	SS	CHECKED	JA
APPROVED	AKL	DATE	27.07.2012

DESIGNER:

AECOM

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

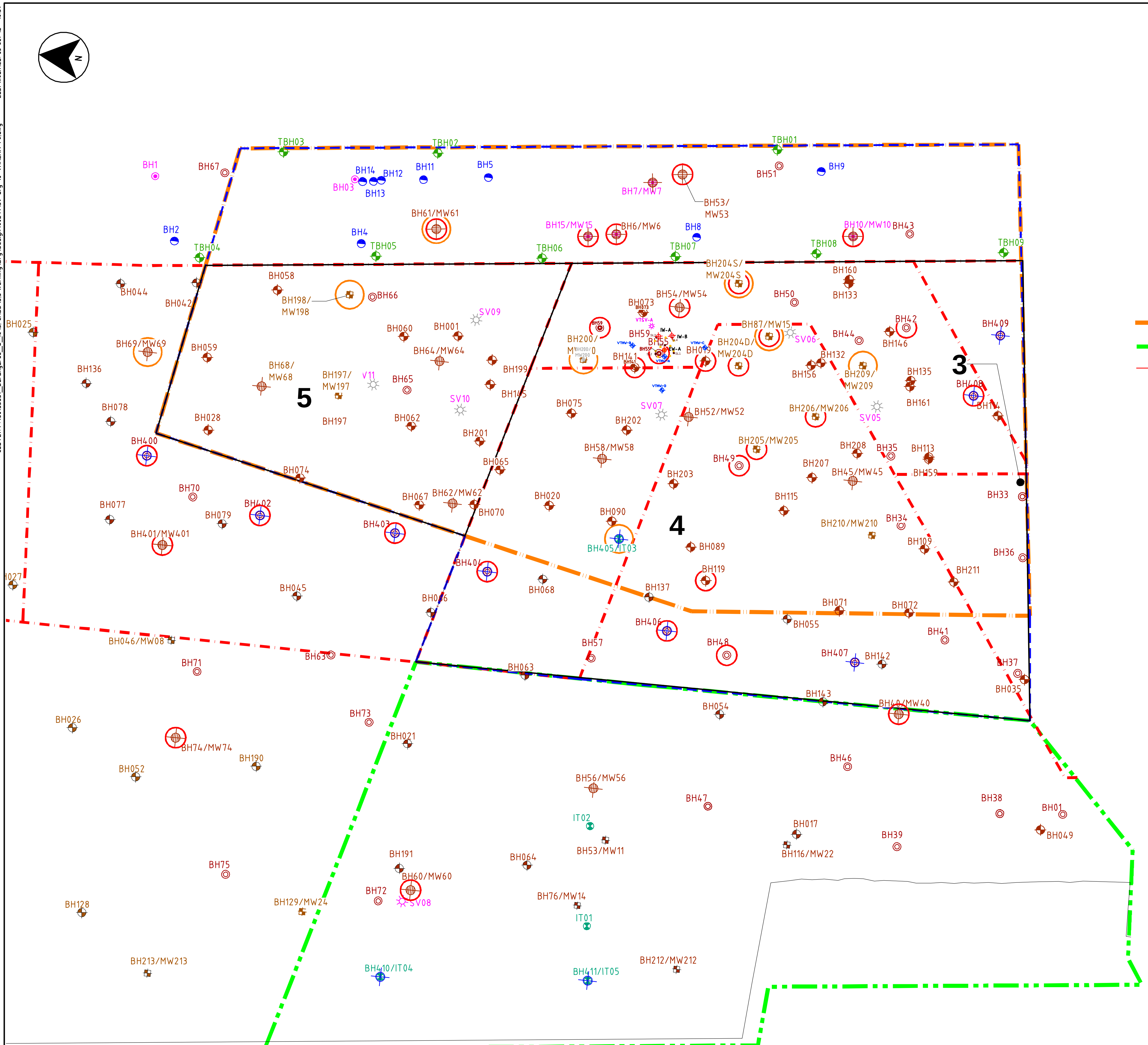
HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

FIGURE F7
ECOLOGICAL SCREEN – GROUNDWATER CoPC

STATUS: FINAL

DRAWING No: 60247139-DRG-10-VHHERA-F7

REV: 01



LEGEND:

- COFFEY BOREHOLE LOCATION
- COFFEY GROUNDWATER WELL LOCATION
- ERM BOREHOLE LOCATION
- ERM GROUNDWATER MONITORING WELL LOCATION
- AECOM BOREHOLE LOCATION
- AECOM SUPPLEMENTARY DGI BOREHOLE LOCATION
- AECOM SUPPLEMENTARY VMP DGI INTERTIDAL WELL LOCATION
- AECOM GROUNDWATER MONITORING WELL LOCATION
- AECOM SOIL VAPOUR LOCATION
- AECOM INTERTIDAL WELL LOCATION
- AECOM STILLING WELL LOCATION
- VMP AREA BOUNDARY
- OTHER REMEDIATION WORKS (NORTH) BOUNDARY
- PROPOSED DEVELOPMENT AREA BOUNDARIES
- 4 PROPOSED DEVELOPMENT BLOCK AREA

NOTE:

LOCATION OF COFFEY GROUNDWATER WELLS ARE APPROXIMATE ONLY.

PRESENCE OF TAR NOTED

PRESENCE OF SHEEN NOTED

This drawing is confidential and shall only be used for the purposes of this project.

REVISIONS				
01	SS	27.02.2012		AKL
No.	BY	DATE	DESCRIPTION	APPD

SCALES:

5000 0 5000 10000 15000mm

1:500 FULL SIZE A1

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE AECOM QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	GW	CHECKED	AKL
DRAWN	SS	CHECKED	JA
APPROVED	AKL	DATE	27.02.2012

DESIGNER:

AECOM

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

FIGURE F8
LOCATIONS OF NOTED GASWORKS IMPACTS

STATUS: FINAL

DRAWING No: 60247139-DRG-10-VHHERA-F8

REV: 01

Cad ref: P:\60153531_Barangaroo_S_(C\5 CADD\5.3 Working\Drg\Design\60247139-drg-10-VHHERA-F8.dwg

Last modified: 03 Oct 12 - 16:51

Appendix C

Vapour Model Algorithms

This page has been left blank intentionally.

Appendix C – Vapour Intrusion Model Algorithms

Vapour Emissions in Indoor Air

The algorithms used to predict indoor air vapour concentrations are those described by Johnson and Ettinger (1991). The algorithms estimate a unitless 'vapour attenuation coefficient' (α), which represents the ratio of the indoor vapour concentration (C_{indoor}) to the vapour concentration at the source (C_{source}) found at some depth (L_T) below a foundation. The attenuation coefficient is then used to calculate a volatilization factor (VF), which represents the ratio of concentration of vapour phase hydrocarbon in indoor air to that in the source media (soil, groundwater or PSH), i.e.:

$$VF = \frac{C_{vapour(m)}}{C_m}\alpha \qquad \textbf{\textit{Equation 1}}$$

where $C_{vapour(m)}$ indicates the vapour phase concentration at source media *m* (soil, groundwater and/or PSH), and C_m indicates the concentration in source media *m*.

The estimated air concentration is then given by:

$$C_{air(m)} = C_m VF \qquad \textbf{\textit{Equation 2}}$$

where $C_{air(m)}$ is the chemical concentration associated with vapours derived from media *m*.

Parameter definitions used in the equations below can be found in **Table 1**.

The attenuation coefficient, α, is estimated by:

$$\alpha = \frac{\left[\frac{D_T^{eff} A_B}{Q_B L_T}\right]\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff}\eta A_B}\right)}{\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff}\eta A_B}\right) + \left[\frac{D_T^{eff} A_B}{Q_B L_T}\right] + \left[\frac{D_T^{eff} A_B}{Q_{soil} L_T}\right]\left(\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff}\eta A_B}\right) - 1\right)} \qquad \textbf{\textit{Equation 3}}$$

where $\alpha = C_{indoor}/C_{source}$ and other parameters are as listed in **Table 1**.

Q_{soil} can be specified directly, or can be calculated using the following analytical solution of Nazaroff (1988):

$$Q_{soil} = \frac{2\pi\Delta P k_v X_{crack}}{\mu \ln(2Z_{crack}/r_{crack})} \qquad \textbf{\textit{Equation 4}}$$

Where r_{crack} is equal to:

$$r_{crack} = \eta(A_B / X_{crack}) \qquad \textbf{\textit{Equation 5}}$$

For cases where Q_{soil} is zero, the above equation simplifies to:

$$\alpha = \frac{\left[\frac{D_T^{eff} A_B}{Q_B L_T}\right]}{1 + \left[\frac{D_T^{eff} A_B}{Q_B L_T}\right] + \left[\frac{D_T^{eff} L_{crack}}{D_{crack}^{eff} L_T \eta}\right]}$$ ***Equation 6***

In the case of a groundwater source, the vapour phase concentration at the source ($C_{source(gw)}$) (mg/cm^3) is estimated by:

$$C_{source(gw)} = C_{gw} H \cdot 10^3 \frac{L}{m^3}$$ ***Equation 7***

If the dissolved phase concentration entered in the model exceeds the pure component aqueous solubility for the chemical, residual phase chemical is considered to be present in the groundwater sample, and the vapour phase concentration is limited to that in equilibrium with the aqueous solubility limit. In this case, the model calculates the vapour source term based on the chemical-specific aqueous solubility, rather than on the groundwater concentration entered in the model.

In the case of a soil source, the vapour phase concentration at the source ($C_{source(s)}$) in mg/m^3 is estimated by:

$$C_{source(s)} = C_{soil} \frac{H\rho_s}{\theta_{ws} + k_{oc} f_{oc} \rho_s + H\theta_{as}} 10^6 \frac{cm^3}{m^3} \frac{kg}{g}$$ ***Equation 8***

When calculating the vapour phase concentration in equilibrium with a soil source, the bulk soil concentration entered in the model is compared to the estimated concentration at which dissolved pore water and vapour phases become saturated (C_{sat}). Where the soil concentration is greater than C_{sat}, residual liquid phase chemical is considered to be present in the soil source area, and the vapour phase concentration is limited to that at C_{sat}. In this case, the model calculates the vapour source term based on C_{sat}, rather than on the bulk soil concentration entered in the model.

In the case of PSH, the vapour phase concentration at the source ($C_{source(P)}$) is estimated from weight fractions in the hydrocarbon source applying Raoult's law, as follows:

$$C_{source(P)} = \left(\frac{\frac{wt.frac._{i,L}}{MW_i}}{\frac{wt.frac._{i,L}}{MW_i} + \frac{(1 - wt.frac._{i,L})}{MW_T}} \right) \left(\frac{VP \cdot MW}{P_T MV} \right) 10^6 \frac{mg}{g} \frac{L}{m^3}$$ ***Equation 9***

For groundwater, L_T is equal to the thickness of the capillary fringe (h_{cap}) plus the thickness of the vadose zone (h_v). In practice, the thickness of the vadose zone for the groundwater to indoor air model is estimated based on reported depth to groundwater, less the assumed h_{cap} (typically obtained from literature sources). For soil, L_T is equal to the depth to the subsurface soil contamination source.

For a subsurface soil source, the effective vapour phase diffusion coefficient between the contaminated soil source and the building foundation ($D^{eff}_{T(s)}$) is estimated by:

$$D^{eff}_{T(s)} = D^{air} \frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^2}$$ **_Equation 10_**

For groundwater, the effective vapour phase diffusion coefficient between the groundwater source and the building foundation ($D^{eff}_{T(gw)}$) is estimated by:

$$D^{eff}_{T(gw)} = \frac{(h_{cap} + h_v)}{\frac{hcap}{D^{eff}_{cap}} + \frac{hv}{D^{eff}_s}}$$ **_Equation 11_**

with

$$D^{eff}_{cap} = D^{air} \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{wat} \frac{1}{H} \frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$ **_Equation 12_**

For both soil and groundwater sources, the effective diffusion through foundation cracks (D^{eff}_{crack}) is estimated by:

$$D^{eff}_{crack} = D^{air} \frac{\theta_{acrack}^{3.33}}{\theta_T^2} + D^{wat} \frac{1}{H} \frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$$ **_Equation 13_**

The algorithms used to predict outdoor vapour concentrations which may results from a surface soil, subsurface soil or groundwater source are those described by ASTM (2002; Table X2.5).

Vapour Emissions in Outdoor Air

The algorithm for groundwater to outdoor air vapour concentration is presented in Equation 14 below based on ASTM (2002):

$$VF_{wamb} = \frac{H}{1 + \left[\frac{U \cdot D \ \cdot L_T}{W \cdot D^{eff}_{T(gw)}} \right]} \cdot 10^3$$ **_Equation 14_**

Where $D^{eff}_{T(gw)}$ is the estimated groundwater diffusion coefficient in accordance with Equation 11.

The estimated outdoor air concentration is determined by Equation 2 above.

The algorithm for soil to outdoor air vapour concentration is presented in Equation 15 below based on ASTM (2002).

$$VF_{samb} = \frac{H \cdot \rho_s}{\left[\theta_{ws} + k_s \cdot \rho_s + H \cdot \theta_{as}\right]\left[1 + \frac{U_{air} \cdot D \cdot L_T}{D^{eff}_{T(s)} \cdot W}\right]}$$ ***Equation 15***

Where $D^{eff}_{T(s)}$ is estimated by Equation 10.

The estimated outdoor air concentration is determined by Equation 2 above.

Table 1 Vapour Model Parameter Definitions

Parameter/Symbol	Definition
A_B	surface area of the enclosed space in contact with soil (cm^2)
$C_{source(m)}$	vapour phase concentration at the media (*m*) source (mg/m^3)
$C_{source(gw)}$	vapour phase concentration at the groundwater source (mg/m^3)
$C_{source(s)}$	vapour phase concentration at the soil source (mg/m^3)
$C_{source(P)}$	vapour phase concentration at the PSH source (mg/m^3)
C_{soil}	Chemical concentration in bulk soil (mg/kg)
C_{gw}	Chemical concentration in groundwater (mg/L)
D^{air}	Chemical-specific diffusion coefficient in air (cm^2/s)
D^{wat}	Chemical-specific diffusion coefficient in water (cm^2/s)
$D^{eff}{}_{cap}$	effective overall vapour-phase diffusion coefficient through capillary fringe (cm^2/s)
$D^{eff}{}_{crack}$	effective overall vapour-phase diffusion coefficient through walls and foundation cracks (cm^2/s)
$D^{eff}{}_{T}$	effective overall vapour-phase diffusion coefficient in soil between the foundation and the depth L_T (cm^2/s)
E_B	Indoor air exchange rate with outdoor air (1/s)
f_{oc}	weight fraction of organic carbon in soil (unitless)
H or HL	unitless Henry's law constant
k_{oc}	Chemical-specific carbon-water sorption coefficient (cm^3/g)
k_v	soil vapour permeability (cm^2)
L_{crack}	the enclosed space foundation thickness (cm)
L_T	the distance (depth) to the vapour source or other point of interest below foundation (cm) (equal to h_{cap}+h_v for groundwater-derived vapour, or the depth of soil contamination for soil-derived vapour)
MV	gas molar volume (22.4 L/mole at standard temperature and pressure)
MW_i=	molecular weight of component *i*

Parameter/Symbol	Definition
MW_T	molecular weight of the total mixture
P_T	total pressure of system (assumed to be atmospheric pressure, or 760 mm Hg)
Q_B	the enclosed space volumetric air flow rate (cm^3/s) of fresh air; usually estimated to be the product of the enclosed space volume (V_B) and the indoor air exchange rate with outdoor air (E_B)
Q_{soil}	the pressure-driven soil gas flow rate from the subsurface into the enclosed space (cm^3/s)
V_B	Enclosed space volume (cm^3)
VP	Chemical specific vapour pressure of pure liquid chemical *i* (mm Hg)
$Wt.frac._{i,L}$	weight fraction of component *i* in the liquid (PSH) source
X_{crack}	Building perimeter (cm)
$X_{i,g}$	mole fraction of component *i* in the vapour phase
$X_{i,L}$	mole fraction of component *i* in the liquid (PSH) source
Z_{crack}	Depth to bottom of slab (cm)
ΔP	pressure differential between soil surface and the enclosed space (g/cm^2-s)
η	the fraction of the enclosed space surface area open for vapour intrusion (unitless), i.e., the areal fraction of cracks in the foundation/slab
μ	viscosity of air (1.81×10^{-4} g/cm-s)
ρ_s	soil bulk density (g/cm^3)
θ_{as}	volumetric air content in vadose zone soils (unitless)
θ_{ws}	volumetric water content in vadose zone soils (unitless)
θ_{ws}	volumetric water content in vadose zone soils (unitless)
θ_T	total soil porosity (unitless)
θ_{acap}	volumetric air content in capillary zone soils (unitless)
θ_{wcap}	volumetric water content in capillary zone soils (unitless)
θ_{acrack}	volumetric air content in foundation/wall cracks (unitless)
θ_{wcrack}	volumetric water content in foundation/wall cracks (unitless)
E	air emissions from the liquid surface (g/s)
VF	volatisation factor
VF_{wamb}	volatisation factor groundwater to ambient (outdoor air) vapours
VF_{samb}	voltisation factor surficial soils to ambient (outdoor air) vapours
K	overall mass transfer coefficient (m/s)
A	liquid surface area (m^2)

Parameter/Symbol	Definition
C_L	concentration of constituent in the liquid phase
U_{10}	windspeed at 10 m above the liquid surface (m/s)
D_w	diffusivity of constituent in water (cm2/^{s})
D_{ether}	diffusivity of ether in water (cm^2/s), adopted 8.5 x 10^{-5} cm^2/s
K	overall mass transfer coefficient (m/s)
k_L	liquid phase mass transfer coefficient (m/s)
k_G	gas phase mass transfer coefficient (m/s)
Keq	equilibrium constant or partition coefficient, concentration in gas phase/ concentration in liquid phase
K_s	soil-water sorption coefficient gH_2O/g soil
U	windspeed (m/s)
W	width of source area parallel to wind or groundwater flow direction (cm)
Sc_G	schmidt number on gas side
µG	viscosity of air (g/cm sec): 1.86 x 10^{-4}
ρ_G	density of air (g/cm^3): 1.29 x 10^{-3}
D	ambient air mixing height (cm)
D_a	diffusivity of constituent in air (cm^2/s)
D_e	effective diameter of impoundment
A	area of impoundment (m^2)
Q	volumetric flow rate (m^3/s)
C_i	initial concentration in waste (g/m^3)
C_L	equilibrium of bulk concentration in the impoundment (g/m^3)
K	overall mass transfer coefficient (m/s)
A	liquid surface area (m^2)
Vol_B	Volume of the basement (m^3)
Air $_{Exc}$	Air exchange rate in basement (exchanges per day)

References

ASTM, 2002. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.* ASTM International. E1739-95 (Reapproved 2002).

Johnson PC. and Ettinger RA. 1991. *Heuristic model for predicting the intrusion rate of contaminant vapors into buildings*. Environ. Sci. Technology. 25:1445-1452.

Nazaroff, W.W., 1988. *Predicting the rate of 222Rn entry from soil into the basement of dwelling due to pressure-driven air flow.* Radiation Protection Dosimetry. 24:199-202.

RAIS, 2008. *Risk Assessment Information System*. http://rais.ornl.gov. U.S. Department of Energy Office of Environmental Management, Oak Ridge Operations Office. Accessed August 2008.

US EPA, 1994. Air Emissions Models for Waste and Wastewater. EPA-453/R-94-080A. November 1994.

This page has been left blank intentionally.

Appendix D

Scenario 1 (Paved Recreation)

This page has been left blank intentionally.

AECOM

1. General Information:	
Site:	Barangaroo
Address:	Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Client:	Lend Lease
Scenario:	Scenario 1 - Paved Recreation (Risk Based Calculations)
Header Colour (Defaults = Blue):	

2. Select Receptor:
Recreational User

3. Select Exposure Pathways to Include:	
	Enter "x" in box, or select from dropdown box.
Soil Pathways	
	Incidental Ingestion of Soil
	Dermal Contact with Soil
	Inhalation of Surface Soil-Derived Dust in Indoor Air
	Inhalation of Surface Soil-Derived Dust in Outdoor Air
	Inhalation of Surface Soil-Derived Vapours in Outdoor Air
	Inhalation of Subsurface Soil-Derived Vapours in Indoor Air
x	Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air
Groundwater Pathways	
	Inhalation of Groundwater-Derived Vapours in Indoor Air
x	Inhalation of Groundwater-Derived Vapours in Outdoor Air
	Ingestion of Potable Groundwater
	Incidental Ingestion of Groundwater (Bathing or Excavation)
	Dermal Contact with Groundwater (Bathing or Excavation)
	Inhalation of Groundwater Vapours (Where GW Enters Trench)

Y	Soil RBSLs saturation limited?
Y	Groundwater RBSLs solubility limited?

4. Select Chemicals for Quantitative Assessment:	Target Hazard Index	Target Cancer Risk	5. Enter Chemical Concentrations (if only calculating RBSLs, enter 1):	
	default = 1 (or manually overwrite)	default = 1×10^{-5} (or manually overwrite)	**Soil (mg/kg)**	**Groundwater (mg/L)**
Acenaphthene	0.20	1.00E-05	270	4.4
Acenaphthylene	0.20	1.00E-05	1000	43
Ammonia	1	1.00E-05		348
Anthracene	0.20	1.00E-05	1200	15
Benz(a)anthracene	1	1.00E-05		
Benzene	**0.25**	1.00E-05	**61**	**41**
Benzo(a)pyrene	1	1.00E-05		
Benzo(b)fluoranthene	1	1.00E-05		
Benzo(g,h,i)perylene	1	1.00E-05		
Benzo(k)fluoranthene	1	1.00E-05		
Chrysene	1	1.00E-05		
Cyanide (CN-)	1	1.00E-05		
Dibenz(a,h)anthracene	1	1.00E-05		
Ethylbenzene	0.25	1.00E-05	8	3
Fluoranthene	0.20	1.00E-05	2100	
Fluorene	0.20	1.00E-05	1300	21
Indeno(1,2,3-cd)pyrene	1	1.00E-05		
Naphthalene	0.20	1.00E-05	8400	280
Phenanthrene	0.20	1.00E-05	3100	74
Phenol	1	1.00E-05		392
Pyrene	0.20	1.00E-05	1700	28
		Blank		
Toluene	**0.250**	1.00E-05	**69**	**18**
TPH C06-C09 aliphatic	**0.125**	1.00E-05	**230**	**74**
TPH C10-C14 aliphatic	**0.125**	1.00E-05	**54000**	**1730**
TPH C10-C14 aromatic	0.125	1.00E-05	542000	1730
TPH C15-C28 aliphatic	0.125	1.00E-05		
TPH C15-C28 aromatic	0.125	1.00E-05		
TPH C29-C36 aliphatic	0.125	1.00E-05		
TPH C29-C36 aromatic	0.25	1.00E-05		
Xylenes (total)	0.25	1.00E-05	94	6.7

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

6. Confirm/Modify Exposure Parameters:		Default Value		Site-Specific Value (leave blank to use default value)		Value Used in Calculations	
Link to Exposure Defaults and Sources		Adult	Child	Adult	Child	Adult	Child
General receptor parameters:	**Units**						
Body weight	kg	70	13	70	13	70	13
Exposure duration	yr	30	6	64	6	64	6
Averaging time (carcinogens)	yr	70	70	70	70	70	70
Averaging time (non-carcinogens)	yr	30	6	64	6	64	6
Incidental Soil Ingestion							
Daily soil ingestion rate	mg/day	25	100			25	100
Exposure frequency for soil ingestion	days/yr	350	350			350	350
Fraction of daily soil intake from site	unitless	0.5	0.5			0.5	0.5
Dermal Absorption of Soil							
Exposed skin surface area for soil contact	cm2	3600	2100			3600	2100
Soil to skin adherence factor	mg/cm2	0.5	0.5			0.5	0.5
Exposure frequency for dermal contact with soil	days/yr	350	350			350	350
Indoor Inhalation							
Exposure time (indoor air)	hrs/day	0	0			0	0
Exposure frequency (indoor air)	days/yr	350	350			350	350
Particulate emission factor (indoor air)	m3/kg	NA	NA			NA	NA
Outdoor Inhalation							
Exposure time (outdoor air)	hrs/day	2	2	2	2	2	2
Exposure frequency (outdoor air)	days/yr	350	350	365	365	365	365
Particulate emission factor (outdoor air)	m3/kg	1.36E+09	1.36E+09			1.36E+09	1.36E+09
Potable Water Ingestion							
Potable water intake rate	L/day	0	0			0	0
Exposure frequency for potable water intake	days/yr	350	350			350	350
Incidental Water Ingestion							
Incidental ingestion rate	L/day	NA	NA			NA	NA
Exposure frequency for incidental water ingestion	days/yr	350	350			350	350
Dermal Contact with Water							
Exposed skin surface for water contact	cm2	18150	6880			18150	6880
Exposure time for dermal water contact	hr/day	1	1			1	1
Exposure frequency for dermal water contact	days/yr	350	350			350	350

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Depth to groundwater (below building, ground surface or trench)	cm	300			LGW	200	Autocalculates from layer thicknesses
Vadose Zone Layer 1							
Thickness	cm	295		173	HV	173	Groundwater assumed to be at a depth of 2 m based on groundwater data for the Site.
SCS Soil Type:				Sand (<12% fines)			The soil type above groundwater across the site consists of fill (mostly sand and gravel), thus sand has conservatively been assumed as the main soil type in this scenario.
Fraction of organic carbon	unitless	0.01		0.002	OC	0.002	
Air-filled porosity (volumetric)	cm3/cm3	0.26		0.321	VACS	0.321	
Water-filled porosity (volumetric)	cm3/cm3	0.12		0.054	vwcvz	0.054	
Total soil porosity	cm3/cm3	0.38		0.375	TPOR	0.375	
Adjustment for vadose zone biodegradation	unitless	1		10	BioA_GW	10	Adjustment for biodegradation in unpaved areas; see text
Vadose Zone Layer 2 (lens)							
Thickness	cm			10	Hvtwo	10	Assumed thickness of concrete pavings in the public open space area.
SCS Soil Type:				User Specified (Enter values in 'Soil Data' worksheet)			Porosities for concrete have been assumed to be sand (multiplied by 1%).
Air-filled porosity (volumetric)	cm3/cm3	NA		0.00321	VACS2	0.00321	
Water-filled porosity (volumetric)	cm3/cm3	NA		0.00054	vwcvz2	0.00054	
Total soil porosity	cm3/cm3	NA		0.00375	TPOR2	0.00375	
Capillary Fringe							
SCS Soil Type (aquifer unit):				Sand (<12% fines)			As above
Thickness of capillary fringe	cm	5		17	hcap	17	
Volumetric air content in capillary fringe soils	cc/cc	0.038		0.122	VAC	0.122	
Volumetric water content in capillary fringe soils	cc/cc	0.342		0.253	vwccap	0.253	
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate	cm/s	225	(e)	378.3	windsp	378.3	Based on the average annual 9am and 3pm windspeeds measured at Observatory Point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site).
Width of source area parallel to wind or groundwater flow direction	cm	4500	(f)	4500	WSA	4500	Conservative default.
Ambient air mixing zone height	cm	200		200	AAMZH	200	Assumes vapours mixed within 2m of ground.

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) Conservative estimate of maximum expected velocity for a sandy or gravelly aquifer (50ft/day = 13 m/day)
(d) Assumes trench is 2 m long.
(e) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(f) For construction/excavation worker, default is 600 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.

AECOM

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

B. Chemical-Specific Fate and Transport Parameters

Chemical	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-H_2O / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	1.01E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	1.01E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	6.20E-03	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	3.28E+01	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	3.54E+02	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	2.92E-01	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	1.17E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	N
Benzo(b)fluoranthene	5.99E+05	1.20E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	N
Benzo(g,h,i)perylene	1.95E+06	3.90E+03	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	N
Benzo(k)fluoranthene	5.87E+05	1.17E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	N
Chrysene	1.81E+05	3.62E+02	2.14E-04	2.00E-03	2.48E-02	6.21E-06	2.28E+02	6.23E-09	N
Cyanide (CN-)	2.84E+00	5.68E-03	5.44E-03	1.00E+06	2.11E-01	2.46E-05	2.70E+01	7.42E+02	Y
Dibenz(a,h)anthracene	1.91E+06	3.82E+03	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	N
Ethylbenzene	4.46E+02	8.92E-01	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	1.11E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	N
Fluorene	9.16E+03	1.83E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	3.90E+03	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	N
Naphthalene	1.54E+03	3.08E+00	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	3.34E+01	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	3.74E-01	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	N
Pyrene	5.43E+04	1.09E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
Toluene	2.34E+02	4.68E-01	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	8.94E+00	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	1.10E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	6.04E+00	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	6.32E+05	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	N
TPH C15-C28 aromatic	3.79E+04	7.58E+01	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	N
TPH C29-C36 aliphatic	6.31E+08	1.26E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	N
TPH C29-C36 aromatic	1.26E+05	2.52E+02	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	N
Xylenes (total)	3.83E+02	7.66E-01	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Consta	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

AECOM

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

Chemical	D_{s1} (cm^2/s)	D_{s2}	D_{s3}	D_{stot}	D_{crack} (cm^2/s)	D_{cap} (cm^2/s)	D_{ws} (cm^2/s)	Convective Factor (unitless)
Acenaphthene	8.18E-03	1.79E-05	-	3.16E-04	3.96E-03	4.07E-04	3.22E-04	3.10E+01
Acenaphthylene	7.28E-03	1.59E-05	-	2.81E-04	3.52E-03	4.00E-04	2.88E-04	3.49E+01
Ammonia	3.69E-02	8.07E-05	-	1.42E-03	1.79E-02	2.69E-03	1.48E-03	6.86E+00
Anthracene	6.31E-03	1.38E-05	-	2.43E-04	3.06E-03	5.05E-04	2.54E-04	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Benzene	1.45E-02	3.17E-05	-	5.58E-04	6.98E-03	5.81E-04	5.60E-04	1.76E+01
Benzo(a)pyrene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Chrysene	NV	NV	NV	NV	NV	NV	NV	NV
Cyanide (CN-)	3.41E-02	7.46E-05	-	1.32E-03	1.65E-02	1.69E-03	1.34E-03	7.44E+00
Dibenz(a,h)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Ethylbenzene	1.11E-02	2.42E-05	-	4.27E-04	5.35E-03	4.44E-04	4.29E-04	2.30E+01
Fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Fluorene	7.11E-03	1.56E-05	-	2.74E-04	3.45E-03	4.31E-04	2.83E-04	3.56E+01
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	NV	NV	NV
Naphthalene	9.78E-03	2.14E-05	-	3.77E-04	4.72E-03	4.24E-04	3.81E-04	2.60E+01
Phenanthrene	5.58E-03	1.22E-05	-	2.15E-04	2.72E-03	5.05E-04	2.26E-04	4.52E+01
Phenol	NV	NV	NV	NV	NV	NV	NV	NV
Pyrene	4.50E-03	9.85E-06	-	1.74E-04	2.26E-03	1.27E-03	1.87E-04	5.43E+01
Toluene	1.26E-02	2.75E-05	-	4.85E-04	6.07E-03	5.04E-04	4.87E-04	2.02E+01
TPH C06-C09 aliphatic	1.62E-02	3.54E-05	-	6.24E-04	7.80E-03	6.45E-04	6.25E-04	1.57E+01
TPH C10-C14 aliphatic	1.62E-02	3.54E-05	-	6.24E-04	7.80E-03	6.45E-04	6.25E-04	1.57E+01
TPH C10-C14 aromatic	1.62E-02	3.54E-05	-	6.24E-04	7.80E-03	6.50E-04	6.26E-04	1.57E+01
TPH C15-C28 aliphatic	NV	NV	NV	NV	NV	NV	NV	NV
TPH C15-C28 aromatic	NV	NV	NV	NV	NV	NV	NV	NV
TPH C29-C36 aliphatic	NV	NV	NV	NV	NV	NV	NV	NV
TPH C29-C36 aromatic	NV	NV	NV	NV	NV	NV	NV	NV
Xylenes (total)	1.37E-02	3.00E-05	-	5.28E-04	6.61E-03	5.50E-04	5.30E-04	1.86E+01

Definition of Parameters

D_s Effective diffusion coefficient in soil based on vapor-phase concentration
D_{crack} Effective diffusion coefficient through foundation cracks
D_{cap} Effective diffusion coefficient through capillary fringe
D_{ws} Effective diffusion coefficient between groundwater and soil surface

Back to User Input Sheet

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

D. Chemical-Specific Volatilisation Factors

Chemical	VF_{wesp} (mg/m^3-air / mg/L-H_2O)	VF_{wamb} (mg/m^3-air / mg/L-H_2O)	VF_{trench} (mg/m^3-air / mg/L -water)
Acenaphthene	2.63E-04	7.19E-08	4.41E-06
Acenaphthylene	1.47E-04	3.99E-08	4.41E-06
Ammonia	7.92E-05	2.90E-08	4.41E-06
Anthracene	6.41E-05	1.72E-08	4.41E-06
Benz(a)anthracene	NV	NV	NV
Benzene	1.29E-02	3.78E-06	4.41E-06
Benzo(a)pyrene	NV	NV	NV
Benzo(b)fluoranthene	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV
Chrysene	NV	NV	NV
Cyanide (CN-)	6.12E-04	2.17E-07	4.41E-06
Dibenz(a,h)anthracene	NV	NV	NV
Ethylbenzene	1.46E-02	4.10E-06	4.41E-06
Fluoranthene	NV	NV	NV
Fluorene	1.22E-04	3.31E-08	4.41E-06
Indeno(1,2,3-cd)pyrene	NV	NV	NV
Naphthalene	7.33E-04	2.04E-07	4.41E-06
Phenanthrene	4.38E-05	1.16E-08	4.41E-06
Phenol	NV	NV	NV
Pyrene	1.03E-05	2.71E-09	4.41E-06
Toluene	1.37E-02	3.92E-06	4.41E-06
TPH C06-C09 aliphatic	3.15E+00	9.39E-04	4.41E-06
TPH C10-C14 aliphatic	3.91E+00	1.16E-03	4.41E-06
TPH C10-C14 aromatic	8.81E-03	2.62E-06	4.41E-06
TPH C15-C28 aliphatic	NV	NV	NV
TPH C15-C28 aromatic	NV	NV	NV
TPH C29-C36 aliphatic	NV	NV	NV
TPH C29-C36 aromatic	NV	NV	NV
Xylenes (total)	1.15E-02	3.34E-06	4.41E-06

Definition of Parameters

VF_{wesp1}	Volatilization factor from groundwater to enclosed-space vapors - no convective transport
VF_{wesp2}	Volatilization factor from groundwater to enclosed-space vapors - with convective transport
VF_{wamb}	Volatilization factor from groundwater to ambient (outdoor) vapors
VF_{trench}	Volatilisation factor from groundwater to trench air (where groundwater seeps into trench - this is mass limited value based on estimated rate of groundwater flow into trench)

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting Shell default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Lower depth of surficial soil zone	cm	100			LDSSZ	100	
Depth to subsurface soil sources (below building, ground surface or trench	cm	100			LS	10.01	Autocalculates from layer thicknesses
Vadose Zone Layer 1 (soil type where source is)							
Thickness	cm	100		0.01	HV	0.01	Assumes that contaminated soils are located directly below concrete pavings
SCS Soil Type:				Sand (<12% fines)			The majority of fill across the site has been identified as sand and gravel with some clay, therefore sand has been conservatively assumed in this scenario
Fraction of organic carbon	unitless	0.01		0.002	OC	0.002	
Soil bulk density	g/cm3	1.7		1.66	sbd	1.66	
Air-filled porosity (volumetric)	cm3/cm3	0.26		0.321	VACS	0.321	
Water-filled porosity (volumetric)	cm3/cm3	0.12		0.054	vwcvz	0.054	
Total soil porosity	cm3/cm3	0.38		0.375	TPOR	0.375	
Vapour phase source partitioning adjustment	unitless	1		10	VPPA	10	The vapour phase partitioning adjustment parameter has been applied to calculate the "volatilization factor from subsurface soils to ambient air" presented below. The parameter was applied to TPH and BTEX chemicals only.
Biodegradation adjustment	unitless	1		10	BioA	10	Adjustment for assumed presence of oxygen (and associated biodegradation of vapours) in unpaved areas. Factor of 10 is considered conservative as it is at lower end of ranges suggested by Davis et al. (2009) and CCME (2008a).
Vadose Zone Layer 2 (lens)							
Thickness	cm			10	Hvtwo	10	Assumed thickness of concrete pavings in the public open space area
SCS Soil Type:				User Specified (Enter values in 'Soil Data' worksheet)			Porosities for concrete have been assumed to be sand (multiplied by 1%)
Air-filled porosity (volumetric)	cm3/cm3	NA		0.00321	VACS2	0.00321	
Water-filled porosity (volumetric)	cm3/cm3	NA		0.00054	vwcvz2	0.00054	
Total soil porosity	cm3/cm3	NA		0.00375	TPOR2	0.00375	
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate)	cm/s	225	(c)	378.3	windsp	378.3	Based on the average annual 9am and 3pm windspeeds measured at observatory point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site).
Width of source area parallel to wind or groundwater flow direction	cm	4500	(d)	4500	WSA	4500	Conservative default.
Ambient air mixing zone height	cm	200		200	AAMZH	200	Assumes vapours mixed within 2m of ground.
Other							
Averaging time for surface emission vapour flux	sec	1.89E+08	(e)		atvapor	1.89E+08	Defaults to receptor exposure duration

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(d) For construction/excavation worker, default is 400 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.
(e) Equals exposure duration for selected receptor. For residential scenario, shortest (child) exposure duration is selected for conservative purposes.

AECOM

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

B. Chemical-Specific Fate and Transport Parameters

CHEMICAL	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-$H_2$0 / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	1.01E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	1.01E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	6.20E-03	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	3.28E+01	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	3.54E+02	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	2.92E-01	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	1.17E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	N
Benzo(b)fluoranthene	5.99E+05	1.20E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	N
Benzo(g,h,i)perylene	1.95E+06	3.90E+03	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	N
Benzo(k)fluoranthene	5.87E+05	1.17E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	N
Chrysene	1.81E+05	3.62E+02	2.14E-04	2.00E-03	2.48E-02	6.21E-06	2.28E+02	6.23E-09	N
Cyanide (CN-)	2.84E+00	5.68E-03	5.44E-03	1.00E+06	2.11E-01	2.46E-05	2.70E+01	7.42E+02	Y
Dibenz(a,h)anthracene	1.91E+06	3.82E+03	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	N
Ethylbenzene	4.46E+02	8.92E-01	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	1.11E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	N
Fluorene	9.16E+03	1.83E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	3.90E+03	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	N
Naphthalene	1.54E+03	3.08E+00	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	3.34E+01	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	3.74E-01	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	N
Pyrene	5.43E+04	1.09E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
Toluene	2.34E+02	4.68E-01	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	8.94E+00	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	1.10E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	6.04E+00	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	6.32E+05	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	N
TPH C15-C28 aromatic	3.79E+04	7.58E+01	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	N
TPH C29-C36 aliphatic	6.31E+08	1.26E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	N
TPH C29-C36 aromatic	1.26E+05	2.52E+02	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	N
Xylenes (total)	3.83E+02	7.66E-01	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Constant	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

CHEMICAL	D_{s1}	D_{s2}	D_{s3}	D_{stot}	D_{crack}	Csat	Convective
	(cm^2/s)				(cm^2/s)	mg/kg	Factor (unitless)
Acenaphthene	8.18E-03	1.79E-05	-	1.79E-05	3.96E-03	3.94E+01	3.10E+01
Acenaphthylene	7.28E-03	1.59E-05	-	1.59E-05	3.52E-03	1.63E+02	3.49E+01
Ammonia	3.69E-02	8.07E-05	-	8.07E-05	1.79E-02	1.87E+04	6.86E+00
Anthracene	6.31E-03	1.38E-05	-	1.38E-05	3.06E-03	1.42E+00	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	3.33E+00	NV
Benzene	1.45E-02	3.17E-05	-	3.17E-05	6.98E-03	6.59E+02	1.76E+01
Benzo(a)pyrene	NV	NV	NV	NV	NV	1.90E+00	NV
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	1.80E+00	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	1.01E+00	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	9.39E-01	NV
Chrysene	NV	NV	NV	NV	NV	7.24E-01	NV
Cyanide (CN-)	3.41E-02	7.46E-05	-	7.47E-05	1.65E-02	3.93E+04	7.44E+00
Dibenz(a,h)anthracene	NV	NV	NV	NV	NV	9.51E+00	NV
Ethylbenzene	1.11E-02	2.42E-05	-	2.43E-05	5.35E-03	1.67E+02	2.30E+01
Fluoranthene	NV	NV	NV	NV	NV	2.89E+01	NV
Fluorene	7.11E-03	1.56E-05	-	1.56E-05	3.45E-03	3.10E+01	3.56E+01
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	7.41E-01	NV
Naphthalene	9.78E-03	2.14E-05	-	2.14E-05	4.72E-03	9.66E+01	2.60E+01
Phenanthrene	5.58E-03	1.22E-05	-	1.22E-05	2.72E-03	3.84E+01	4.52E+01
Phenol	NV	NV	NV	NV	NV	3.37E+04	NV
Pyrene	4.50E-03	9.85E-06	-	9.86E-06	2.26E-03	1.47E+01	5.43E+01
Toluene	1.26E-02	2.75E-05	-	2.75E-05	6.07E-03	2.91E+02	2.02E+01
TPH C06-C09 aliphatic	1.62E-02	3.54E-05	-	3.54E-05	7.80E-03	2.21E+02	1.57E+01
TPH C10-C14 aliphatic	1.62E-02	3.54E-05	-	3.54E-05	7.80E-03	1.11E+02	1.57E+01
TPH C10-C14 aromatic	1.62E-02	3.54E-05	-	3.54E-05	7.80E-03	1.54E+02	1.57E+01
TPH C15-C28 aliphatic	NV	NV	NV	NV	NV	7.02E+01	NV
TPH C15-C28 aromatic	NV	NV	NV	NV	NV	8.04E+01	NV
TPH C29-C36 aliphatic	NV	NV	NV	NV	NV	3.16E+00	NV
TPH C29-C36 aromatic	NV	NV	NV	NV	NV	1.66E+00	NV
Xylenes (total)	1.37E-02	3.00E-05	-	3.00E-05	6.61E-03	8.90E+00	1.86E+01

Definition of Parameters

D_s Effective diffusion coefficient in soil based on vapor-phase concentration
D_{crack} Effective diffusion coefficient through foundation cracks
C_{sat} Soil concentration at which dissolved pore-water and vapor phases become saturated

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

D. Chemical-Specific Volatilisation Factors

CHEMICAL	VF_{as1}	VF_{as2}	$VF_{p\ (indoor)}$	$VF_{p\ (outdoor)}$	VF_{samb}	VF_{sesp}
	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	m^3-air / mg/kg-	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)
Acenaphthene	7.26E-08	5.22E-05	-	7.35E-10	7.93E-09	2.87E-06
Acenaphthylene	5.39E-08	5.22E-05	-	7.35E-10	4.37E-09	1.60E-06
Ammonia	7.35E-07	5.22E-05	-	7.35E-10	8.12E-07	2.16E-04
Anthracene	1.94E-08	5.22E-05	-	7.35E-10	5.67E-10	2.10E-07
Benz(a)anthracene	NV	NV	-	7.35E-10	NV	NV
Benzene	2.78E-07	5.22E-05	-	7.35E-10	1.16E-06	3.89E-04
Benzo(a)pyrene	NV	NV	-	7.35E-10	NV	NV
Benzo(b)fluoranthene	NV	NV	-	7.35E-10	NV	NV
Benzo(g,h,i)perylene	NV	NV	-	7.35E-10	NV	NV
Benzo(k)fluoranthene	NV	NV	-	7.35E-10	NV	NV
Chrysene	NV	NV	-	7.35E-10	NV	NV
Cyanide (CN-)	2.02E-06	5.22E-05	-	7.35E-10	6.15E-06	1.68E-03
Dibenz(a,h)anthracene	NV	NV	-	7.35E-10	NV	NV
Ethylbenzene	1.77E-06	5.22E-05	-	7.35E-10	4.70E-07	1.64E-03
Fluoranthene	NV	NV	-	7.35E-10	NV	NV
Fluorene	3.63E-09	5.22E-05	-	7.35E-10	1.98E-09	7.27E-08
Indeno(1,2,3-cd)pyrene	NV	NV	-	7.35E-10	NV	NV
Naphthalene	2.21E-07	5.22E-05	-	7.35E-10	7.35E-08	2.61E-05
Phenanthrene	1.58E-09	5.22E-05	-	7.35E-10	3.76E-10	1.41E-08
Phenol	NV	NV	-	7.35E-10	NV	NV
Pyrene	4.18E-09	5.22E-05	-	7.35E-10	2.63E-11	9.96E-09
Toluene	2.31E-06	5.22E-05	-	7.35E-10	8.02E-07	2.75E-03
TPH C06-C09 aliphatic	6.14E-06	5.22E-05	-	7.35E-10	5.67E-06	1.86E-02
TPH C10-C14 aliphatic	8.88E-07	5.22E-05	-	7.35E-10	1.18E-07	3.89E-04
TPH C10-C14 aromatic	5.69E-08	5.22E-05	-	7.35E-10	4.86E-08	1.60E-05
TPH C15-C28 aliphatic	NV	NV	-	7.35E-10	NV	NV
TPH C15-C28 aromatic	NV	NV	-	7.35E-10	NV	NV
TPH C29-C36 aliphatic	NV	NV	-	7.35E-10	NV	NV
TPH C29-C36 aromatic	NV	NV	-	7.35E-10	NV	NV
Xylenes (total)	1.73E-07	5.22E-05	-	7.35E-10	4.50E-07	1.52E-04

Definition of Parameters

VF_{as}	Volatilization factor from surficial soils to ambient air (vapors) - use lower of two values
VF_{p}	Volatilization factor from surficial soils to ambient air (particulates)
VF_{samb}	Volatilization factor from subsurface soils to ambient air
VF_{sesp1}	Volatilization factor from soil to enclosed-space vapors
VF_{trench}	Volatilisation factor from subsurface soil to trench air (where soil contamination is below base of trench)

Summary of Estimated Health Risks
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

Exposure Pathway	Threshold Risk Estimates		Non-Threshold Risk
	Adult Exposure	Childhood Exposure	Estimates (Lifetime Exposure)
Incidental Ingestion of Soil	-	-	-
Dermal Contact with Soil	-	-	-
Inhalation of Surface Soil-Derived Dust in Indoor Air	-	-	-
Inhalation of Surface Soil-Derived Dust in Outdoor Air	-	-	-
Inhalation of Surface Soil-Derived Vapours in Outdoor Air	-	-	-
Inhalation of Subsurface Soil-Derived Vapours in Indoor Air	-	-	-
Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air	8.2E-04	8.2E-04	3.5E-08
Inhalation of Groundwater-Derived Vapours in Indoor Air	-	-	-
Inhalation of Groundwater-Derived Vapours in Outdoor Air	1.6E-03	1.6E-03	7.7E-08
Inhalation of Groundwater Vapours (Where GW Enters Trench)	-	-	-
Ingestion of Potable Groundwater	-	-	-
Incidental Ingestion of Groundwater (Bathing or Excavation)	-	-	-
Dermal Contact with Groundwater (Bathing or Excavation)	-	-	-
TOTAL	**2.5E-03**	**2.5E-03**	**1.1E-07**

Health Risk Calculations - Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Chemical	Soil Conc. (mg/kg)	Csat (mg/kg)	Volatilisation Factor from Subsurface Soil to Outdoor Air [(mg/m3)/(mg/kg)]	Vapour Concentration in Outdoor Air (From Subsurface Soil) (mg/m3)	Threshold Intake and Risk Calculations Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (kg/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Child Exposure Factor (threshold) (kg/m3)	Child Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Child) (unitless)
Acenaphthene	270	3.94E+01	7.93E-09	3.12E-07	2.10E-01	6.61E-10	2.60E-08	1.24E-07	6.61E-10	2.60E-08	1.24E-07
Acenaphthylene	1000	1.63E+02	4.37E-09	7.10E-07	2.10E-01	3.64E-10	5.92E-08	2.82E-07	3.64E-10	5.92E-08	2.82E-07
Ammonia	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	1.42E+00	5.67E-10	8.08E-10	1.05E+00	4.73E-11	6.74E-11	6.42E-11	4.73E-11	6.74E-11	6.42E-11
Benz(a)anthracene	-	-	NV	-	-	-	-	-	-	-	-
Benzene	61	6.59E+02	1.16E-06	7.08E-05	9.60E-03	9.67E-08	5.90E-06	6.14E-04	9.67E-08	5.90E-06	6.14E-04
Benzo(a)pyrene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Chrysene	-	-	NV	-	-	-	-	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	NV	-	-	-	-	-	-	-	-
Ethylbenzene	8	1.67E+02	4.70E-07	3.76E-06	1.30E+00	3.92E-08	3.13E-07	2.41E-07	3.92E-08	3.13E-07	2.41E-07
Fluoranthene	2100	2.89E+01	NV	-	1.40E-01	-	-	-	-	-	-
Fluorene	1300	3.10E+01	1.98E-09	6.15E-08	1.40E-01	1.65E-10	5.12E-09	3.66E-08	1.65E-10	5.12E-09	3.66E-08
Indeno(1,2,3-cd)pyrene	-	-	NV	-	-	-	-	-	-	-	-
Naphthalene	8400	9.66E+01	7.35E-08	7.10E-06	3.00E-03	6.13E-09	5.92E-07	1.97E-04	6.13E-09	5.92E-07	1.97E-04
Phenanthrene	3100	3.84E+01	3.76E-10	1.44E-08	2.10E-01	3.13E-11	1.20E-09	5.73E-09	3.13E-11	1.20E-09	5.73E-09
Phenol	-	-	NV	-	-	-	-	-	-	-	-
Pyrene	1700	1.47E+01	2.63E-11	3.85E-10	1.05E-01	2.19E-12	3.21E-11	3.06E-10	2.19E-12	3.21E-11	3.06E-10
Toluene	69	2.91E+02	8.02E-07	5.53E-05	5.00E+00	6.68E-08	4.61E-06	9.22E-07	6.68E-08	4.61E-06	9.22E-07
TPH C06-C09 aliphatic	230	2.21E+02	5.67E-06	1.25E-03	1.84E+01	4.72E-07	1.04E-04	5.68E-06	4.72E-07	1.04E-04	5.68E-06
TPH C10-C14 aliphatic	54000	1.11E+02	1.18E-07	1.32E-05	1.00E+00	9.87E-09	1.10E-06	1.10E-06	9.87E-09	1.10E-06	1.10E-06
TPH C10-C14 aromatic	542000	1.54E+02	4.86E-08	7.50E-06	2.00E-01	4.05E-09	6.25E-07	3.13E-06	4.05E-09	6.25E-07	3.13E-06
TPH C15-C28 aliphatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	NV	-	-	-	-	-	-	-	-
Xylenes (total)	94	8.90E+00	4.50E-07	4.00E-06	2.20E-01	3.75E-08	3.34E-07	1.52E-06	3.75E-08	3.34E-07	1.52E-06
TOTAL								**8.25E-04**			**8.25E-04**

Chemical	Non-Threshold Intake and Risk Calculations Inhalation Unit Risk (ug/m3)-1	Adult Exposure Factor (non-threshold) (kg/m3)	Child Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Adjusted Air Concentration (non-threshold) (mg/m3)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	-	-	-	-	-	-
Acenaphthylene	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-
Benz(a)anthracene	-	-	-	-	-	-
Benzene	6.00E-06	8.84E-08	8.29E-09	9.67E-08	5.90E-06	3.54E-08
Benzo(a)pyrene	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-	-
Chrysene	-	-	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-
Phenanthrene	-	-	-	-	-	-
Phenol	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-
Toluene	-	-	-	-	-	-
TPH C06-C09 aliphatic	-	-	-	-	-	-
TPH C10-C14 aliphatic	-	-	-	-	-	-
TPH C10-C14 aromatic	-	-	-	-	-	-
TPH C15-C28 aliphatic	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-
Xylenes (total)	-	-	-	-	-	-
TOTAL						**3.54E-08**

Health Risk Calculations - Inhalation of Groundwater-Derived Vapours in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Chemical	Groundwater Concentration (mg/L)	Aqueous Solubility (mg/L)	Volatilisation Factor from Groundwater to Outdoor Air [(mg/m3)/(mg/L)]	Vapour Concentration in Outdoor Air (From Subsurface Groundwater) (mg/m3)	Threshold Intake and Risk Calculations: Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (L/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Child Exposure Factor (threshold) (L/m3)	Child Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Child) (unitless)
Acenaphthene	4.4	3.90E+00	7.19E-08	2.81E-07	2.10E-01	6.00E-09	2.34E-08	1.11E-07	6.00E-09	2.34E-08	1.11E-07
Acenaphthylene	43	1.61E+01	3.99E-08	6.42E-07	2.10E-01	3.33E-09	5.35E-08	2.55E-07	3.33E-09	5.35E-08	2.55E-07
Ammonia	348	4.82E+05	2.90E-08	1.01E-05	6.95E-02	2.42E-09	8.41E-07	1.21E-05	2.42E-09	8.41E-07	1.21E-05
Anthracene	15	4.34E-02	1.72E-08	7.46E-10	1.05E+00	1.43E-09	6.21E-11	5.92E-11	1.43E-09	6.21E-11	5.92E-11
Benz(a)anthracene	-	-	NV	-	-	-	-	-	-	-	-
Benzene	41	1.79E+03	3.78E-06	1.55E-04	9.60E-03	3.15E-07	1.29E-05	1.35E-03	3.15E-07	1.29E-05	1.35E-03
Benzo(a)pyrene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Chrysene	-	-	NV	-	-	-	-	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	NV	-	-	-	-	-	-	-	-
Ethylbenzene	3	1.69E+02	4.10E-06	1.23E-05	1.30E+00	3.42E-07	1.03E-06	7.89E-07	3.42E-07	1.03E-06	7.89E-07
Fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Fluorene	21	1.69E+00	3.31E-08	5.59E-08	1.40E-01	2.76E-09	4.66E-09	3.33E-08	2.76E-09	4.66E-09	3.33E-08
Indeno(1,2,3-cd)pyrene	-	-	NV	-	-	-	-	-	-	-	-
Naphthalene	280	3.10E+01	2.04E-07	6.32E-06	3.00E-03	1.70E-08	5.27E-07	1.76E-04	1.70E-08	5.27E-07	1.76E-04
Phenanthrene	74	1.15E+00	1.16E-08	1.34E-08	2.10E-01	9.70E-10	1.12E-09	5.31E-09	9.70E-10	1.12E-09	5.31E-09
Phenol	392	8.28E+04	NV	-	2.00E-01	-	-	-	-	-	-
Pyrene	28	1.35E-01	2.71E-09	3.66E-10	1.05E-01	2.26E-10	3.05E-11	2.91E-10	2.26E-10	3.05E-11	2.91E-10
Toluene	18	5.26E+02	3.92E-06	7.06E-05	5.00E+00	3.27E-07	5.88E-06	1.18E-06	3.27E-07	5.88E-06	1.18E-06
TPH C06-C09 aliphatic	74	1.18E+01	9.39E-04	1.11E-02	1.84E+01	7.83E-05	9.24E-04	5.02E-05	7.83E-05	9.24E-04	5.02E-05
TPH C10-C14 aliphatic	1730	9.99E-02	1.16E-03	1.16E-04	1.00E+00	9.70E-05	9.69E-06	9.69E-06	9.70E-05	9.69E-06	9.69E-06
TPH C10-C14 aromatic	1730	2.53E+01	2.62E-06	6.64E-05	2.00E-01	2.19E-07	5.53E-06	2.77E-05	2.19E-07	5.53E-06	2.77E-05
TPH C15-C28 aliphatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	NV	-	-	-	-	-	-	-	-
Xylenes (total)	6.7	1.06E+01	3.34E-06	2.24E-05	2.20E-01	2.78E-07	1.87E-06	8.48E-06	2.78E-07	1.87E-06	8.48E-06
TOTAL								**1.63E-03**			**1.63E-03**

Chemical	Non-Threshold Intake and Risk Calculations: Inhalation Unit Risk (ug/m3)-1	Adult Exposure Factor (non-threshold) (L/m3)	Child Exposure Factor (non-threshold) (L/m3)	Lifetime Exposure Factor (non-threshold) (L/m3)	Lifetime Exposure Adjusted Air Concentration (non-threshold) (mg/m3)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	-	-	-	-	-	-
Acenaphthylene	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-
Benz(a)anthracene	-	-	-	-	-	-
Benzene	6.00E-06	2.88E-07	2.70E-08	3.15E-07	1.29E-05	7.75E-08
Benzo(a)pyrene	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-	-
Chrysene	-	-	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-
Phenanthrene	-	-	-	-	-	-
Phenol	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-
Toluene	-	-	-	-	-	-
TPH C06-C09 aliphatic	-	-	-	-	-	-
TPH C10-C14 aliphatic	-	-	-	-	-	-
TPH C10-C14 aromatic	-	-	-	-	-	-
TPH C15-C28 aliphatic	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-
Xylenes (total)	-	-	-	-	-	-
TOTAL						**7.75E-08**

Soil RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity) (kg/mg)			RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Vapour Only Risk at Csat (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL	
			Vapours from Subsurface Soil Outdoors	TOTAL (All Pathways)	Vapours from Subsurface Soil Outdoors	Total Vapour Pathways	TOTAL (All Pathways)					Vapours from Subsurface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	kg/mg	kg/mg	kg/mg	mg/kg			mg/kg	%	%
Acenaphthene	270	3.94E+01	1.24E-07	1.24E-07	3.15E-09	3.15E-09	3.15E-09	6.36E+07	1.24E-07	1.24E-07	**6.36E+07**	0.00%	0.00%
Acenaphthylene	1000	1.63E+02	2.82E-07	2.82E-07	1.73E-09	1.73E-09	1.73E-09	1.15E+08	2.82E-07	2.82E-07	**1.15E+08**	0.00%	0.00%
Ammonia	-	-	-	-	-		-	-	-	-	**-**	-	
Anthracene	1200	1.42E+00	6.42E-11	6.42E-11	4.50E-11	4.50E-11	4.50E-11	4.44E+09	6.42E-11	6.42E-11	**4.44E+09**	0.00%	0.00%
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	
Benzene	61	6.59E+02	6.14E-04	6.14E-04	1.01E-05	1.01E-05	1.01E-05	2.48E+04	6.64E-03	6.64E-03	**2.48E+04**	2.66%	2.66%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	**-**	-	
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	
Chrysene	-	-	-	-	-		-	-	-	-	**-**	-	
Cyanide (CN-)	-	-	-	-	-		-	-	-	-	**-**	-	
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	
Ethylbenzene	8	1.67E+02	2.41E-07	2.41E-07	3.01E-08	3.01E-08	3.01E-08	8.29E+06	5.03E-06	5.03E-06	**8.29E+06**	0.00%	0.00%
Fluoranthene	2100	2.89E+01	-	-	-		-	-	-	-	**-**	-	
Fluorene	1300	3.10E+01	3.66E-08	3.66E-08	1.18E-09	1.18E-09	1.18E-09	1.70E+08	3.66E-08	3.66E-08	**1.70E+08**	0.00%	0.00%
Indeno(1,2,3-cd)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	
Naphthalene	8400	9.66E+01	1.97E-04	1.97E-04	2.04E-06	2.04E-06	2.04E-06	9.79E+04	1.97E-04	1.97E-04	**9.79E+04**	0.10%	0.10%
Phenanthrene	3100	3.84E+01	5.73E-09	5.73E-09	1.49E-10	1.49E-10	1.49E-10	1.34E+09	5.73E-09	5.73E-09	**1.34E+09**	0.00%	0.00%
Phenol	-	-	-	-	-		-	-	-	-	**-**	-	
Pyrene	1700	1.47E+01	3.06E-10	3.06E-10	2.08E-11	2.08E-11	2.08E-11	9.60E+09	3.06E-10	3.06E-10	**9.60E+09**	0.00%	0.00%
Toluene	69	2.91E+02	9.22E-07	9.22E-07	1.34E-08	1.34E-08	1.34E-08	1.87E+07	3.89E-06	3.89E-06	**1.87E+07**	0.00%	0.00%
TPH C06-C09 aliphatic	230	2.21E+02	5.68E-06	5.68E-06	2.57E-08	2.57E-08	2.57E-08	4.87E+06	5.68E-06	5.68E-06	**4.87E+06**	0.00%	0.00%
TPH C10-C14 aliphatic	54000	1.11E+02	1.10E-06	1.10E-06	9.87E-09	9.87E-09	9.87E-09	1.27E+07	1.10E-06	1.10E-06	**1.27E+07**	0.00%	0.00%
TPH C10-C14 aromatic	542000	1.54E+02	3.13E-06	3.13E-06	2.03E-08	2.03E-08	2.03E-08	6.17E+06	3.13E-06	3.13E-06	**6.17E+06**	0.00%	0.00%
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	
Xylenes (total)	94		1.52E-06	1.52E-06	1.61E-08	1.61E-08	1.61E-08	1.55E+07	2.50E-01	-	**1.55E+07**	100.00%	100.00%
			-	-	-		-	-	-	-	**-**	-	

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Soil RBSL Derivation - Child Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity) (kg/mg)			RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Vapour Only Risk at Csat (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL (%)	
			Vapours from Subsurface Soil Outdoors	TOTAL (All Pathways)	Vapours from Subsurface Soil Outdoors	Total Vapour Pathways	TOTAL (All Pathways)					Vapours from Subsurface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	kg/mg	kg/mg	kg/mg	mg/kg	HI	HI	mg/kg	%	%
Acenaphthene	270	3.94E+01	1.24E-07	1.24E-07	3.15E-09	3.15E-09	3.15E-09	6.36E+07	1.24E-07	1.24E-07	**6.36E+07**	0.00%	0.00%
Acenaphthylene	1000	1.63E+02	2.82E-07	2.82E-07	1.73E-09	1.73E-09	1.73E-09	1.15E+08	2.82E-07	2.82E-07	**1.15E+08**	0.00%	0.00%
Ammonia	-	-	-	-	-		-	-	-	-	**-**	-	-
Anthracene	1200	1.42E+00	6.42E-11	6.42E-11	4.50E-11	4.50E-11	4.50E-11	4.44E+09	6.42E-11	6.42E-11	**4.44E+09**	0.00%	0.00%
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzene	61	6.59E+02	6.14E-04	6.14E-04	1.01E-05	1.01E-05	1.01E-05	2.48E+04	6.64E-03	6.64E-03	**2.48E+04**	2.66%	2.66%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Chrysene	-	-	-	-	-		-	-	-	-	**-**	-	-
Cyanide (CN-)	-	-	-	-	-		-	-	-	-	**-**	-	-
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Ethylbenzene	8	1.67E+02	2.41E-07	2.41E-07	3.01E-08	3.01E-08	3.01E-08	8.29E+06	5.03E-06	5.03E-06	**8.29E+06**	0.00%	0.00%
Fluoranthene	2100	2.89E+01	-	-	-		-	-	-	-	**-**	-	-
Fluorene	1300	3.10E+01	3.66E-08	3.66E-08	1.18E-09	1.18E-09	1.18E-09	1.70E+08	3.66E-08	3.66E-08	**1.70E+08**	0.00%	0.00%
Indeno(1,2,3-cd)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Naphthalene	8400	9.66E+01	1.97E-04	1.97E-04	2.04E-06	2.04E-06	2.04E-06	9.79E+04	1.97E-04	1.97E-04	**9.79E+04**	0.10%	0.10%
Phenanthrene	3100	3.84E+01	5.73E-09	5.73E-09	1.49E-10	1.49E-10	1.49E-10	1.34E+09	5.73E-09	5.73E-09	**1.34E+09**	0.00%	0.00%
Phenol	-	-	-	-	-		-	-	-	-	**-**	-	-
Pyrene	1700	1.47E+01	3.06E-10	3.06E-10	2.08E-11	2.08E-11	2.08E-11	9.60E+09	3.06E-10	3.06E-10	**9.60E+09**	0.00%	0.00%
Toluene	69	2.91E+02	9.22E-07	9.22E-07	1.34E-08	1.34E-08	1.34E-08	1.87E+07	3.89E-06	3.89E-06	**1.87E+07**	0.00%	0.00%
TPH C06-C09 aliphatic	230	2.21E+02	5.68E-06	5.68E-06	2.57E-08	2.57E-08	2.57E-08	4.87E+06	5.68E-06	5.68E-06	**4.87E+06**	0.00%	0.00%
TPH C10-C14 aliphatic	54000	1.11E+02	1.10E-06	1.10E-06	9.87E-09	9.87E-09	9.87E-09	1.27E+07	1.10E-06	1.10E-06	**1.27E+07**	0.00%	0.00%
TPH C10-C14 aromatic	542000	1.54E+02	3.13E-06	3.13E-06	2.03E-08	2.03E-08	2.03E-08	6.17E+06	3.13E-06	3.13E-06	**6.17E+06**	0.00%	0.00%
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-

Soil RBSL Derivation - Non-Threshold Lifetime Health Effects (Adult and Child)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (ILCR)		Risk/Soil Concentration (i.e., exposure and toxicity factor)			RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Vapour Only Risk at Csat (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL	
			Vapours from Subsurface Soil Outdoors	TOTAL	Vapours from Subsurface Soil Outdoors	Total Vapour Pathways	TOTAL					Vapours from Subsurface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	kg/mg	kg/mg	kg/mg	mg/kg			mg/kg	%	%
Acenaphthene	270	3.94E+01	-	-	-		-	-	-	-	-	-	-
Acenaphthylene	1000	1.63E+02	-	-	-		-	-	-	-	-	-	-
Ammonia	-	-	-	-	-		-	-	-	-	-	-	-
Anthracene	1200	1.42E+00	-	-	-		-	-	-	-	-	-	-
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	-	-	-
Benzene	61	6.59E+02	3.54E-08		5.80E-10	5.80E-10	5.80E-10	1.72E+04	3.82E-07	3.82E-07	**1.72E+04**	100.00%	100.00%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	-	-	-
Chrysene	-	-	-	-	-		-	-	-	-	-	-	-
Cyanide (CN-)	-	-	-	-	-		-	-	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	-	-	-
Ethylbenzene	8	1.67E+02	-	-	-		-	-	-	-	-	-	-
Fluoranthene	2100	2.89E+01	-	-	-		-	-	-	-	-	-	-
Fluorene	1300	-	-	-	-		-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-		-	-	-	-	-	-	-
Naphthalene	8400	9.66E+01	-	-	-		-	-	-	-	-	-	-
Phenanthrene	3100	3.84E+01	-	-	-		-	-	-	-	-	-	-
Phenol	-	-	-	-	-		-	-	-	-	-	-	-
Pyrene	1700	1.47E+01	-	-	-		-	-	-	-	-	-	-
Toluene	69	2.91E+02	-	-	-		-	-	-	-	-	-	-
TPH C06-C09 aliphatic	230	2.21E+02	-	-	-		-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.11E+02	-	-	-		-	-	-	-	-	-	-
TPH C10-C14 aromatic	542000	1.54E+02	-	-	-		-	-	-	-	-	-	-
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	-	-	-
Xylenes (total)	94	-	-	-	-		-	-	-	-	-	-	-
								-				-	

Groundwater RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

			Risk at Input Groundwater Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity)							Pathway Contributions to Total Estimated Risk at RBSL	
	Cgw	Solubility	GW to Outdoor Vapour	TOTAL (All Pathways)	GW to Outdoor Vapour	Total Vapour Pathways	TOTAL (All Pathways)	RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Vapour Only Risk at Sol (if necessary)	Adopted RBSL	GW to Outdoor Vapour	TOTAL
Chemical	mg/L	mg/L	unitless	unitless	L/mg	L/mg	L/mg	mg/L			mg/L	%	%
Acenaphthene	4.4	3.90E+00	1.11E-07	1.11E-07	2.86E-08	2.86E-08	2.86E-08	7.00E+06	1.11E-07	1.11E-07	**7.00E+06**	0.00%	0.00%
Acenaphthylene	43	1.61E+01	2.55E-07	2.55E-07	1.58E-08	1.58E-08	1.58E-08	1.26E+07	2.55E-07	2.55E-07	**1.26E+07**	0.00%	0.00%
Ammonia	348	4.82E+05	1.21E-05	1.21E-05	3.48E-08	3.48E-08	3.48E-08	2.88E+07	1.68E-02	1.68E-02	**2.88E+07**	1.68%	1.68%
Anthracene	15	4.34E-02	5.92E-11	5.92E-11	1.36E-09	1.36E-09	1.36E-09	1.47E+08	5.92E-11	5.92E-11	**1.47E+08**	0.00%	0.00%
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzene	41	1.79E+03	1.35E-03	1.35E-03	3.28E-05	3.28E-05	3.28E-05	7.62E+03	5.87E-02	5.87E-02	**7.62E+03**	23.49%	23.49%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Chrysene	-	-	-	-	-		-	-	-	-	**-**	-	-
Cyanide (CN-)	-	-	-	-	-		-	-	-	-	**-**	-	-
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Ethylbenzene	3	1.69E+02	7.89E-07	7.89E-07	2.63E-07	2.63E-07	2.63E-07	9.50E+05	4.45E-05	4.45E-05	**9.50E+05**	0.02%	0.02%
Fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Fluorene	21	1.69E+00	3.33E-08	3.33E-08	1.97E-08	1.97E-08	1.97E-08	1.02E+07	3.33E-08	3.33E-08	**1.02E+07**	0.00%	0.00%
Indeno(1,2,3-cd)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Naphthalene	280	3.10E+01	1.76E-04	1.76E-04	5.66E-06	5.66E-06	5.66E-06	3.53E+04	1.76E-04	1.76E-04	**3.53E+04**	0.09%	0.09%
Phenanthrene	74	1.15E+00	5.31E-09	5.31E-09	4.62E-09	4.62E-09	4.62E-09	4.33E+07	5.31E-09	5.31E-09	**4.33E+07**	0.00%	0.00%
Phenol	392	8.28E+04	-	-	-		-	-	-	-	**-**	-	-
Pyrene	28	1.35E-01	2.91E-10	2.91E-10	2.15E-09	2.15E-09	2.15E-09	9.29E+07	2.91E-10	2.91E-10	**9.29E+07**	0.00%	0.00%
Toluene	18	5.26E+02	1.18E-06	1.18E-06	6.54E-08	6.54E-08	6.54E-08	3.82E+06	3.44E-05	3.44E-05	**3.82E+06**	0.01%	0.01%
TPH C06-C09 aliphatic	74	1.18E+01	5.02E-05	5.02E-05	4.25E-06	4.25E-06	4.25E-06	2.94E+04	5.02E-05	5.02E-05	**2.94E+04**	0.04%	0.04%
TPH C10-C14 aliphatic	1730	9.99E-02	9.69E-06	9.69E-06	9.70E-05	9.70E-05	9.70E-05	1.29E+03	9.69E-06	9.69E-06	**1.29E+03**	0.01%	0.01%
TPH C10-C14 aromatic	1730	2.53E+01	2.77E-05	2.77E-05	1.09E-06	1.09E-06	1.09E-06	1.14E+05	2.77E-05	2.77E-05	**1.14E+05**	0.02%	0.02%
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-
Xylenes (total)	6.7	1.06E+01	8.48E-06	8.48E-06	1.27E-06	1.27E-06	1.27E-06	1.98E+05	1.34E-05	1.34E-05	**1.98E+05**	0.01%	0.01%

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Groundwater RBSL Derivation - Child Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Chemical	Cgw	Solubility	Risk at Input Groundwater Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity)			RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Vapour Only Risk at Sol (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL	
			GW to Outdoor Vapour	TOTAL (All Pathways)	GW to Outdoor Vapour	Total Vapour Pathways	TOTAL (All Pathways)					GW to Outdoor Vapour	TOTAL
	mg/L	mg/L	unitless	unitless	L/mg	L/mg	L/mg	mg/L			mg/L	%	%
Acenaphthene	4.4	3.90E+00	1.11E-07	1.11E-07	2.86E-08	2.86E-08	2.86E-08	7.00E+06	1.11E-07	1.11E-07	**7.00E+06**	0.00%	0.00%
Acenaphthylene	43	1.61E+01	2.55E-07	2.55E-07	1.58E-08	1.58E-08	1.58E-08	1.26E+07	2.55E-07	2.55E-07	**1.26E+07**	0.00%	0.00%
Ammonia	348	4.82E+05	1.21E-05	1.21E-05	3.48E-08	3.48E-08	3.48E-08	2.88E+07	1.68E-02	1.68E-02	**2.88E+07**	1.68%	1.68%
Anthracene	15	4.34E-02	5.92E-11	5.92E-11	1.36E-09	1.36E-09	1.36E-09	1.47E+08	5.92E-11	5.92E-11	**1.47E+08**	0.00%	0.00%
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzene	41	1.79E+03	1.35E-03	1.35E-03	3.28E-05	3.28E-05	3.28E-05	7.62E+03	5.87E-02	5.87E-02	**7.62E+03**	23.49%	23.49%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Chrysene	-	-	-	-	-		-	-	-	-	**-**	-	-
Cyanide (CN-)	-	-	-	-	-		-	-	-	-	**-**	-	-
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Ethylbenzene	3	1.69E+02	7.89E-07	7.89E-07	2.63E-07	2.63E-07	2.63E-07	9.50E+05	4.45E-05	4.45E-05	**9.50E+05**	0.02%	0.02%
Fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Fluorene	21	1.69E+00	3.33E-08	3.33E-08	1.97E-08	1.97E-08	1.97E-08	1.02E+07	3.33E-08	3.33E-08	**1.02E+07**	0.00%	0.00%
Indeno(1,2,3-cd)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Naphthalene	280	3.10E+01	1.76E-04	1.76E-04	5.66E-06	5.66E-06	5.66E-06	3.53E+04	1.76E-04	1.76E-04	**3.53E+04**	0.09%	0.09%
Phenanthrene	74	1.15E+00	5.31E-09	5.31E-09	4.62E-09	4.62E-09	4.62E-09	4.33E+07	5.31E-09	5.31E-09	**4.33E+07**	0.00%	0.00%
Phenol	392	8.28E+04	-	-	-		-	-	-	-	**-**	-	-
Pyrene	28	1.35E-01	2.91E-10	2.91E-10	2.15E-09	2.15E-09	2.15E-09	9.29E+07	2.91E-10	2.91E-10	**9.29E+07**	0.00%	0.00%
Toluene	18	5.26E+02	1.18E-06	1.18E-06	6.54E-08	6.54E-08	6.54E-08	3.82E+06	3.44E-05	3.44E-05	**3.82E+06**	0.01%	0.01%
TPH C06-C09 aliphatic	74	1.18E+01	5.02E-05	5.02E-05	4.25E-06	4.25E-06	4.25E-06	2.94E+04	5.02E-05	5.02E-05	**2.94E+04**	0.04%	0.04%
TPH C10-C14 aliphatic	1730	9.99E-02	9.69E-06	9.69E-06	9.70E-05	9.70E-05	9.70E-05	1.29E+03	9.69E-06	9.69E-06	**1.29E+03**	0.01%	0.01%
TPH C10-C14 aromatic	1730	2.53E+01	2.77E-05	2.77E-05	1.09E-06	1.09E-06	1.09E-06	1.14E+05	2.77E-05	2.77E-05	**1.14E+05**	0.02%	0.02%
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Groundwater RBSL Derivation - Non-Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Chemical	Cgw	Solubility	Risk at Input Groundwater Concentration (ILCR)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity)			RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Vapour Only Risk at Sol (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL	
			GW to Outdoor Vapour	TOTAL (All Pathways)	GW to Outdoor Vapour	Total Vapour Pathways	TOTAL (All Pathways)					GW to Outdoor Vapour	TOTAL
	mg/L	mg/L	unitless	unitless	L/mg	L/mg	L/mg	mg/L			mg/L	%	%
Acenaphthene	4.4	3.90E+00	-	-	-		-	-	-	-	-	-	-
Acenaphthylene	43	1.61E+01	-	-	-		-	-	-	-	-	-	-
Ammonia	348	4.82E+05	-	-	-		-	-	-	-	-	-	-
Anthracene	15	4.34E-02	-	-	-		-	-	-	-	-	-	-
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	-	-	-
Benzene	41	1.79E+03	7.75E-08	7.75E-08	1.89E-09	1.89E-09	1.89E-09	5.29E+03	3.38E-06	3.38E-06	**5.29E+03**	33.83%	33.83%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	-	-	-
Chrysene	-	-	-	-	-		-	-	-	-	-	-	-
Cyanide (CN-)	-	-	-	-	-		-	-	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	-	-	-
Ethylbenzene	3	1.69E+02	-	-	-		-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-		-	-	-	-	-	-	-
Fluorene	21	1.69E+00	-	-	-		-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-		-	-	-	-	-	-	-
Naphthalene	280	3.10E+01	-	-	-		-	-	-	-	-	-	-
Phenanthrene	74	1.15E+00	-	-	-		-	-	-	-	-	-	-
Phenol	392	8.28E+04	-	-	-		-	-	-	-	-	-	-
Pyrene	28	1.35E-01	-	-	-		-	-	-	-	-	-	-
Toluene	18	5.26E+02	-	-	-		-	-	-	-	-	-	-
TPH C06-C09 aliphatic	74	1.18E+01	-	-	-		-	-	-	-	-	-	-
TPH C10-C14 aliphatic	1730	9.99E-02	-	-	-		-	-	-	-	-	-	-
TPH C10-C14 aromatic	1730	2.53E+01	-	-	-		-	-	-	-	-	-	-
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	-	-	-

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Summary of Derived RBSLs
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Risk Based Calculations) Scenario

Back to User Input Sheet

Chemical	Soil RBSLs (mg/kg)						Groundwater RBSLs (mg/L)					
	Adult Threshold	Child Threshold	Non-Threshold (Lifetime)	Adopted RBSL (Lowest)	Saturation Limited?	Site Concentration	Adult Threshold	Child Threshold	Non-Threshold (Lifetime)	Adopted RBSL (Lowest)	Solubility Limited?	Site Concentration
Acenaphthene	6.36E+07	6.36E+07	-	**6.36E+07**	>Sat	2.70E+02	7.00E+06	7.00E+06	-	**7.00E+06**	>Sol	4.40E+00
Acenaphthylene	1.15E+08	1.15E+08	-	**1.15E+08**	>Sat	1.00E+03	1.26E+07	1.26E+07	-	**1.26E+07**	>Sol	4.30E+01
Ammonia	-	-	-	-	-	-	2.88E+07	2.88E+07	-	**2.88E+07**	>Sol	3.48E+02
Anthracene	4.44E+09	4.44E+09	-	**4.44E+09**	>Sat	1.20E+03	1.47E+08	1.47E+08	-	**1.47E+08**	>Sol	1.50E+01
Benz(a)anthracene	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	2.48E+04	2.48E+04	1.72E+04	**1.72E+04**	>Sat	6.10E+01	7.62E+03	7.62E+03	5.29E+03	**5.29E+03**	>Sol	4.10E+01
Benzo(a)pyrene	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	8.29E+06	8.29E+06	-	**8.29E+06**	>Sat	8.00E+00	9.50E+05	9.50E+05	-	**9.50E+05**	>Sol	3.00E+00
Fluoranthene	-	-	-	-	-	-	-	-	-	-	-	-
Fluorene	1.70E+08	1.70E+08	-	**1.70E+08**	>Sat	1.30E+03	1.02E+07	1.02E+07	-	**1.02E+07**	>Sol	2.10E+01
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	9.79E+04	9.79E+04	-	**9.79E+04**	>Sat	8.40E+03	3.53E+04	3.53E+04	-	**3.53E+04**	>Sol	2.80E+02
Phenanthrene	1.34E+09	1.34E+09	-	**1.34E+09**	>Sat	3.10E+03	4.33E+07	4.33E+07	-	**4.33E+07**	>Sol	7.40E+01
Phenol	-	-	-	-	-	-	-	-	-	-	-	-
Pyrene	9.60E+09	9.60E+09	-	**9.60E+09**	>Sat	1.70E+03	9.29E+07	9.29E+07	-	**9.29E+07**	>Sol	2.80E+01
Toluene	1.87E+07	1.87E+07	-	**1.87E+07**	>Sat	6.90E+01	3.82E+06	3.82E+06	-	**3.82E+06**	>Sol	1.80E+01
TPH C06-C09 aliphatic	4.87E+06	4.87E+06	-	**4.87E+06**	>Sat	2.30E+02	2.94E+04	2.94E+04	-	**2.94E+04**	>Sol	7.40E+01
TPH C10-C14 aliphatic	1.27E+07	1.27E+07	-	**1.27E+07**	>Sat	5.40E+04	1.29E+03	1.29E+03	-	**1.29E+03**	>Sol	1.73E+03
TPH C10-C14 aromatic	6.17E+06	6.17E+06	-	**6.17E+06**	>Sat	5.42E+05	1.14E+05	1.14E+05	-	**1.14E+05**	>Sol	1.73E+03
TPH C15-C28 aliphatic	-	-	-	-	-	-	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	-	-	-	-	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes (total)	1.55E+07	1.55E+07	-	**1.55E+07**	>Sat	9.40E+01	1.98E+05	1.98E+05	-	**1.98E+05**	>Sol	6.70E+00

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Pathways included in derivation of Soil RBSL:
x Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air
Pathways included in derivation of Groundwater RBSL:
x Inhalation of Groundwater-Derived Vapours in Outdoor Air

This page has been left blank intentionally.

Appendix E

Scenario 2 (Intrusive Maintenance)

This page has been left blank intentionally.

AECOM

1. General Information:

Site:	Barangaroo
Address:	Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Client:	Lend Lease
Scenario:	Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations)

Header Colour (Defaults = Blue):

2. Select Receptor:

Construction/Excavation Worker

3. Select Exposure Pathways to Include:

Enter "x" in box, or select from dropdown box.

Soil Pathways

x	Incidental Ingestion of Soil
x	Dermal Contact with Soil
	Inhalation of Surface Soil-Derived Dust in Indoor Air
x	Inhalation of Surface Soil-Derived Dust in Outdoor Air
x	Inhalation of Surface Soil-Derived Vapours in Outdoor Air
	Inhalation of Subsurface Soil-Derived Vapours in Indoor Air
	Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air

Groundwater Pathways

	Inhalation of Groundwater-Derived Vapours in Indoor Air
	Inhalation of Groundwater-Derived Vapours in Outdoor Air
	Ingestion of Potable Groundwater
x	Incidental Ingestion of Groundwater (Bathing or Excavation)
x	Dermal Contact with Groundwater (Bathing or Excavation)
x	Inhalation of Groundwater Vapours (Where GW Enters Trench)

	Soil RBSLs saturation limited?
	Groundwater RBSLs solubility limited?

4. Select Chemicals for Quantitative Assessment / 5. Enter Chemical Concentrations (if only calculating RBSLs, enter 1):

4. Select Chemicals for Quantitative Assessment:	Target Hazard Index	Target Cancer Risk	Soil (mg/kg)	Groundwater (mg/L)
	default = 1 (or manually overwrite)	default = $1x10^{-5}$ (or manually overwrite)		
Acenaphthene	0.2	1.00E-05	270	4.4
Acenaphthylene	0.2	1.00E-05	1000	43
Ammonia	1	1.00E-05		348
Anthracene	0.2	1.00E-05	1200	15
Benz(a)anthracene	1	1.00E-05	910	13
Benzene	0.25	1.00E-05	61	41
Benzo(a)pyrene	1	1.00E-05	650	9.3
Benzo(b)fluoranthene	1	1.00E-05	820	8.3
Benzo(g,h,i)perylene	1	1.00E-05	310	4.2
Benzo(k)fluoranthene	1	1.00E-05	320	3.7
Chrysene	1	1.00E-05	630	9.3
Cyanide (CN-)	1	1.00E-05		
Dibenz(a,h)anthracene	1	1.00E-05	73	0.82
Ethylbenzene	0.25	1.00E-05	8	3
Fluoranthene	0.2	1.00E-05	2100	26
Fluorene	0.2	1.00E-05	1300	21
Indeno(1,2,3-cd)pyrene	1	1.00E-05	250	3.1
Naphthalene	0.2	1.00E-05	8400	283
Phenanthrene	0.2	1.00E-05	3100	74
Phenol	1	1.00E-05		392
Pyrene	0.2	1.00E-05	1700	28
		Blank		
Toluene	0.25	1.00E-05	69	18
TPH C06-C09 aliphatic	0.125	1.00E-05	230	74
TPH C10-C14 aliphatic	0.125	1.00E-05	54000	1700
TPH C10-C14 aromatic	0.125	1.00E-05	54000	1700
TPH C15-C28 aliphatic	0.125	1.00E-05	72000	1520
TPH C15-C28 aromatic	0.125	1.00E-05	72000	1520
TPH C29-C36 aliphatic	0.125	1.00E-05	21000	330
TPH C29-C36 aromatic	0.125	1.00E-05	21000	330
Xylenes (total)	0.25	1.00E-05	94	6.7

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

6. Confirm/Modify Exposure Parameters:

Link to Exposure Defaults and Sources

	Units	Default Value Adult	Default Value Child	Site-Specific Value (leave blank to use default value) Adult	Site-Specific Value Child	Value Used in Calculations Adult	Value Used in Calculations Child	
General receptor parameters:	**Units**							
Body weight	kg	70	N/A	70		70	N/A	
Exposure duration	yr	1	N/A	1		1	N/A	
Averaging time (carcinogens)	yr	70	N/A	70		70	N/A	
Averaging time (non-carcinogens)	yr	1	N/A	1		1	N/A	
Incidental Soil Ingestion								
Daily soil ingestion rate	mg/day	200	N/A	330		330	N/A	
Exposure frequency for soil ingestion	days/yr	240	N/A	15		15	N/A	
Fraction of daily soil intake from site	unitless	1	N/A	1		1	N/A	
Dermal Absorption of Soil								
Exposed skin surface area for soil contact	cm2	5000	N/A	3600		3600	N/A	
Soil to skin adherence factor	mg/cm2	0.5	N/A	1.5		1.5	N/A	
Exposure frequency for dermal contact with soil	days/yr	240	N/A	15		15	N/A	
Indoor Inhalation								
Exposure time (indoor air)	hrs/day	NA	N/A			NA	N/A	
Exposure frequency (indoor air)	days/yr	240	N/A			240	N/A	
Particulate emission factor (indoor air)	m3/kg	NA	N/A			NA	N/A	
Outdoor Inhalation								
Exposure time (outdoor air)	hrs/day	8	N/A	8		8	N/A	
Exposure frequency (outdoor air)	days/yr	240	N/A	15		15	N/A	
Particulate emission factor (outdoor air)	m3/kg	1.00E+05	N/A	3.60E+07		3.60E+07	N/A	*
Potable Water Ingestion								
Potable water intake rate	L/day	0	N/A			0	N/A	
Exposure frequency for potable water intake	days/yr	240	N/A			240	N/A	
Incidental Water Ingestion								
Incidental ingestion rate	L/day	0.05	N/A	0.005		0.005	N/A	
Exposure frequency for incidental water ingestio	days/yr	240	N/A	15		15	N/A	
Dermal Contact with Water								
Exposed skin surface for water contact	cm2	6510	N/A	3900		3900	N/A	**
Exposure time for dermal water contact	hr/day	8	N/A	1		1	N/A	
Exposure frequency for dermal water contact	days/yr	240	N/A	15		15	N/A	

* USEPA (2002)

\# USEPA (1997) (Exposure factors handbook) - based on assumption that head, forearms and hands will be exposed. 50th percentile data

** USEPA (1997) (Exposure factors handbook) - based on assumption that lower legs and feet only would be contacting water. 50th percen

Summary of Estimated Health Risks
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

Exposure Pathway	Threshold Risk Estimates		Non-Threshold Risk Estimates (Lifetime Exposure)
	Adult Exposure	Childhood Exposure	
Incidental Ingestion of Soil	1.12E+00	-	1.2E-06
Dermal Contact with Soil	1.26E+00	-	9.6E-05
Inhalation of Surface Soil-Derived Dust in Indoor Air	-	-	-
Inhalation of Surface Soil-Derived Dust in Outdoor Air	1.56E-03	-	4.6E-07
Inhalation of Surface Soil-Derived Vapours in Outdoor Air	8.64E-02	-	1.4E-08
Inhalation of Subsurface Soil-Derived Vapours in Indoor Air	-	-	-
Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air	-	-	-
Inhalation of Groundwater-Derived Vapours in Indoor Air	-	-	-
Inhalation of Groundwater-Derived Vapours in Outdoor Air	-	-	-
Inhalation of Groundwater Vapours (Where GW Enters Trench)	9.01E+00	-	1.6E-06
Ingestion of Potable Groundwater	-	-	-
Incidental Ingestion of Groundwater (Bathing or Excavation)	6.57E-01	-	3.0E-07
Dermal Contact with Groundwater (Bathing or Excavation)	1.27E+02	-	1.3E-04
TOTAL	**139.60**		**2.3E-04**

Total Risk Contribution in Soil and Groundwater
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

Hazard Index Risk Summary

Chemical	Risk at Input Soil Concentration (Hazard Index)					Risk at Input Groundwater Concentration (Hazard Index)				Chemical Specific Total Hazard Index	% Contribution to Total Hazard Index Risk
	Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL (All Soil Pathways)	Groundwater Ingestion	Dermal Contact	Groundwater Vapour Inhalation in a Trench	TOTAL (All Groundwater Pathways)		
	unitless	unitless	unitless	unitless	unitless	unitless	unitless	unitless	unitless	unitless	%
Acenaphthene	8.72E-04	1.85E-03	4.89E-07	1.30E-04	0.003	0.0002	0.01	0.0084	0.02	0.03	0.02%
Acenaphthylene	3.23E-03	6.87E-03	1.81E-06	3.99E-04	0.010	0.0021	0.15	0.0347	0.19	0.20	0.13%
Ammonia	-	-	-	-		-	-	2.2682	2.27	2.27	1.62%
Anthracene	7.75E-04	1.65E-03	4.35E-07	2.52E-07	0.002	0.0001	0.02	0.0000	0.02	0.02	0.01%
Benz(a)anthracene	-	-	-	-		-	-	-			-
Benzene	2.36E-02	-	2.42E-06	1.69E-02	0.041	0.2407	2.80	1.9347	4.97	5.01	3.56%
Benzo(a)pyrene	-	-	-	-		-	-	-			-
Benzo(b)fluoranthene	-	-	-	-		-	-	-			-
Benzo(g,h,i)perylene	-	-	-	-		-	-	-			-
Benzo(k)fluoranthene	-	-	-	-		-	-	-			-
Chrysene	-	-	-	-		-	-	-			-
Cyanide (CN-)	-	-	-	-		-	-	-			-
Dibenz(a,h)anthracene	-	-	-	-		-	-	-			-
Ethylbenzene	1.60E-05	-	2.34E-09	1.04E-05	0.000026	0.0001	0.00	0.0010	0.00	0.0046	0.00%
Fluoranthene	1.02E-02	2.16E-02	5.71E-06	-	0.032	0.0019	0.46	-	0.46	0.49	0.33%
Fluorene	6.30E-03	1.34E-02	3.53E-06	7.70E-05	0.020	0.0015	0.13	0.0055	0.14	0.16	0.10%
Indeno(1,2,3-cd)pyrene	-	-	-	-		-	-	-			-
Naphthalene	8.14E-02	1.73E-01	1.07E-03	6.81E-02	0.324	0.0415	1.51	4.6810	6.23	6.56	4.46%
Phenanthrene	1.00E-02	2.13E-02	5.62E-06	2.77E-05	0.031	0.0036	0.41	0.0025	0.41	0.44	0.30%
Phenol	-	-	-	-		0.0038	0.01	-	0.02	0.02	0.01%
Pyrene	1.10E-02	2.34E-02	6.16E-06	5.59E-06	0.034	0.0027	0.43	0.0006	0.43	0.47	0.31%
Toluene	5.99E-05	-	5.25E-09	3.05E-05	0.00009	0.0002	0.01	0.0016	0.01	0.01	0.01%
TPH C06-C09 aliphatic	8.91E-06	-	4.76E-09	7.06E-05	0.000	0.0000	0.01	0.0003	0.01	0.01	0.00%
TPH C10-C14 aliphatic	1.05E-01	-	2.05E-05	9.44E-05	0.105	0.0499	50.21	0.0000	50.26	50.37	36.00%
TPH C10-C14 aromatic	2.62E-01	-	1.03E-04	4.20E-04	0.262	0.1248	12.46	0.0573	12.64	12.90	9.05%
TPH C15-C28 aliphatic	6.97E-03	1.14E-02	3.91E-06	4.10E-07	0.018	0.0022	0.88	0.0000	0.88	0.90	0.63%
TPH C15-C28 aromatic	4.65E-01	7.61E-01	2.61E-04	2.20E-05	1.226	0.1487	41.30	0.0046	41.45	42.68	29.69%
TPH C29-C36 aliphatic	2.03E-03	3.33E-03	1.14E-06	1.32E-08	0.005	0.0005	0.17	0.0000	0.17	0.17	0.12%
TPH C29-C36 aromatic	1.36E-01	2.22E-01	7.61E-05	-	0.358	0.0323	16.50	-	16.53	16.89	11.84%
Xylenes (total)	1.02E-04	-	1.63E-07	6.70E-05	0.00017	0.0001	0.00	0.0138	0.018	0.018	0.01%
Risk Totals	**1.12**	**1.26**	**0.002**	**0.09**	**2.47**	**0.66**	**127.46**	**9.01**	**137.13**	**139.60**	

Total Risk Contribution in Soil and Groundwater
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario
ILCR Risk Summary

Back to User Input Sheet

	Risk at Input Soil Concentration (ILCR)					Risk at Input Groundwater Concentration (ILCR)					
	Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL (All Soil Pathways)	Groundwater Ingestion	Dermal Contact with Groundwater	Groundwater Vapour Inhalation in a Trench	TOTAL (All Groundwater Pathways)	Chemical Specific Total ILCR	% Contribution to Total ILCR Risk
Chemical	unitless	unitless	unitless	unitless	unitless	unitless	unitless	unitless	unitless	unitless	%
Acenaphthene	-	-	-	-	-	-	-	-	-		-
Acenaphthylene	-	-	-	-	-	-	-	-	-		-
Ammonia	-	-	-	-	-	-	-	-	-		-
Anthracene	-	-	-	-	-	-	-	-	-		-
Benz(a)anthracene	1.08E-07	2.30E-07	4.30E-08	-	3.82E-07	2.34E-08	1.01E-05	-	1.01E-05	1.05E-05	4.56%
Benzene	5.91E-09	-	1.99E-12	1.39E-08	1.98E-08	6.02E-08	6.99E-07	1.59E-06	2.35E-06	2.37E-06	1.03%
Benzo(a)pyrene	7.74E-07	9.57E-05	3.07E-07	-	9.68E-05	1.68E-07	9.33E-05	-	9.34E-05	1.90E-04	82.57%
Benzo(b)fluoranthene	9.76E-08	2.08E-07	3.88E-08	-	3.44E-07	1.50E-08	4.87E-06	-	4.88E-06	5.23E-06	2.27%
Benzo(g,h,i)perylene	3.69E-09	7.85E-09	1.47E-09	-	1.30E-08	7.57E-10	6.62E-07	-	6.62E-07	6.75E-07	0.29%
Benzo(k)fluoranthene	3.81E-08	8.10E-08	1.51E-08	-	1.34E-07	6.67E-09	3.60E-06	-	3.60E-06	3.74E-06	1.62%
Chrysene	7.50E-09	1.59E-08	2.98E-09	-	2.64E-08	1.68E-09	7.80E-07	-	7.81E-07	8.08E-07	0.35%
Cyanide (CN-)	-	-	-	-	-	-	-	-	-		-
Dibenz(a,h)anthracene	8.69E-08	1.85E-07	3.45E-08	-	3.06E-07	1.48E-08	1.10E-05	-	1.10E-05	1.13E-05	4.91%
Ethylbenzene	-	-	-	-	-	-	-	-	-		-
Fluoranthene	-	-	-	-	-	-	-	-	-		-
Fluorene	-	-	-	-	-	-	-	-	-		-
Indeno(1,2,3-cd)pyrene	2.98E-08	6.33E-08	1.18E-08	-	1.05E-07	5.59E-09	5.41E-06	-	5.41E-06	5.52E-06	2.40%
Naphthalene	-	-	-	-	-	-	-	-	-		-
Phenanthrene	-	-	-	-	-	-	-	-	-		-
Phenol	-	-	-	-	-	-	-	-	-		-
Pyrene	-	-	-	-	-	-	-	-	-		-
Toluene	-	-	-	-	-	-	-	-	-		-
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-	-		-
TPH C10-C14 aliphatic	-	-	-	-	-	-	-	-	-		-
TPH C10-C14 aromatic	-	-	-	-	-	-	-	-	-		-
TPH C15-C28 aliphatic	-	-	-	-	-	-	-	-	-		-
TPH C15-C28 aromatic	-	-	-	-	-	-	-	-	-		-
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	-		-
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-	-		-
Xylenes (total)	-	-	-	-	-	-	-	-	-		-
Risk Totals	1.15E-06	9.65E-05	4.55E-07	1.39E-08	9.81E-05	3.0E-07	1.3E-04	1.6E-06	1.32E-04	2.30E-04	

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Depth to groundwater (below building, ground surface or trench)	cm	300			LGW	300	Autocalculates from layer thicknesses
Vadose Zone Layer 1							
Thickness	cm	295			HV	295	
SCS Soil Type:							
Fraction of organic carbon	unitless	0.01			OC	0.01	
Air-filled porosity (volumetric)	cm3/cm3	0.26			VACS	0.26	
Water-filled porosity (volumetric)	cm3/cm3	0.12			vwcvz	0.12	
Total soil porosity	cm3/cm3	0.38			TPOR	0.38	
Convective vapour flow term							
Calculate convective flow term? (ENTER Y or N)		Y			Conv	Y	
Convective flow rate (if specified directly)	cm3/sec						
Convective flow through slab (calculated)	cm3/sec	10.88			Qs	10.88	
Slab Area	cm2	700000			Ab	700000	
Areal fraction of cracks in foundations/walls	cm^2-cracks/cm^2-total area	0.0019			Nuc	0.0019	
Soil vapour permeability	cm^2	1.00E-08			kv	1.00E-08	
Indoor-outdoor pressure differential	$g/cm\text{-}s^2$	40			dP	40	
Slab perimeter	cm	3400			Xcrack	3400	
Depth to bottom of slab	cm	15			Zcrack	15	
Viscosity of air	g/cm-s	1.81E-04			uair	1.81E-04	Viscosity of air at 20 deg C.
Additional Trench Characteristics (for GW level above base of trench, i.e., assumes groundwater flows into trench)							
Groundwater seepage velocity (into trench)	cm/sec	1.50E-02	(c)	1.50E-02	Vgw	0.015	default for permeable fill (max expected for
Depth of groundwater in trench	cm	50		50	Dgw	50	assumes gw may be present at 2 mbgl (on average) and
Dimension of trench (length or width) perpendicular to GW flow	cm	200	(d)	200	WSAtrench	200	maximum assumed trench dimension
Flow rate of groundwater in trench	cm3/sec				Qgw	150	Calculated from above three parameters
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate	cm/s	22.5	(e)	37.8	windsp	37.8	Based on the average annual 9am and 3pm windspeeds measured at observatory point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site), divided by 10
Width of source area parallel to wind or groundwater flow direction	cm	600	(f)	600	WSA	600	2 m deep and 2 m long trench
Ambient air mixing zone height	cm	200		200	AAMZH	200	assumes all vapours mixed w/in trench

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) Conservative estimate of maximum expected velocity for a sandy or gravelly aquifer (50ft/day = 13 m/day)
(d) Assumes trench is 2 m long.
(e) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(f) For construction/excavation worker, default is 600 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.

Back to User Input Sheet

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

B. Chemical-Specific Fate and Transport Parameters

Chemical	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-H_2O / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	5.03E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	5.03E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	3.10E-02	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	1.64E+02	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	1.77E+03	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	1.46E+00	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	5.87E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	N
Benzo(b)fluoranthene	5.99E+05	5.99E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	N
Benzo(g,h,i)perylene	1.95E+06	1.95E+04	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	N
Benzo(k)fluoranthene	5.87E+05	5.87E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	N
Chrysene	1.81E+05	1.81E+03	2.14E-04	2.00E-03	2.48E-02	6.21E-06	2.28E+02	6.23E-09	N
Cyanide (CN-)	2.84E+00	2.84E-02	5.44E-03	1.00E+06	2.11E-01	2.46E-05	2.70E+01	7.42E+02	Y
Dibenz(a,h)anthracene	1.91E+06	1.91E+04	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	N
Ethylbenzene	4.46E+02	4.46E+00	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	5.55E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	N
Fluorene	9.16E+03	9.16E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	1.95E+04	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	N
Naphthalene	1.54E+03	1.54E+01	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	1.67E+02	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	1.87E+00	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	N
Pyrene	5.43E+04	5.43E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
#REF!	-	-	-	-	-	-	-	-	-
Toluene	2.34E+02	2.34E+00	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	4.47E+01	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	5.50E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	3.02E+01	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	3.16E+06	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	Y
TPH C15-C28 aromatic	3.79E+04	3.79E+02	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	Y
TPH C29-C36 aliphatic	6.31E+08	6.31E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	Y
TPH C29-C36 aromatic	1.26E+05	1.26E+03	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	N
Xylenes (total)	3.83E+02	3.83E+00	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Consta	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

Chemical	D_{s1}	D_{s2}	D_{s3}	D_{stot}	D_{crack}	D_{cap}	D_{ws}	Convective
	(cm^2/s)				(cm^2/s)	(cm^2/s)	(cm^2/s)	Factor (unitless)
Acenaphthene	3.96E-03	-	-	3.96E-03	3.96E-03	2.22E-04	3.09E-03	3.10E+01
Acenaphthylene	3.52E-03	-	-	3.52E-03	3.52E-03	2.97E-04	2.98E-03	3.49E+01
Ammonia	1.79E-02	-	-	1.79E-02	1.79E-02	3.28E-03	1.67E-02	6.86E+00
Anthracene	3.06E-03	-	-	3.06E-03	3.06E-03	6.77E-04	2.89E-03	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Benzene	6.98E-03	-	-	6.98E-03	6.98E-03	2.04E-05	1.04E-03	1.76E+01
Benzo(a)pyrene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Chrysene	NV	NV	NV	NV	NV	NV	NV	NV
Cyanide (CN-)	1.65E-02	-	-	1.65E-02	1.65E-02	9.06E-04	1.28E-02	7.44E+00
Dibenz(a,h)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Ethylbenzene	5.35E-03	-	-	5.35E-03	5.35E-03	1.40E-05	7.26E-04	2.30E+01
Fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Fluorene	3.45E-03	-	-	3.45E-03	3.45E-03	3.96E-04	3.05E-03	3.56E+01
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	NV	NV	NV
Naphthalene	4.72E-03	-	-	4.72E-03	4.72E-03	9.83E-05	2.65E-03	2.60E+01
Phenanthrene	2.72E-03	-	-	2.72E-03	2.72E-03	7.56E-04	2.60E-03	4.52E+01
Phenol	NV	NV	NV	NV	NV	NV	NV	NV
Pyrene	2.26E-03	-	-	2.26E-03	2.26E-03	2.90E-03	2.27E-03	5.43E+01
#REF!	-	-	-	-	-	-	-	-
Toluene	6.07E-03	-	-	6.07E-03	6.07E-03	1.66E-05	8.60E-04	2.02E+01
TPH C06-C09 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.30E-05	7.08E-04	1.57E+01
TPH C10-C14 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.08E-04	1.57E+01
TPH C10-C14 aromatic	7.80E-03	-	-	7.80E-03	7.80E-03	2.67E-05	1.33E-03	1.57E+01
TPH C15-C28 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.07E-04	1.57E+01
TPH C15-C28 aromatic	7.82E-03	-	-	7.82E-03	7.82E-03	4.10E-04	6.01E-03	1.57E+01
TPH C29-C36 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.07E-04	1.57E+01
TPH C29-C36 aromatic	NV	NV	NV	NV	NV	NV	NV	NV
Xylenes (total)	6.61E-03	-	-	6.61E-03	6.61E-03	2.00E-05	1.02E-03	1.86E+01

Definition of Parameters

D_s Effective diffusion coefficient in soil based on vapor-phase concentration
D_{crack} Effective diffusion coefficient through foundation cracks
D_{cap} Effective diffusion coefficient through capillary fringe
D_{ws} Effective diffusion coefficient between groundwater and soil surface

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

D. Chemical-Specific Volatilisation Factors

Chemical	VF_{wesp} (mg/m^3-air / mg/L-H_2O)	VF_{wamb} (mg/m^3-air / mg/L-H_2O)	VF_{trench} (mg/m^3-air / mg/L -water)
Acenaphthene	1.12E-03	6.15E-06	3.31E-02
Acenaphthylene	6.78E-04	3.68E-06	3.31E-02
Ammonia	1.92E-04	2.90E-06	3.31E-02
Anthracene	3.24E-04	1.74E-06	3.31E-02
Benz(a)anthracene	NV	NV	NV
Benzene	1.55E-02	6.27E-05	3.31E-02
Benzo(a)pyrene	NV	NV	NV
Benzo(b)fluoranthene	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV
Chrysene	NV	NV	NV
Cyanide (CN-)	1.49E-03	1.84E-05	3.31E-02
Dibenz(a,h)anthracene	NV	NV	NV
Ethylbenzene	1.62E-02	6.18E-05	3.31E-02
Fluoranthene	NV	NV	NV
Fluorene	5.80E-04	3.17E-06	3.31E-02
Indeno(1,2,3-cd)pyrene	NV	NV	NV
Naphthalene	2.43E-03	1.26E-05	3.31E-02
Phenanthrene	2.31E-04	1.19E-06	3.31E-02
Phenol	NV	NV	NV
Pyrene	5.94E-05	2.92E-07	3.31E-02
#REF!	-	-	-
Toluene	1.57E-02	6.16E-05	3.31E-02
TPH C06-C09 aliphatic	2.48E+00	9.46E-03	3.31E-02
TPH C10-C14 aliphatic	3.08E+00	1.17E-02	3.31E-02
TPH C10-C14 aromatic	1.17E-02	4.97E-05	3.31E-02
TPH C15-C28 aliphatic	4.06E+00	1.55E-02	3.31E-02
TPH C15-C28 aromatic	1.03E-03	7.79E-06	3.31E-02
TPH C29-C36 aliphatic	4.18E+00	1.59E-02	3.31E-02
TPH C29-C36 aromatic	NV	NV	NV
Xylenes (total)	1.42E-02	5.72E-05	3.31E-02

Definition of Parameters

VF_{wesp1}	Volatilization factor from groundwater to enclosed-space vapors - no convective transport
VF_{wesp2}	Volatilization factor from groundwater to enclosed-space vapors - with convective transport
VF_{wamb}	Volatilization factor from groundwater to ambient (outdoor) vapors
VF_{trench}	Volatilisation factor from groundwater to trench air (where groundwater seeps into trench - this is mass limited value based on estimated rate of groundwater flow into trench)

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting Shell default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Lower depth of surficial soil zone	cm	100		2000	LDSSZ	2000	large value to eliminate mass limiting in surface soil
Depth to subsurface soil sources (below building, ground surface or trench	cm	100			LS	100	Autocalculates from layer thicknesses
Vadose Zone Layer 1 (soil type where source is)							
Thickness	cm	100			HV	100	
SCS Soil Type:				Sand and gravel (<12% fines)			The majority of fill across the site has been identified as sand and gravel with some clay
Fraction of organic carbon	unitless	0.01		0.002	OC	0.002	
Soil bulk density	g/cm3	1.7		1.66	sbd	1.66	
Air-filled porosity (volumetric)	cm3/cm3	0.26		0.321	VACS	0.321	
Water-filled porosity (volumetric)	cm3/cm3	0.12		0.054	vwcvz	0.054	
Total soil porosity	cm3/cm3	0.38		0.375	TPOR	0.375	
Vapour phase source partitioning adjustment	unitless	1		10	VPPA	10	The biodegradation adjustment parameter has been applied to calculate the "volatilization factor from surface soils to ambient air" presented below. The parameter was applied to TPH and BTEX chemicals only.
Biodegradation adjustment	unitless	1		1	BioA	1	Conservatively assumes no soil vapour biodegradation
Vadose Zone Layer 2 (lens)							
Thickness	cm				Hvtwo		
SCS Soil Type:							
Air-filled porosity (volumetric)	cm3/cm3	NA			VACS2	NA	
Water-filled porosity (volumetric)	cm3/cm3	NA			vwcvz2	NA	
Total soil porosity	cm3/cm3	NA			TPOR2	NA	
Convective vapour flow term							
Calculate convective flow term?		Y			Conv	Y	
Convective flow rate (if specified directly)	cm3/sec						
Convective flow through slab (calculated)	cm3/sec	10.88			Qs	10.88	
Slab Area	cm2	700000			Ab	700000	
Areal fraction of cracks in foundations/walls	cm^2-cracks/cm^2-total area	0.0019			Nuc		
Soil vapour permeability	cm^2	1.00E-08			kv	1.00E-08	
Indoor-outdoor pressure differential	$g/cm\text{-}s^2$	40			dP	40	
Slab perimeter	cm	3400			Xcrack	3400	
Depth to bottom of slab	cm	15			Zcrack	15	
Viscosity of air	g/cm-s	1.81E-04			uair	1.81E-04	
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate)	cm/s	22.5	(c)	37.8	windsp	37.8	Based on the average annual 9am and 3pm windspeeds measured at observatory point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site), divided by 10
Width of source area parallel to wind or groundwater flow direction	cm	600	(d)	600	WSA	600	2 m deep and 2 m long trench
Ambient air mixing zone height	cm	200		200	AAMZH	200	assumes all vapours mixed w/in trench
Other							
Averaging time for surface emission vapour flux	sec	3.15E+07	(e)		atvapor	3.15E+07	Defaults to receptor exposure duration

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(d) For construction/excavation worker, default is 400 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.
(e) Equals exposure duration for selected receptor. For residential scenario, shortest (child) exposure duration is selected for conservative purposes.

AECOM

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

B. Chemical-Specific Fate and Transport Parameters

CHEMICAL	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-$H_2$0 / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	1.01E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	1.01E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	6.20E-03	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	3.28E+01	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	3.54E+02	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	2.92E-01	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	1.17E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	N
Benzo(b)fluoranthene	5.99E+05	1.20E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	N
Benzo(g,h,i)perylene	1.95E+06	3.90E+03	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	N
Benzo(k)fluoranthene	5.87E+05	1.17E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	N
Chrysene	1.81E+05	3.62E+02	2.14E-04	2.00E-03	2.48E-02	6.21E-06	2.28E+02	6.23E-09	N
Cyanide (CN-)	2.84E+00	5.68E-03	5.44E-03	1.00E+06	2.11E-01	2.46E-05	2.70E+01	7.42E+02	Y
Dibenz(a,h)anthracene	1.91E+06	3.82E+03	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	N
Ethylbenzene	4.46E+02	8.92E-01	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	1.11E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	N
Fluorene	9.16E+03	1.83E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	3.90E+03	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	N
Naphthalene	1.54E+03	3.08E+00	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	3.34E+01	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	3.74E-01	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	N
Pyrene	5.43E+04	1.09E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
#REF!	-	-	-	-	-	-	-	-	-
Toluene	2.34E+02	4.68E-01	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	8.94E+00	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	1.10E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	6.04E+00	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	6.32E+05	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	Y
TPH C15-C28 aromatic	3.79E+04	7.58E+01	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	Y
TPH C29-C36 aliphatic	6.31E+08	1.26E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	Y
TPH C29-C36 aromatic	1.26E+05	2.52E+02	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	N
Xylenes (total)	3.83E+02	7.66E-01	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Constant	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

CHEMICAL	D_{s1}	D_{s2}	D_{s3}	D_{stot}	D_{crack}	Csat	Convective
	(cm^2/s)				(cm^2/s)	mg/kg	Factor (unitless)
Acenaphthene	8.18E-03	-	-	8.18E-03	3.96E-03	3.94E+01	3.10E+01
Acenaphthylene	7.28E-03	-	-	7.28E-03	3.52E-03	1.63E+02	3.49E+01
Ammonia	3.69E-02	-	-	3.69E-02	1.79E-02	1.87E+04	6.86E+00
Anthracene	6.31E-03	-	-	6.31E-03	3.06E-03	1.42E+00	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	3.33E+00	NV
Benzene	1.45E-02	-	-	1.45E-02	6.98E-03	6.59E+02	1.76E+01
Benzo(a)pyrene	NV	NV	NV	NV	NV	1.90E+00	NV
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	1.80E+00	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	1.01E+00	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	9.39E-01	NV
Chrysene	NV	NV	NV	NV	NV	7.24E-01	NV
Cyanide (CN-)	3.41E-02	-	-	3.41E-02	1.65E-02	3.93E+04	7.44E+00
Dibenz(a,h)anthracene	NV	NV	NV	NV	NV	9.51E+00	NV
Ethylbenzene	1.11E-02	-	-	1.11E-02	5.35E-03	1.67E+02	2.30E+01
Fluoranthene	NV	NV	NV	NV	NV	2.89E+01	NV
Fluorene	7.11E-03	-	-	7.11E-03	3.45E-03	3.10E+01	3.56E+01
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	7.41E-01	NV
Naphthalene	9.78E-03	-	-	9.78E-03	4.72E-03	9.66E+01	2.60E+01
Phenanthrene	5.58E-03	-	-	5.58E-03	2.72E-03	3.84E+01	4.52E+01
Phenol	NV	NV	NV	NV	NV	3.37E+04	NV
Pyrene	4.50E-03	-	-	4.50E-03	2.26E-03	1.47E+01	5.43E+01
Toluene	1.26E-02	-	-	1.26E-02	6.07E-03	2.91E+02	2.02E+01
TPH C06-C09 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	2.21E+02	1.57E+01
TPH C10-C14 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	1.11E+02	1.57E+01
TPH C10-C14 aromatic	1.62E-02	-	-	1.62E-02	7.80E-03	1.54E+02	1.57E+01
TPH C15-C28 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	7.02E+01	1.57E+01
TPH C15-C28 aromatic	1.62E-02	-	-	1.62E-02	7.82E-03	8.04E+01	1.57E+01
TPH C29-C36 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	3.16E+00	1.57E+01
TPH C29-C36 aromatic	NV	NV	NV	NV	NV	1.66E+00	NV
Xylenes (total)	1.37E-02	-	-	1.37E-02	6.61E-03	8.90E+00	1.86E+01

Definition of Parameters

D_s Effective diffusion coefficient in soil based on vapor-phase concentration

D_{crack} Effective diffusion coefficient through foundation cracks

C_{sat} Soil concentration at which dissolved pore-water and vapor phases become saturated

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

D. Chemical-Specific Volatilisation Factors

CHEMICAL	VF_{as1}	VF_{as2}	$VF_{p\ (indoor)}$	$VF_{p\ (outdoor)}$	VF_{samb}	VF_{sesp}
	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)
Acenaphthene	5.07E-05	8.36E-03	-	2.78E-08	4.84E-06	2.34E-04
Acenaphthylene	3.77E-05	8.36E-03	-	2.78E-08	2.67E-06	1.42E-04
Ammonia	5.13E-04	8.36E-03	-	2.78E-08	4.95E-04	6.07E-03
Anthracene	1.36E-05	8.36E-03	-	2.78E-08	3.46E-07	2.07E-05
Benz(a)anthracene	NV	NV	-	2.78E-08	NV	NV
Benzene	1.94E-04	8.36E-03	-	2.78E-08	7.07E-04	2.08E-02
Benzo(a)pyrene	NV	NV	-	2.78E-08	NV	NV
Benzo(b)fluoranthene	NV	NV	-	2.78E-08	NV	NV
Benzo(g,h,i)perylene	NV	NV	-	2.78E-08	NV	NV
Benzo(k)fluoranthene	NV	NV	-	2.78E-08	NV	NV
Chrysene	NV	NV	-	2.78E-08	NV	NV
Cyanide (CN-)	1.41E-03	8.36E-03	-	2.78E-08	3.75E-03	4.95E-02
Dibenz(a,h)anthracene	NV	NV	-	2.78E-08	NV	NV
Ethylbenzene	1.24E-04	8.36E-03	-	2.78E-08	2.87E-04	1.07E-01
Fluoranthene	NV	NV	-	2.78E-08	NV	NV
Fluorene	2.54E-05	8.36E-03	-	2.78E-08	1.21E-06	6.55E-06
Indeno(1,2,3-cd)pyrene	NV	NV	-	2.78E-08	NV	NV
Naphthalene	1.54E-04	8.36E-03	-	2.78E-08	4.48E-05	1.86E-03
Phenanthrene	1.10E-05	8.36E-03	-	2.78E-08	2.29E-07	1.51E-06
Phenol	NV	NV	-	2.78E-08	NV	NV
Pyrene	2.92E-06	8.36E-03	-	2.78E-08	1.60E-08	1.24E-06
Toluene	1.61E-04	8.36E-03	-	2.78E-08	4.89E-04	1.63E-01
TPH C06-C09 aliphatic	4.29E-04	8.36E-03	-	2.78E-08	3.46E-03	9.17E-01
TPH C10-C14 aliphatic	6.20E-05	8.36E-03	-	2.78E-08	7.22E-05	1.92E-02
TPH C10-C14 aromatic	3.97E-05	8.36E-03	-	2.78E-08	2.97E-05	7.87E-04
TPH C15-C28 aliphatic	2.99E-06	8.36E-03	-	2.78E-08	1.68E-06	4.45E-05
TPH C15-C28 aromatic	2.10E-06	8.36E-03	-	2.78E-08	8.29E-07	2.20E-05
TPH C29-C36 aliphatic	2.14E-06	8.36E-03	-	2.78E-08	8.64E-07	2.29E-05
TPH C29-C36 aromatic	NV	NV	-	2.78E-08	NV	NV
Xylenes (total)	1.21E-04	8.36E-03	-	2.78E-08	2.74E-04	8.46E-03

Definition of Parameters

VF_{as} Volatilization factor from surficial soils to ambient air (vapors) - use lower of two values
VF_{p} Volatilization factor from surficial soils to ambient air (particulates)
VF_{samb} Volatilization factor from subsurface soils to ambient air
VF_{sesp1} Volatilization factor from soil to enclosed-space vapors
VF_{trench} Volatilisation factor from subsurface soil to trench air (where soil contamination is below base of trench)

Health Risk Calculations - Incidental Soil Ingestion
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Chemical	Soil Concentration (mg/kg)	Oral Soil Bioavailability Factor (unitless)	Threshold Intake and Risk Calculations: Oral RfD (mg/kg/day)	Adult Intake Factor (threshold) (kg/kg/day)	Adult Intake (threshold) (mg/kg/day)	Hazard Index (Adult) (unitless)	Non-Threshold Intake and Risk Calculations: Oral CSF (mg/kg/day)-1	Adult Intake Factor (non-threshold) (kg/kg/day)	Lifetime Intake Factor (non-threshold) (kg/kg/day)	Lifetime Intake (non-threshold) (mg/kg/day)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	270	1.00E+00	6.00E-02	1.94E-07	5.23E-05	8.72E-04	-	-	-	-	-
Acenaphthylene	1000	1.00E+00	6.00E-02	1.94E-07	1.94E-04	3.23E-03	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	1.00E+00	3.00E-01	1.94E-07	2.32E-04	7.75E-04	-	-	-	-	-
Benz(a)anthracene	910	1.00E+00	-	-	-	-	4.30E-02	2.77E-09	2.77E-09	2.52E-06	1.08E-07
Benzene	61	1.00E+00	5.00E-04	1.94E-07	1.18E-05	2.36E-02	3.50E-02	2.77E-09	2.77E-09	1.69E-07	5.91E-09
Benzo(a)pyrene	650	1.00E+00	-	-	-	-	4.30E-01	2.77E-09	2.77E-09	1.80E-06	7.74E-07
Benzo(b)fluoranthene	820	1.00E+00	-	-	-	-	4.30E-02	2.77E-09	2.77E-09	2.27E-06	9.76E-08
Benzo(g,h,i)perylene	310	1.00E+00	-	-	-	-	4.30E-03	2.77E-09	2.77E-09	8.58E-07	3.69E-09
Benzo(k)fluoranthene	320	1.00E+00	-	-	-	-	4.30E-02	2.77E-09	2.77E-09	8.86E-07	3.81E-08
Chrysene	630	1.00E+00	-	-	-	-	4.30E-03	2.77E-09	2.77E-09	1.74E-06	7.50E-09
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	73	1.00E+00	-	-	-	-	4.30E-01	2.77E-09	2.77E-09	2.02E-07	8.69E-08
Ethylbenzene	8	1.00E+00	9.71E-02	1.94E-07	1.55E-06	1.60E-05	-	-	-	-	-
Fluoranthene	2100	1.00E+00	4.00E-02	1.94E-07	4.07E-04	1.02E-02	-	-	-	-	-
Fluorene	1300	1.00E+00	4.00E-02	1.94E-07	2.52E-04	6.30E-03	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	1.00E+00	-	-	-	-	4.30E-02	2.77E-09	2.77E-09	6.92E-07	2.98E-08
Naphthalene	8400	1.00E+00	2.00E-02	1.94E-07	1.63E-03	8.14E-02	-	-	-	-	-
Phenanthrene	3100	1.00E+00	6.00E-02	1.94E-07	6.01E-04	1.00E-02	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-
Pyrene	1700	1.00E+00	3.00E-02	1.94E-07	3.29E-04	1.10E-02	-	-	-	-	-
Toluene	69	1.00E+00	2.23E-01	1.94E-07	1.34E-05	5.99E-05	-	-	-	-	-
TPH C06-C09 aliphatic	230	1.00E+00	5.00E+00	1.94E-07	4.46E-05	8.91E-06	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.00E+00	1.00E-01	1.94E-07	1.05E-02	1.05E-01	-	-	-	-	-
TPH C10-C14 aromatic	54000	1.00E+00	4.00E-02	1.94E-07	1.05E-02	2.62E-01	-	-	-	-	-
TPH C15-C28 aliphatic	72000	1.00E+00	2.00E+00	1.94E-07	1.39E-02	6.97E-03	-	-	-	-	-
TPH C15-C28 aromatic	72000	1.00E+00	3.00E-02	1.94E-07	1.39E-02	4.65E-01	-	-	-	-	-
TPH C29-C36 aliphatic	21000	1.00E+00	2.00E+00	1.94E-07	4.07E-03	2.03E-03	-	-	-	-	-
TPH C29-C36 aromatic	21000	1.00E+00	3.00E-02	1.94E-07	4.07E-03	1.36E-01	-	-	-	-	-
Xylenes (total)	94	1.00E+00	1.79E-01	1.94E-07	1.82E-05	1.02E-04	-	-	-	-	-
TOTAL						**1.12E+00**					**1.15E-06**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Health Risk Calculations - Dermal Contact with Soil
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

			Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Soil Concentration (mg/kg)	Dermal Absorption Factor (DAF) (unitless)	Dermal RfD (mg/kg/day)	Adult Intake Factor (threshold) (kg/kg/day)	Adult Intake (threshold) (mg/kg/day)	Hazard Index (Adult) (unitless)	Dermal CSF (mg/kg/day)-1	Adult Intake Factor (non-threshold) (kg/kg/day)	Lifetime Intake Factor (non-threshold) (kg/kg/day)	Lifetime Intake (non-threshold) (mg/kg/day)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	270	0.13	6.00E-02	4.12E-07	1.11E-04	1.85E-03	-	-	-	-	-
Acenaphthylene	1000	0.13	6.00E-02	4.12E-07	4.12E-04	6.87E-03	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	0.13	3.00E-01	4.12E-07	4.95E-04	1.65E-03	-	-	-	-	-
Benz(a)anthracene	910	0.13	-	-	-	-	4.30E-02	5.89E-09	5.89E-09	5.36E-06	2.30E-07
Benzene	61	-	5.00E-04	-	-	-	3.50E-02	-	-	-	-
Benzo(a)pyrene	650	0.13	-	-	-	-	2.50E+01	5.89E-09	5.89E-09	3.83E-06	9.57E-05
Benzo(b)fluoranthene	820	0.13	-	-	-	-	4.30E-02	5.89E-09	5.89E-09	4.83E-06	2.08E-07
Benzo(g,h,i)perylene	310	0.13	-	-	-	-	4.30E-03	5.89E-09	5.89E-09	1.83E-06	7.85E-09
Benzo(k)fluoranthene	320	0.13	-	-	-	-	4.30E-02	5.89E-09	5.89E-09	1.88E-06	8.10E-08
Chrysene	630	0.13	-	-	-	-	4.30E-03	5.89E-09	5.89E-09	3.71E-06	1.59E-08
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	73	0.13	-	-	-	-	4.30E-01	5.89E-09	5.89E-09	4.30E-07	1.85E-07
Ethylbenzene	8	-	9.71E-02	-	-	-	-	-	-	-	-
Fluoranthene	2100	0.13	4.00E-02	4.12E-07	8.65E-04	2.16E-02	-	-	-	-	-
Fluorene	1300	0.13	4.00E-02	4.12E-07	5.36E-04	1.34E-02	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	0.13	-	-	-	-	4.30E-02	5.89E-09	5.89E-09	1.47E-06	6.33E-08
Naphthalene	8400	0.13	2.00E-02	4.12E-07	3.46E-03	1.73E-01	-	-	-	-	-
Phenanthrene	3100	0.13	6.00E-02	4.12E-07	1.28E-03	2.13E-02	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-
Pyrene	1700	0.13	3.00E-02	4.12E-07	7.01E-04	2.34E-02	-	-	-	-	-
Toluene	69	-	2.23E-01	-	-	-	-	-	-	-	-
TPH C06-C09 aliphatic	230	-	5.00E+00	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	-	1.00E-01	-	-	-	-	-	-	-	-
TPH C10-C14 aromatic	54000	-	4.00E-02	-	-	-	-	-	-	-	-
TPH C15-C28 aliphatic	72000	0.1	2.00E+00	3.17E-07	2.28E-02	1.14E-02	-	-	-	-	-
TPH C15-C28 aromatic	72000	0.1	3.00E-02	3.17E-07	2.28E-02	7.61E-01	-	-	-	-	-
TPH C29-C36 aliphatic	21000	0.1	2.00E+00	3.17E-07	6.66E-03	3.33E-03	-	-	-	-	-
TPH C29-C36 aromatic	21000	0.1	3.00E-02	3.17E-07	6.66E-03	2.22E-01	-	-	-	-	-
Xylenes (total)	94	-	1.79E-01	-	-	-	-	-	-	-	-
TOTAL						**1.26E+00**					**9.65E-05**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

AECOM

Health Risk Calculations - Inhalation of Soil-Derived Particulates in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

			Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Soil Conc (mg/kg)	Particulate Concentration in Outdoor Air (From Surface Soil) (m3/kg)	Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (kg/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Inhalation Unit Risk (ug/m3)-1	Adult Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Adjusted Air Concentration (non-threshold) (mg/m3)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	270	2.78E-08	2.10E-01	3.81E-10	1.03E-07	4.89E-07	-	-	-	-	-
Acenaphthylene	1000	2.78E-08	2.10E-01	3.81E-10	3.81E-07	1.81E-06	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	2.78E-08	1.05E+00	3.81E-10	4.57E-07	4.35E-07	-	-	-	-	-
Benz(a)anthracene	910	2.78E-08	-	-	-	-	8.70E-03	5.44E-12	5.44E-12	4.95E-09	4.30E-08
Benzene	61	2.78E-08	9.60E-03	3.81E-10	2.32E-08	2.42E-06	6.00E-06	5.44E-12	5.44E-12	3.32E-10	1.99E-12
Benzo(a)pyrene	650	2.78E-08	-	-	-	-	8.70E-02	5.44E-12	5.44E-12	3.53E-09	3.07E-07
Benzo(b)fluoranthene	820	2.78E-08	-	-	-	-	8.70E-03	5.44E-12	5.44E-12	4.46E-09	3.88E-08
Benzo(g,h,i)perylene	310	2.78E-08	-	-	-	-	8.70E-04	5.44E-12	5.44E-12	1.69E-09	1.47E-09
Benzo(k)fluoranthene	320	2.78E-08	-	-	-	-	8.70E-03	5.44E-12	5.44E-12	1.74E-09	1.51E-08
Chrysene	630	2.78E-08	-	-	-	-	8.70E-04	5.44E-12	5.44E-12	3.42E-09	2.98E-09
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	73	2.78E-08	-	-	-	-	8.70E-02	5.44E-12	5.44E-12	3.97E-10	3.45E-08
Ethylbenzene	8	2.78E-08	1.30E+00	3.81E-10	3.04E-09	2.34E-09	-	-	-	-	-
Fluoranthene	2100	2.78E-08	1.40E-01	3.81E-10	7.99E-07	5.71E-06	-	-	-	-	-
Fluorene	1300	2.78E-08	1.40E-01	3.81E-10	4.95E-07	3.53E-06	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	2.78E-08	-	-	-	-	8.70E-03	5.44E-12	5.44E-12	1.36E-09	1.18E-08
Naphthalene	8400	2.78E-08	3.00E-03	3.81E-10	3.20E-06	1.07E-03	-	-	-	-	-
Phenanthrene	3100	2.78E-08	2.10E-01	3.81E-10	1.18E-06	5.62E-06	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-
Pyrene	1700	2.78E-08	1.05E-01	3.81E-10	6.47E-07	6.16E-06	-	-	-	-	-
Toluene	69	2.78E-08	5.00E+00	3.81E-10	2.63E-08	5.25E-09	-	-	-	-	-
TPH C06-C09 aliphatic	230	2.78E-08	1.84E+01	3.81E-10	8.75E-08	4.76E-09	-	-	-	-	-
TPH C10-C14 aliphatic	54000	2.78E-08	1.00E+00	3.81E-10	2.05E-05	2.05E-05	-	-	-	-	-
TPH C10-C14 aromatic	54000	2.78E-08	2.00E-01	3.81E-10	2.05E-05	1.03E-04	-	-	-	-	-
TPH C15-C28 aliphatic	72000	2.78E-08	7.00E+00	3.81E-10	2.74E-05	3.91E-06	-	-	-	-	-
TPH C15-C28 aromatic	72000	2.78E-08	1.05E-01	3.81E-10	2.74E-05	2.61E-04	-	-	-	-	-
TPH C29-C36 aliphatic	21000	2.78E-08	7.00E+00	3.81E-10	7.99E-06	1.14E-06	-	-	-	-	-
TPH C29-C36 aromatic	21000	2.78E-08	1.05E-01	3.81E-10	7.99E-06	7.61E-05	-	-	-	-	-
Xylenes (total)	94	2.78E-08	2.20E-01	3.81E-10	3.58E-08	1.63E-07	-	-	-	-	-
TOTAL						**1.56E-03**					**4.55E-07**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Health Risk Calculations - Inhalation of Surface Soil-Derived Vapours in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

					Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Soil Conc. (mg/kg)	Csat (mg/kg)	Volatilisation Factor from Subsurface Soil to Outdoor Air [(mg/m3)/(mg/kg)]	Vapour Concentration in Outdoor Air (From Surface Soil) (mg/m3)	Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (kg/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Inhalation Unit Risk (ug/m3)-1	Adult Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Adjusted Air Concentration (non-threshold) (mg/m3)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	270	3.94E+01	5.07E-05	2.00E-03	2.10E-01	6.95E-07	2.74E-05	1.30E-04	-	-	-	-	-
Acenaphthylene	1000	1.63E+02	3.77E-05	6.12E-03	2.10E-01	5.16E-07	8.38E-05	3.99E-04	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	1.42E+00	1.36E-05	1.93E-05	1.05E+00	1.86E-07	2.65E-07	2.52E-07	-	-	-	-	-
Benz(a)anthracene	910	3.33E+00	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Benzene	61	6.59E+02	1.94E-04	1.18E-02	9.60E-03	2.66E-06	1.62E-04	1.69E-02	6.00E-06	3.80E-08	3.80E-08	2.32E-06	1.39E-08
Benzo(a)pyrene	650	1.90E+00	NV	-	-	-	-	-	8.70E-02	-	-	-	-
Benzo(b)fluoranthene	820	1.80E+00	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Benzo(g,h,i)perylene	310	1.01E+00	NV	-	-	-	-	-	8.70E-04	-	-	-	-
Benzo(k)fluoranthene	320	9.39E-01	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Chrysene	630	7.24E-01	NV	-	-	-	-	-	8.70E-04	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	73	9.51E+00	NV	-	-	-	-	-	8.70E-02	-	-	-	-
Ethylbenzene	8	1.67E+02	1.24E-04	9.88E-04	1.30E+00	1.69E-06	1.35E-05	1.04E-05	-	-	-	-	-
Fluoranthene	2100	2.89E+01	NV	-	1.40E-01	-	-	-	-	-	-	-	-
Fluorene	1300	3.10E+01	2.54E-05	7.87E-04	1.40E-01	3.47E-07	1.08E-05	7.70E-05	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	7.41E-01	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Naphthalene	8400	9.66E+01	1.54E-04	1.49E-02	3.00E-03	2.12E-06	2.04E-04	6.81E-02	-	-	-	-	-
Phenanthrene	3100	3.84E+01	1.10E-05	4.25E-04	2.10E-01	1.51E-07	5.82E-06	2.77E-05	-	-	-	-	-
Phenol	-	-	NV	-	-	-	-	-	-	-	-	-	-
Pyrene	1700	1.47E+01	2.92E-06	4.28E-05	1.05E-01	4.00E-08	5.86E-07	5.59E-06	-	-	-	-	-
Toluene	69	2.91E+02	1.61E-04	1.11E-02	5.00E+00	2.21E-06	1.53E-04	3.05E-05	-	-	-	-	-
TPH C06-C09 aliphatic	230	2.21E+02	4.29E-04	9.48E-02	1.84E+01	5.88E-06	1.30E-03	7.06E-05	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.11E+02	6.20E-05	6.89E-03	1.00E+00	8.49E-07	9.44E-05	9.44E-05	-	-	-	-	-
TPH C10-C14 aromatic	54000	1.54E+02	3.97E-05	6.13E-03	2.00E-01	5.44E-07	8.40E-05	4.20E-04	-	-	-	-	-
TPH C15-C28 aliphatic	72000	7.02E+01	2.99E-06	2.10E-04	7.00E+00	4.09E-08	2.87E-06	4.10E-07	-	-	-	-	-
TPH C15-C28 aromatic	72000	8.04E+01	2.10E-06	1.69E-04	1.05E-01	2.88E-08	2.31E-06	2.20E-05	-	-	-	-	-
TPH C29-C36 aliphatic	21000	3.16E+00	2.14E-06	6.77E-06	7.00E+00	2.94E-08	9.27E-08	1.32E-08	-	-	-	-	-
TPH C29-C36 aromatic	21000	1.66E+00	NV	-	1.05E-01	-	-	-	-	-	-	-	-
Xylenes (total)	94	8.90E+00	1.21E-04	1.08E-03	2.20E-01	1.66E-06	1.47E-05	6.70E-05	-	-	-	-	-
TOTAL								**8.64E-02**					**1.39E-08**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Health Risk Calculations - Incidental Ingestion of Groundwater (bathing or excavation)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

		Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Groundwater Concentration (mg/L)	Oral RfD (mg/kg/day)	Adult Intake Factor (threshold) (L/kg/day)	Adult Intake (threshold) (mg/kg/day)	Hazard Index (Adult) (unitless)	Oral CSF (mg/kg/day)-1	Adult Intake Factor (non-threshold) (L/kg/day)	Lifetime Intake Factor (non-threshold) (L/kg/day)	Lifetime Intake (non-threshold) (mg/kg/day)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	4.4	6.00E-02	2.94E-06	1.29E-05	2.15E-04	-	-	-	-	-
Acenaphthylene	43	6.00E-02	2.94E-06	1.26E-04	2.10E-03	-	-	-	-	-
Ammonia	348	-	-	-	-	-	-	-	-	-
Anthracene	15	3.00E-01	2.94E-06	4.40E-05	1.47E-04	-	-	-	-	-
Benz(a)anthracene	13	-	-	-	-	4.30E-02	4.19E-08	4.19E-08	5.45E-07	2.34E-08
Benzene	41	5.00E-04	2.94E-06	1.20E-04	2.41E-01	3.50E-02	4.19E-08	4.19E-08	1.72E-06	6.02E-08
Benzo(a)pyrene	9.3	-	-	-	-	4.30E-01	4.19E-08	4.19E-08	3.90E-07	1.68E-07
Benzo(b)fluoranthene	8.3	-	-	-	-	4.30E-02	4.19E-08	4.19E-08	3.48E-07	1.50E-08
Benzo(g,h,i)perylene	4.2	-	-	-	-	4.30E-03	4.19E-08	4.19E-08	1.76E-07	7.57E-10
Benzo(k)fluoranthene	3.7	-	-	-	-	4.30E-02	4.19E-08	4.19E-08	1.55E-07	6.67E-09
Chrysene	9.3	-	-	-	-	4.30E-03	4.19E-08	4.19E-08	3.90E-07	1.68E-09
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	0.82	-	-	-	-	4.30E-01	4.19E-08	4.19E-08	3.44E-08	1.48E-08
Ethylbenzene	3	9.71E-02	2.94E-06	8.81E-06	9.07E-05	-	-	-	-	-
Fluoranthene	26	4.00E-02	2.94E-06	7.63E-05	1.91E-03	-	-	-	-	-
Fluorene	21	4.00E-02	2.94E-06	6.16E-05	1.54E-03	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	-	-	-	-	4.30E-02	4.19E-08	4.19E-08	1.30E-07	5.59E-09
Naphthalene	283	2.00E-02	2.94E-06	8.31E-04	4.15E-02	-	-	-	-	-
Phenanthrene	74	6.00E-02	2.94E-06	2.17E-04	3.62E-03	-	-	-	-	-
Phenol	392	3.00E-01	2.94E-06	1.15E-03	3.84E-03	-	-	-	-	-
Pyrene	28	3.00E-02	2.94E-06	8.22E-05	2.74E-03	-	-	-	-	-
Toluene	18	2.23E-01	2.94E-06	5.28E-05	2.37E-04	-	-	-	-	-
TPH C06-C09 aliphatic	74	5.00E+00	2.94E-06	2.17E-04	4.34E-05	-	-	-	-	-
TPH C10-C14 aliphatic	1700	1.00E-01	2.94E-06	4.99E-03	4.99E-02	-	-	-	-	-
TPH C10-C14 aromatic	1700	4.00E-02	2.94E-06	4.99E-03	1.25E-01	-	-	-	-	-
TPH C15-C28 aliphatic	1520	2.00E+00	2.94E-06	4.46E-03	2.23E-03	-	-	-	-	-
TPH C15-C28 aromatic	1520	3.00E-02	2.94E-06	4.46E-03	1.49E-01	-	-	-	-	-
TPH C29-C36 aliphatic	330	2.00E+00	2.94E-06	9.69E-04	4.84E-04	-	-	-	-	-
TPH C29-C36 aromatic	330	3.00E-02	2.94E-06	9.69E-04	3.23E-02	-	-	-	-	-
Xylenes (total)	6.7	1.79E-01	2.94E-06	1.97E-05	1.10E-04	-	-	-	-	-
Bold denotes soil/ groundwater SSTC has been proposed (see text for details)										
TOTAL					**6.57E-01**					**2.96E-07**

Health Risk Calculations - Dermal Contact with Groundwater (bathing or excavation)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Chemical	Groundwater Concentration (mg/L)	Dermal Permeability Constant (kp) (cm/hr)	Threshold Intake and Risk Calculations: Dermal RfD (mg/kg/day)	Adult Intake Factor (threshold) (L/kg/day)	Adult Intake (threshold) (mg/kg/day)	Hazard Index (Adult) (unitless)	Non-Threshold Intake and Risk Calculations: Dermal CSF (mg/kg/day)-1	Adult Intake Factor (non-threshold) (L/kg/day)	Lifetime Intake Factor (non-threshold) (L/kg/day)	Lifetime Intake (non-threshold) (mg/kg/day)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	4.4	0.086	6.00E-02	1.97E-04	8.66E-04	0.01	-	-	-	-	-
Acenaphthylene	43	0.0911	6.00E-02	2.09E-04	8.97E-03	0.15	-	-	-	-	-
Ammonia	348	0.001	-	-	-	-	-	-	-	-	-
Anthracene	15	0.142	3.00E-01	3.25E-04	4.88E-03	0.02	-	-	-	-	-
Benz(a)anthracene	13	0.552	-	-	-	-	4.30E-02	1.81E-05	1.81E-05	2.35E-04	1.01E-05
Benzene	41	0.0149	5.00E-04	3.41E-05	1.40E-03	2.80	3.50E-02	4.87E-07	4.87E-07	2.00E-05	6.99E-07
Benzo(a)pyrene	9.3	0.713	-	-	-	-	4.30E-01	2.33E-05	2.33E-05	2.17E-04	9.33E-05
Benzo(b)fluoranthene	8.3	0.417	-	-	-	-	4.30E-02	1.36E-05	1.36E-05	1.13E-04	4.87E-06
Benzo(g,h,i)perylene	4.2	1.12	-	-	-	-	4.30E-03	3.66E-05	3.66E-05	1.54E-04	6.62E-07
Benzo(k)fluoranthene	3.7	0.691	-	-	-	-	4.30E-02	2.26E-05	2.26E-05	8.36E-05	3.60E-06
Chrysene	9.3	0.596	-	-	-	-	4.30E-03	1.95E-05	1.95E-05	1.81E-04	7.80E-07
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	0.82	0.953	-	-	-	-	4.30E-01	3.12E-05	3.12E-05	2.56E-05	1.10E-05
Ethylbenzene	3	0.0493	9.71E-02	1.13E-04	3.39E-04	0.00	-	-	-	-	-
Fluoranthene	26	0.308	4.00E-02	7.05E-04	1.83E-02	0.46	-	-	-	-	-
Fluorene	21	0.11	4.00E-02	2.52E-04	5.29E-03	0.13	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	1.24	-	-	-	-	4.30E-02	4.06E-05	4.06E-05	1.26E-04	5.41E-06
Naphthalene	283	0.0466	2.00E-02	1.07E-04	3.02E-02	1.51	-	-	-	-	-
Phenanthrene	74	0.144	6.00E-02	3.30E-04	2.44E-02	0.41	-	-	-	-	-
Phenol	392	0.00434	3.00E-01	9.94E-06	3.90E-03	0.01	-	-	-	-	-
Pyrene	28	0.201	3.00E-02	4.60E-04	1.29E-02	0.43	-	-	-	-	-
Toluene	18	0.0311	2.23E-01	7.12E-05	1.28E-03	0.01	-	-	-	-	-
TPH C06-C09 aliphatic	74	0.196	5.00E+00	4.49E-04	3.32E-02	0.01	-	-	-	-	-
TPH C10-C14 aliphatic	1700	1.29	1.00E-01	2.95E-03	5.02E+00	50.21	-	-	-	-	-
TPH C10-C14 aromatic	1700	0.128	4.00E-02	2.93E-04	4.98E-01	12.46	-	-	-	-	-
TPH C15-C28 aliphatic	1520	0.506	2.00E+00	1.16E-03	1.76E+00	0.88	-	-	-	-	-
TPH C15-C28 aromatic	1520	0.356	3.00E-02	8.15E-04	1.24E+00	41.30	-	-	-	-	-
TPH C29-C36 aliphatic	330	0.444	2.00E+00	1.02E-03	3.35E-01	0.17	-	-	-	-	-
TPH C29-C36 aromatic	330	0.655	3.00E-02	1.50E-03	4.95E-01	16.50	-	-	-	-	-
Xylenes (total)	6.7	0.0471	1.79E-01	1.08E-04	7.23E-04	0.00	-	-	-	-	-
TOTAL						**1.27E+02**					**1.30E-04**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Health Risk Calculations - Inhalation of Groundwater-Derived Vapours in Trench Air (where groundwater enters trench)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

					Threshold Intake and Risk Calculations				Non-Threshold Intake Risk Calculations				
Chemical	Groundwater Concentration (mg/L)	Aqueous Solubility (mg/L)	Volatilisation Factor from Groundwater to Trench Air (where GW enters trench) [(mg/m3)/(mg/L)]	Vapour Concentration in Trench Air (from GW within trench) (mg/m3)	Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (L/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Inhalation Unit Risk (ug/m3)-1	Adult Exposure Factor (non-threshold) (L/m3)	Lifetime Exposure Factor (non-threshold) (L/m3)	Lifetime Exposure Adjusted Air Concentration (non-threshold) (mg/m3)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	4.4	3.90E+00	3.31E-02	1.29E-01	2.10E-01	4.53E-04	1.77E-03	8.41E-03	-	-	-	-	-
Acenaphthylene	43	1.61E+01	3.31E-02	5.32E-01	2.10E-01	4.53E-04	7.29E-03	3.47E-02	-	-	-	-	-
Ammonia	348	4.82E+05	3.31E-02	1.15E+01	6.95E-02	4.53E-04	1.58E-01	2.27E+00	-	-	-	-	-
Anthracene	15	4.34E-02	3.31E-02	1.44E-03	1.05E+00	4.53E-04	1.97E-05	1.87E-05	-	-	-	-	-
Benz(a)anthracene	13	9.40E-03	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Benzene	41	1.79E+03	3.31E-02	1.36E+00	9.60E-03	4.53E-04	1.86E-02	1.93E+00	6.00E-06	6.47E-06	6.47E-06	2.65E-04	1.59E-06
Benzo(a)pyrene	9.3	1.62E-03	NV	-	-	-	-	-	8.70E-02	-	-	-	-
Benzo(b)fluoranthene	8.3	1.50E-03	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Benzo(g,h,i)perylene	4.2	2.60E-04	NV	-	-	-	-	-	8.70E-04	-	-	-	-
Benzo(k)fluoranthene	3.7	8.00E-04	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Chrysene	9.3	2.00E-03	NV	-	-	-	-	-	8.70E-04	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	0.82	2.49E-03	NV	-	-	-	-	-	8.70E-02	-	-	-	-
Ethylbenzene	3	1.69E+02	3.31E-02	9.92E-02	1.30E+00	4.53E-04	1.36E-03	1.05E-03	-	-	-	-	-
Fluoranthene	26	2.60E-01	NV	-	1.40E-01	-	-	-	-	-	-	-	-
Fluorene	21	1.69E+00	3.31E-02	5.59E-02	1.40E-01	4.53E-04	7.66E-04	5.47E-03	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	1.90E-04	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Naphthalene	283	3.10E+01	3.31E-02	1.03E+00	3.00E-03	4.53E-04	1.40E-02	4.68E+00	-	-	-	-	-
Phenanthrene	74	1.15E+00	3.31E-02	3.80E-02	2.10E-01	4.53E-04	5.21E-04	2.48E-03	-	-	-	-	-
Phenol	392	8.28E+04	NV	-	2.00E-01	-	-	-	-	-	-	-	-
Pyrene	28	1.35E-01	3.31E-02	4.46E-03	1.05E-01	4.53E-04	6.12E-05	5.82E-04	-	-	-	-	-
Toluene	18	5.26E+02	3.31E-02	5.95E-01	5.00E+00	4.53E-04	8.15E-03	1.63E-03	-	-	-	-	-
TPH C06-C09 aliphatic	74	1.18E+01	3.31E-02	3.90E-01	1.84E+01	4.53E-04	5.35E-03	2.91E-04	-	-	-	-	-
TPH C10-C14 aliphatic	1700	9.99E-02	3.31E-02	3.30E-03	1.00E+00	4.53E-04	4.53E-05	4.53E-05	-	-	-	-	-
TPH C10-C14 aromatic	1700	2.53E+01	3.31E-02	8.37E-01	2.00E-01	4.53E-04	1.15E-02	5.73E-02	-	-	-	-	-
TPH C15-C28 aliphatic	1520	1.11E-04	3.31E-02	3.67E-06	7.00E+00	4.53E-04	5.03E-08	7.18E-09	-	-	-	-	-
TPH C15-C28 aromatic	1520	1.06E+00	3.31E-02	3.51E-02	1.05E-01	4.53E-04	4.80E-04	4.57E-03	-	-	-	-	-
TPH C29-C36 aliphatic	330	2.50E-06	3.31E-02	8.27E-08	7.00E+00	4.53E-04	1.13E-09	1.62E-10	-	-	-	-	-
TPH C29-C36 aromatic	330	6.60E-03	NV	-	1.05E-01	-	-	-	-	-	-	-	-
Xylenes (total)	6.7	1.06E+01	3.31E-02	2.22E-01	2.20E-01	4.53E-04	3.04E-03	1.38E-02	-	-	-	-	-
TOTAL								**9.01E+00**					**1.59E-06**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Soil RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (Hazard Index)					Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity) (kg/mg)							RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Vapour Only Risk at Csat (if necessary)	Revised RBSL (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL				
			Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL (All Pathways)	Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL (All Pathways)						Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	unitless	unitless	unitless	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	mg/kg			mg/kg	mg/kg	%	%	%	%	%
Acenaphthene	270	3.94E+01	8.72E-04	1.85E-03	4.89E-07	1.30E-04	2.86E-03	3.23E-06	6.87E-06	1.81E-09	3.31E-06	1.01E-05	3.31E-06	1.34E-05	1.49E+04	1.51E-01	1.30E-04	1.98E+04	**1.98E+04**	31.95%	67.97%	0.02%	0.07%	100.00%
Acenaphthylene	1000	1.63E+02	3.23E-03	6.87E-03	1.81E-06	3.99E-04	1.05E-02	3.23E-06	6.87E-06	1.81E-09	2.46E-06	1.01E-05	2.46E-06	1.26E-05	1.59E+04	1.61E-01	3.99E-04	1.98E+04	**1.98E+04**	31.91%	67.88%	0.02%	0.20%	100.00%
Ammonia	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Anthracene	1200	1.42E+00	7.75E-04	1.65E-03	4.35E-07	2.52E-07	2.42E-03	6.46E-07	1.37E-06	3.62E-10	1.77E-07	2.02E-06	1.77E-07	2.20E-06	9.10E+04	1.84E-01	2.52E-07	9.90E+04	**9.90E+04**	31.97%	68.01%	0.02%	0.00%	100.00%
Benz(a)anthracene	910	3.33E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Benzene	61	6.59E+02	2.36E-02	-	2.42E-06	1.69E-02	4.05E-02	3.87E-04	-	3.96E-08	2.77E-04	3.88E-04	2.77E-04	6.64E-04	3.76E+02	2.50E-01	-	-	**3.76E+02**	58.32%	-	0.01%	41.67%	100.00%
Benzo(a)pyrene	650	1.90E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Benzo(b)fluoranthene	820	1.80E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Benzo(g,h,i)perylene	310	1.01E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Benzo(k)fluoranthene	320	9.39E-01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Chrysene	630	7.24E-01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Dibenz(a,h)anthracene	73	9.51E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Ethylbenzene	8	1.67E+02	1.60E-05	-	2.34E-09	1.04E-05	2.64E-05	2.00E-06	-	2.93E-10	1.30E-06	2.00E-06	1.30E-06	3.30E-06	7.58E+04	1.52E-01	2.17E-04	1.25E+05	**1.25E+05**	99.90%	-	0.01%	0.09%	100.00%
Fluoranthene	2100	2.89E+01	1.02E-02	2.16E-02	5.71E-06	-	3.18E-02	4.84E-06	1.03E-05	2.72E-09	-	1.51E-05		1.51E-05	1.32E+04	2.00E-01	-	-	**1.32E+04**	31.97%	68.01%	0.02%	-	100.00%
Fluorene	1300	-	6.30E-03	1.34E-02	3.53E-06	7.70E-05	1.98E-02	4.84E-06	1.03E-05	2.72E-09	5.92E-08	1.51E-05	5.92E-08	1.52E-05	1.32E+04	-	-	-	**1.32E+04**	31.85%	67.75%	0.02%	0.39%	100.00%
Indeno(1,2,3-cd)pyrene	250	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Naphthalene	8400	9.66E+01	8.14E-02	1.73E-01	1.07E-03	6.81E-02	3.24E-01	9.69E-06	2.06E-05	1.27E-07	7.05E-04	3.04E-05	7.05E-04	7.36E-04	2.72E+02	7.64E-02	6.81E-02	4.33E+03	**4.33E+03**	20.99%	44.66%	0.27%	34.07%	100.00%
Phenanthrene	3100	3.84E+01	1.00E-02	2.13E-02	5.62E-06	2.77E-05	3.13E-02	3.23E-06	6.87E-06	1.81E-09	7.20E-07	1.01E-05	7.20E-07	1.08E-05	1.85E+04	1.87E-01	2.77E-05	1.98E+04	**1.98E+04**	31.97%	68.00%	0.02%	0.01%	100.00%
Phenol	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Pyrene	1700	1.47E+01	1.10E-02	2.34E-02	6.16E-06	5.59E-06	3.43E-02	6.46E-06	1.37E-05	3.62E-09	3.81E-07	2.02E-05	3.81E-07	2.06E-05	9.72E+03	1.96E-01	5.59E-06	9.90E+03	**9.90E+03**	31.97%	68.01%	0.02%	0.00%	100.00%
Toluene	69	2.91E+02	5.99E-05	-	5.25E-09	3.05E-05	9.05E-05	8.69E-07	-	7.61E-11	4.42E-07	8.69E-07	4.42E-07	1.31E-06	1.91E+05	1.66E-01	1.29E-04	2.88E+05	**2.88E+05**	99.94%	-	0.01%	0.05%	100.00%
TPH C06-C09 aliphatic	230	2.21E+02	8.91E-06	-	4.76E-09	7.06E-05	7.95E-05	3.87E-08	-	2.07E-11	3.19E-07	3.88E-08	3.19E-07	3.58E-07	3.49E+05	1.36E-02	7.06E-05	3.22E+06	**3.22E+06**	99.89%	-	0.05%	0.06%	100.00%
TPH C10-C14 aliphatic	54000	1.11E+02	1.05E-01	-	2.05E-05	9.44E-05	1.05E-01	1.94E-06	-	3.81E-10	8.49E-07	1.94E-06	8.49E-07	2.79E-06	4.49E+04	8.70E-02	9.44E-05	6.45E+04	**6.45E+04**	99.90%	-	0.02%	0.08%	100.00%
TPH C10-C14 aromatic	54000	1.54E+02	2.62E-01	-	1.03E-04	4.20E-04	2.62E-01	4.84E-06	-	1.90E-09	2.72E-06	4.85E-06	2.72E-06	7.57E-06	1.65E+04	8.05E-02	4.20E-04	2.57E+04	**2.57E+04**	99.62%	-	0.04%	0.34%	100.00%
TPH C15-C28 aliphatic	72000	7.02E+01	6.97E-03	1.14E-02	3.91E-06	4.10E-07	1.84E-02	9.69E-08	1.59E-07	5.44E-11	5.85E-09	2.55E-07	5.85E-09	2.61E-07	4.78E+05	1.22E-01	4.10E-07	4.89E+05	**4.89E+05**	37.92%	62.06%	0.02%	0.00%	100.00%
TPH C15-C28 aromatic	72000	8.04E+01	4.65E-01	7.61E-01	2.61E-04	2.20E-05	1.23E+00	6.46E-06	1.06E-05	3.62E-09	2.74E-07	1.70E-05	2.74E-07	1.73E-05	7.22E+03	1.23E-01	2.20E-05	7.34E+03	**7.34E+03**	37.92%	62.04%	0.02%	0.02%	100.00%
TPH C29-C36 aliphatic	21000	3.16E+00	2.03E-03	3.33E-03	1.14E-06	1.32E-08	5.36E-03	9.69E-08	1.59E-07	5.44E-11	4.20E-09	2.55E-07	4.20E-09	2.60E-07	4.81E+05	1.23E-01	1.32E-08	4.89E+05	**4.89E+05**	37.92%	62.06%	0.02%	0.00%	100.00%
TPH C29-C36 aromatic	21000	1.66E+00	1.36E-01	2.22E-01	7.61E-05	-	3.58E-01	6.46E-06	1.06E-05	3.62E-09	-	1.70E-05		1.70E-05	7.34E+03	-	-	-	**7.34E+03**	37.92%	62.06%	0.02%	-	100.00%
Xylenes (total)	94	-	1.02E-04	-	1.63E-07	6.70E-05	1.69E-04	1.08E-06	-	1.73E-09	7.12E-07	1.08E-06	7.12E-07	1.80E-06	1.39E+05	-	-	-	**1.39E+05**	60.25%	-	0.10%	39.65%	100.00%

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Soil RBSL Derivation - Non-Threshold Lifetime Health Effects (Adult and Child)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (ILCR)					Risk/Soil Concentration (i.e., exposure and toxicity factor)							RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL				
			Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL	Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL				Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	unitless	unitless	unitless	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	mg/kg		mg/kg	%	%	%	%	%
Acenaphthene	270	3.94E+01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Acenaphthylene	1000	1.63E+02	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Anthracene	1200	1.42E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Benz(a)anthracene	910	3.33E+00	1.08E-07	2.30E-07	4.30E-08	-	3.82E-07	1.19E-10	2.53E-10	4.73E-11	-	4.19E-10		4.19E-10	2.38E+04	1.00E-05	-	-	-	-	-	-
Benzene	61	6.59E+02	5.91E-09	-	1.99E-12	1.39E-08	1.98E-08	9.69E-11	-	3.26E-14	2.28E-10	9.69E-11	2.28E-10	3.25E-10	3.08E+04	3.13E-06	**1.02E+05**	98.46%	-	0.03%	231.59%	330.09%
Benzo(a)pyrene	650	1.90E+00	7.74E-07	9.57E-05	3.07E-07	-	9.68E-05	1.19E-09	1.47E-07	4.73E-10	-	1.49E-07		1.49E-07	6.72E+01	1.00E-05	**6.72E+01**	0.80%	98.88%	0.32%	-	100.00%
Benzo(b)fluoranthene	820	1.80E+00	9.76E-08	2.08E-07	3.88E-08	-	3.44E-07	1.19E-10	2.53E-10	4.73E-11	-	4.19E-10		4.19E-10	2.38E+04	1.00E-05	-	-	-	-	-	-
Benzo(g,h,i)perylene	310	1.01E+00	3.69E-09	7.85E-09	1.47E-09	-	1.30E-08	1.19E-11	2.53E-11	4.73E-12	-	4.19E-11		4.19E-11	2.38E+05	1.00E-05	-	-	-	-	-	-
Benzo(k)fluoranthene	320	9.39E-01	3.81E-08	8.10E-08	1.51E-08	-	1.34E-07	1.19E-10	2.53E-10	4.73E-11	-	4.19E-10		4.19E-10	2.38E+04	1.00E-05	-	-	-	-	-	-
Chrysene	630	7.24E-01	7.50E-09	1.59E-08	2.98E-09	-	2.64E-08	1.19E-11	2.53E-11	4.73E-12	-	4.19E-11		4.19E-11	2.38E+05	1.00E-05	-	-	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	73	9.51E+00	8.69E-08	1.85E-07	3.45E-08	-	3.06E-07	1.19E-09	2.53E-09	4.73E-10	-	4.19E-09		4.19E-09	2.38E+03	1.00E-05	-	-	-	-	-	-
Ethylbenzene	8	1.67E+02	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Fluoranthene	2100	2.89E+01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Fluorene	1300	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	-	2.98E-08	6.33E-08	1.18E-08	-	1.05E-07	1.19E-10	2.53E-10	4.73E-11	-	4.19E-10		4.19E-10	2.38E+04	1.00E-05	-	-	-	-	-	-
Naphthalene	8400	9.66E+01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Phenanthrene	3100	3.84E+01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Pyrene	1700	1.47E+01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Toluene	69	2.91E+02	-	-	-	-	-	-	-	-	-			-	-	-	-					
TPH C06-C09 aliphatic	230	2.21E+02	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.11E+02	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C10-C14 aromatic	54000	1.54E+02	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C15-C28 aliphatic	72000	7.02E+01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C15-C28 aromatic	72000	8.04E+01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C29-C36 aliphatic	21000	3.16E+00	-	-	-	-	-	-	-	-	-			-	-	-	-					
TPH C29-C36 aromatic	21000	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Xylenes (total)	94	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Groundwater RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Chemical	Cgw	Solubility	Risk at Input Groundwater Concentration (Hazard Index) GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	TOTAL (All Pathways)	Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity) GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL (All Pathways)	RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Vapour Only Risk at Sol (if necessary)	Revised RBSL (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	TOTAL
	mg/L	mg/L	unitless	unitless	unitless	unitless	L/mg	L/mg	L/mg	L/mg	L/mg	L/mg	mg/L			mg/L	mg/L	%	%	%	%
Acenaphthene	4.4	3.90E+00	8.41E-03	2.15E-04	1.44E-02	2.31E-02	2.16E-03	4.89E-05	3.28E-03	3.33E-03	2.16E-03	5.49E-03	3.64E+01	1.30E-01	8.41E-03	5.75E+01	**5.75E+01**	4.21%	1.41%	94.39%	100.00%
Acenaphthylene	43	1.61E+01	3.47E-02	2.10E-03	1.49E-01	1.86E-01	2.16E-03	4.89E-05	3.48E-03	3.53E-03	2.16E-03	5.68E-03	3.52E+01	1.59E-01	3.47E-02	4.69E+01	**4.69E+01**	17.36%	1.15%	81.49%	100.00%
Ammonia	348	4.82E+05	2.27E+00	-	-	2.27E+00	6.52E-03	-	-		6.52E-03	6.52E-03	1.53E+02	1.00E+00	-	-	**1.53E+02**	100.00%	-	-	100.00%
Anthracene	15	4.34E-02	1.87E-05	1.47E-04	1.63E-02	1.64E-02	4.31E-04	9.78E-06	1.08E-03	1.09E-03	4.31E-04	1.52E-03	1.31E+02	1.43E-01	1.87E-05	1.83E+02	**1.83E+02**	0.01%	0.89%	99.10%	100.00%
Benz(a)anthracene	13	9.40E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Benzene	41	1.79E+03	1.93E+00	2.41E-01	2.80E+00	4.97E+00	4.72E-02	5.87E-03	6.82E-02	7.41E-02	4.72E-02	1.21E-01	2.06E+00	2.50E-01	-	-	**2.06E+00**	38.90%	4.84%	56.25%	100.00%
Benzo(a)pyrene	9.3	1.62E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Benzo(b)fluoranthene	8.3	1.50E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Benzo(g,h,i)perylene	4.2	2.60E-04	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Benzo(k)fluoranthene	3.7	8.00E-04	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Chrysene	9.3	2.00E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Cyanide (CN-)	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Dibenz(a,h)anthracene	0.82	2.49E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Ethylbenzene	3	1.69E+02	1.05E-03	9.07E-05	3.49E-03	4.62E-03	3.48E-04	3.02E-05	1.16E-03	1.19E-03	3.48E-04	1.54E-03	1.62E+02	2.50E-01	-	-	**1.62E+02**	22.61%	1.96%	75.43%	100.00%
Fluoranthene	26	2.60E-01	-	1.91E-03	4.58E-01	4.60E-01	-	7.34E-05	1.76E-02	1.77E-02		1.77E-02	1.13E+01	2.00E-01	-	-	**1.13E+01**	-	0.41%	99.59%	100.00%
Fluorene	21	1.69E+00	5.47E-03	1.54E-03	1.32E-01	1.39E-01	3.24E-03	7.34E-05	6.30E-03	6.37E-03	3.24E-03	9.61E-03	2.08E+01	1.38E-01	5.47E-03	3.05E+01	**3.05E+01**	2.73%	1.12%	96.15%	100.00%
Indeno(1,2,3-cd)pyrene	3.1	1.90E-04	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Naphthalene	283	3.10E+01	4.68E+00	4.15E-02	1.51E+00	6.23E+00	1.51E-01	1.47E-04	5.33E-03	5.48E-03	1.51E-01	1.56E-01	1.28E+00	2.00E-01	-	-	**1.28E+00**	96.50%	0.09%	3.41%	100.00%
Phenanthrene	74	1.15E+00	2.48E-03	3.62E-03	4.07E-01	4.13E-01	2.16E-03	4.89E-05	5.50E-03	5.54E-03	2.16E-03	7.70E-03	2.60E+01	1.46E-01	2.48E-03	3.56E+01	**3.56E+01**	1.24%	0.87%	97.89%	100.00%
Phenol	392	8.28E+04	-	3.84E-03	1.30E-02	1.68E-02	-	9.78E-06	3.31E-05	4.29E-05		4.29E-05	2.33E+04	1.00E+00	-	-	**2.33E+04**	-	22.80%	77.20%	100.00%
Pyrene	28	1.35E-01	5.82E-04	2.74E-03	4.30E-01	4.33E-01	4.31E-03	9.78E-05	1.53E-02	1.54E-02	4.31E-03	1.98E-02	1.01E+01	1.57E-01	5.82E-04	1.29E+01	**1.29E+01**	0.29%	0.63%	99.08%	100.00%
Toluene	18	5.26E+02	1.63E-03	2.37E-04	5.75E-03	7.62E-03	9.06E-05	1.32E-05	3.19E-04	3.32E-04	9.06E-05	4.23E-04	5.91E+02	2.44E-01	4.77E-02	6.09E+02	**6.09E+02**	19.06%	3.20%	77.73%	100.00%
TPH C06-C09 aliphatic	74	1.18E+01	2.91E-04	4.34E-05	6.64E-03	6.98E-03	2.46E-05	5.87E-07	8.98E-05	9.03E-05	2.46E-05	1.15E-04	1.09E+03	9.85E-02	2.91E-04	1.38E+03	**1.38E+03**	0.23%	0.65%	99.12%	100.00%
TPH C10-C14 aliphatic	1700	9.99E-02	4.53E-05	4.99E-02	5.02E+01	5.03E+01	4.53E-04	2.94E-05	2.95E-02	2.96E-02	4.53E-04	3.00E-02	4.16E+00	1.23E-01	4.53E-05	4.23E+00	**4.23E+00**	0.04%	0.10%	99.86%	100.00%
TPH C10-C14 aromatic	1700	2.53E+01	5.73E-02	1.25E-01	1.25E+01	1.26E+01	2.26E-03	7.34E-05	7.33E-03	7.40E-03	2.26E-03	9.67E-03	1.29E+01	1.25E-01	-	-	**1.29E+01**	23.43%	0.76%	75.81%	100.00%
TPH C15-C28 aliphatic	1520	1.11E-04	7.18E-09	2.23E-03	8.80E-01	8.83E-01	6.47E-05	1.47E-06	5.79E-04	5.81E-04	6.47E-05	6.45E-04	1.94E+02	1.12E-01	7.18E-09	2.15E+02	**2.15E+02**	0.00%	0.25%	99.75%	100.00%
TPH C15-C28 aromatic	1520	1.06E+00	4.57E-03	1.49E-01	4.13E+01	4.15E+01	4.31E-03	9.78E-05	2.72E-02	2.73E-02	4.31E-03	3.16E-02	3.96E+00	1.12E-01	4.57E-03	4.42E+00	**4.42E+00**	3.66%	0.35%	96.00%	100.00%
TPH C29-C36 aliphatic	330	2.50E-06	1.62E-10	4.84E-04	1.68E-01	1.68E-01	6.47E-05	1.47E-06	5.08E-04	5.10E-04	6.47E-05	5.74E-04	2.18E+02	1.11E-01	1.62E-10	2.45E+02	**2.45E+02**	0.00%	0.29%	99.71%	100.00%
TPH C29-C36 aromatic	330	6.60E-03	-	3.23E-02	1.65E+01	1.65E+01	-	9.78E-05	5.00E-02	5.01E-02		5.01E-02	2.50E+00	1.25E-01	-	-	**2.50E+00**	-	0.20%	99.80%	100.00%
Xylenes (total)	6.7	1.06E+01	1.38E-02	1.10E-04	4.04E-03	1.79E-02	2.06E-03	1.64E-05	6.02E-04	6.19E-04	2.06E-03	2.68E-03	9.34E+01	7.96E-02	2.18E-02	3.69E+02	**3.69E+02**	8.73%	2.42%	88.85%	100.00%

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Groundwater RBSL Derivation - Non-Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Chemical	Cgw	Solubility	Risk at Input Groundwater Concentration (ILCR)				Risk/GW Concentration (i.e., pathway specific factor for exposure and toxicity)						RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Revised RBSL (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL			
			GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	TOTAL (All Pathways)	GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL (All Pathways)					GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	TOTAL
	mg/L	mg/L	unitless	unitless	unitless	unitless	L/mg	L/mg	L/mg	L/mg	L/mg	L/mg	mg/L		mg/L	mg/L	%	%	%	%
Acenaphthene	4.4	3.90E+00	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Acenaphthylene	43	1.61E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Ammonia	348	4.82E+05	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Anthracene	15	4.34E-02	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Benz(a)anthracene	13	9.40E-03	-	2.34E-08	1.01E-05	1.01E-05	-	1.80E-09	7.76E-07	7.78E-07		7.78E-07	1.29E+01	1.00E-05	-	-	-	-	-	-
Benzene	41	1.79E+03	1.59E-06	6.02E-08	6.99E-07	2.35E-06	3.88E-08	1.47E-09	1.71E-08	1.85E-08	3.88E-08	5.74E-08	1.74E+02	1.00E-05	-	**1.74E+02**	67.70%	2.56%	29.74%	100.00%
Benzo(a)pyrene	9.3	1.62E-03	-	1.68E-07	9.33E-05	9.34E-05	-	1.80E-08	1.00E-05	1.00E-05		1.00E-05	9.95E-01	1.00E-05	-	**9.95E-01**	-	0.18%	99.82%	100.00%
Benzo(b)fluoranthene	8.3	1.50E-03	-	1.50E-08	4.87E-06	4.88E-06	-	1.80E-09	5.87E-07	5.88E-07		5.88E-07	1.70E+01	1.00E-05	-	-	-	-	-	-
Benzo(g,h,i)perylene	4.2	2.60E-04	-	7.57E-10	6.62E-07	6.62E-07	-	1.80E-10	1.58E-07	1.58E-07		1.58E-07	6.34E+01	1.00E-05	-	-	-	-	-	-
Benzo(k)fluoranthene	3.7	8.00E-04	-	6.67E-09	3.60E-06	3.60E-06	-	1.80E-09	9.72E-07	9.74E-07		9.74E-07	1.03E+01	1.00E-05	-	-	-	-	-	-
Chrysene	9.3	2.00E-03	-	1.68E-09	7.80E-07	7.81E-07	-	1.80E-10	8.38E-08	8.40E-08		8.40E-08	1.19E+02	1.00E-05	-	**1.19E+02**	-	0.21%	99.79%	100.00%
Cyanide (CN-)	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	0.82	2.49E-03	-	1.48E-08	1.10E-05	1.10E-05	-	1.80E-08	1.34E-05	1.34E-05		1.34E-05	7.45E-01	1.00E-05	-	-	-	-	-	-
Ethylbenzene	3	1.69E+02	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Fluoranthene	26	2.60E-01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Fluorene	21	1.69E+00	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	1.90E-04	-	5.59E-09	5.41E-06	5.41E-06	-	1.80E-09	1.74E-06	1.75E-06		1.75E-06	5.73E+00	1.00E-05	-	-	-	-	-	-
Naphthalene	283	3.10E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Phenanthrene	74	1.15E+00	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Phenol	392	8.28E+04	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Pyrene	28	1.35E-01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
#REF!	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Toluene	18	5.26E+02	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C06-C09 aliphatic	74	1.18E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	1700	9.99E-02	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C10-C14 aromatic	1700	2.53E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C15-C28 aliphatic	1520	1.11E-04	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C15-C28 aromatic	1520	1.06E+00	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C29-C36 aliphatic	330	2.50E-06	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	330	6.60E-03	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Xylenes (total)	6.7	1.06E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-

Bold denotes soil/ groundwater SSTC has been proposed (see text for details

Summary of Derived RBSLs
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Post-Development) (Risk Based Calculations) Scenario

Back to User Input Sheet

Chemical	Soil RBSLs (mg/kg)						Groundwater RBSLs (mg/L)					
	Adult Threshold	Child Threshold	Non-Threshold (Lifetime)	Adopted RBSL (Lowest)	Saturation Limited?	Site Concentration	Adult Threshold	Child Threshold	Non-Threshold (Lifetime)	Adopted RBSL (Lowest)	Solubility Limited?	Site Concentration
Acenaphthene	1.98E+04	-	-	**1.98E+04**	-	2.70E+02	5.75E+01	-	-	**5.75E+01**	-	4.40E+00
Acenaphthylene	1.98E+04	-	-	**1.98E+04**	-	1.00E+03	4.69E+01	-	-	**4.69E+01**	-	4.30E+01
Ammonia	-	-	-	**-**	-	-	1.53E+02	-	-	**1.53E+02**	-	3.48E+02
Anthracene	9.90E+04	-	-	**9.90E+04**	-	1.20E+03	1.83E+02	-	-	**1.83E+02**	-	1.50E+01
Benz(a)anthracene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Benzene	3.76E+02	-	1.02E+05	**3.76E+02**	-	6.10E+01	2.06E+00	-	1.74E+02	**2.06E+00**	-	4.10E+01
Benzo(a)pyrene	-	-	6.72E+01	**6.72E+01**	-	6.50E+02	-	-	9.95E-01	**9.95E-01**	-	9.30E+00
Benzo(b)fluoranthene	-	-	-	**-**	-	-	-	-				-
Benzo(g,h,i)perylene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Benzo(k)fluoranthene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Chrysene	-	-	-	**-**	-	-	-	-			-	-
Cyanide (CN-)	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Dibenz(a,h)anthracene	-	-	-	**-**	-	-	-	-			-	-
Ethylbenzene	1.25E+05	-	-	**1.25E+05**	-	8.00E+00	1.62E+02	-	-	**1.62E+02**	-	3.00E+00
Fluoranthene	1.32E+04	-	-	**1.32E+04**	-	2.10E+03	1.13E+01	-	-	**1.13E+01**	-	2.60E+01
Fluorene	1.32E+04	-	-	**1.32E+04**	-	1.30E+03	3.05E+01	-	-	**3.05E+01**	-	2.10E+01
Indeno(1,2,3-cd)pyrene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Naphthalene	4.33E+03	-	-	**4.33E+03**	-	8.40E+03	1.28E+00	-	-	**1.28E+00**	-	2.83E+02
Phenanthrene	1.98E+04	-	-	**1.98E+04**	-	3.10E+03	3.56E+01	-	-	**3.56E+01**	-	7.40E+01
Phenol	-	-	-	**-**	-	-	2.33E+04	-	-	**2.33E+04**	-	3.92E+02
Pyrene	9.90E+03	-	-	**9.90E+03**	-	1.70E+03	1.29E+01	-	-	**1.29E+01**	-	2.80E+01
Toluene	2.88E+05	-	-	**2.88E+05**	-	6.90E+01	6.09E+02	-	-	**6.09E+02**	-	1.80E+01
TPH C06-C09 aliphatic	3.22E+06	-	-	**3.22E+06**	-	2.30E+02	1.38E+03	-	-	**1.38E+03**	-	7.40E+01
TPH C10-C14 aliphatic	6.45E+04	-	-	**6.45E+04**	-	5.40E+04	4.23E+00	-	-	**4.23E+00**	-	1.70E+03
TPH C10-C14 aromatic	2.57E+04	-	-	**2.57E+04**	-	5.40E+04	1.29E+01	-	-	**1.29E+01**	-	1.70E+03
TPH C15-C28 aliphatic	4.89E+05	-	-	**4.89E+05**	-	7.20E+04	2.15E+02	-	-	**2.15E+02**	-	1.52E+03
TPH C15-C28 aromatic	7.34E+03	-	-	**7.34E+03**	-	7.20E+04	4.42E+00	-	-	**4.42E+00**	-	1.52E+03
TPH C29-C36 aliphatic	4.89E+05	-	-	**4.89E+05**	-	2.10E+04	2.45E+02	-	-	**2.45E+02**	-	3.30E+02
TPH C29-C36 aromatic	7.34E+03	-	-	**7.34E+03**	-	2.10E+04	2.50E+00	-	-	**2.50E+00**	-	3.30E+02
Xylenes (total)	1.39E+05	-	-	**1.39E+05**	-	9.40E+01	3.69E+02	-	-	**3.69E+02**	-	6.70E+00

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Pathways included in derivation of Soil RBSL:

- x Incidental Ingestion of Soil
- x Dermal Contact with Soil
- x Inhalation of Soil-Derived Dust in Outdoor Air
- x Inhalation of Surface Soil-Derived Vapours in Outdoor Air

SSTL for carcinogenic PAH's is included in SSTL for BaP

Pathways included in derivation of Groundwater RBSL:

- x Incidental Ingestion of Groundwater (Bathing or Excavation)
- x Dermal Contact with Groundwater (Bathing or Excavation)
- x Inhalation of Groundwater Vapours (Where GW Enters Trench)

Appendix F

Toxicity Profiles

This page has been left blank intentionally.

Ammonia – Toxicological profile

The following information has been taken from ATSDR (2004):

General

Ammonia occurs naturally as a product of decomposing organic material and volcanic eruptions and has a number of commercial applications including the manufacture of fertilizers, plastics, synthetic fibers and resins and explosives.

In the atmosphere, ammonia can react with acidic substances in the air to produce ammonium aerosols, which can be subject to dry or wet deposition. The best estimate of the half-life of atmospheric ammonia is a few days. In water, ammonia can volatilize to the atmosphere, be removed by microbial processes, or adsorb to sediment and suspended organic material. In soil, ammonia can volatilize to the atmosphere, adsorb to soil particles, undergo microbial transformation to nitrate or nitrite anions, or be taken up by plants.

For the general population, the most likely source of exposure to elevated levels of ammonia is from the use of household cleaners containing ammonia or ammonium salts. People who live near farms, who visit farms during the application of fertilizer, or who live near cattle feedlots, poultry confinement buildings, or other areas where animal populations are concentrated can also be exposed to ammonia. There is also the possibility for exposure to ammonia via water and food ingestion. If untreated surface water is ingested, the average uptake would be 0.36 mg/day (assuming an ammonia concentration in untreated water of 0.18 mg/L and a consumption rate of 2 L/day). For most sources of drinking water, however, adsorption, nitrification, and the conversion of ammonia to chloramines upon chlorination will result in negligible levels of ammonia in most drinking water supplies. Food ingestion can also lead to an exposure to ammonia, primarily due to the use of various ammonium salts as food stabilizers; the estimated exposure from these food additives is 18 mg/day.

Populations that live or work near a hazardous waste site that contains ammonia or ammonium salts could be exposed to above-average levels of ammonia in soil, water, or air in similar concentrations as those in agricultural settings. While these exposures may occur, the half-life of ammonia in nature is probably very short..

Non-carcinogenic Health Effects

No health effects have been found in humans exposed to typical environmental concentrations of ammonia. Exposure to high levels of ammonia in air may be irritating to your skin, eyes, throat, and lungs and cause coughing and burns. Lung damage and death may occur after exposure to very high concentrations of ammonia. Some people with asthma may be more sensitive to breathing ammonia than others.

Swallowing concentrated solutions of ammonia can cause burns in your mouth, throat, and stomach. Splashing ammonia into your eyes can cause burns and even blindness.

Carcinogenicity and Genotoxicity

There is no evidence that ammonia causes cancer. The Department of Health and Human Services (DHHS), the USEPA, and the International Agency for Research on Cancer (IARC), have not classified ammonia for carcinogenicity.

The available animal and human data indicate that ammonia and ammonium ions may have clastogenic and mutagenic properties, however the majority of studies that indicated positive genotoxicity results were associated with ammonium compounds and were tested on animals. Human studies are inconclusive.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for Ammonia

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Inhalation	Minimal Risk Level (MRL)	Threshold	6.95×10^{-2} mg/m^3	ATSDR (2004)	Chronic duration
Inhalation	Reference Concentration (RfC)	Threshold	0.1 mg/m^3	USEPA (2011)	

Adopted Threshold Dose-Response Values

Dose-response values for ammonia have not been published by Australian regulatory bodies or by the World Health Organization (WHO), and AECOM has therefore adopted the Minimal Risk Level (MRL) of 6.95×10^{-2} published by ATSDR (2004) for assessment of threshold inhalation exposure to ammonia.

No dose-response values have been published or adopted to assess oral exposure to ammonia. According to ATSDR (2004), the amount of excess ammonia that can be safely ingested is considered to be substantial.

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

Ammonia has not been classified for carcinogenic effects, and no relationship has been reported between oral or inhalation exposure to ammonia and cancer or carcinogenicity in humans (ATSDR, 2004).

References

ATSDR, 2004. *Toxicological Profile for Ammonia*. Agency for Toxic Substances and Disease Registry. September, 2004.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

USEPA, 2011. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Center for Environmental Assessment, Office of Research and Development. Accessed May 2011.

Benzene – Toxicological profile

The following information has been taken from ATSDR (2007):

General

Although benzene occurs naturally and is emitted by volcanoes and forest fires, the greatest sources are associated with the manufacture of plastics, resins, and nylon and other synthetic fibres. Benzene is used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides and is a natural part of crude oil, gasoline, and cigarette smoke.

Non-carcinogenic Health Effects

Damage to both the humoral and cellular components of the immune system has been known to occur in humans following inhalation exposure. This is manifested by decreased levels of antibodies and decreased levels of leukocytes in workers. Animal data support these findings.

The most characteristic systemic effect resulting from intermediate and chronic benzene exposure is arrested development of blood cells. Early biomarkers of exposure to relatively low levels of benzene include depressed numbers of one or more of the circulating blood cell types. A common clinical finding in benzene hematotoxicity is cytopenia, which is a decrease in various cellular elements of the circulating blood manifested as anemia, leukopenia, or thrombocytopenia in humans and in animals. Benzene associated cytopenias vary and may involve a reduction in one (unicellular cytopenias) to all three (pancytopenia) cellular elements of the blood.

Benzene causes a life-threatening disorder called aplastic anemia in humans and animals. This disorder is characterized by reduction of all cellular elements in the peripheral blood and in bone marrow, leading to fibrosis, an irreversible replacement of bone marrow. Benzene has also been associated with acute non-lymphocytic leukemia in humans, and aplastic anemia may be an early indicator of developing acute non-lymphocytic leukemia in some cases.

Limited information is available on other systemic effects reported in humans and is associated with high–level benzene exposure. Respiratory effects have been noted after acute exposure of humans to benzene vapors. Cardiovascular effects, particularly ventricular fibrillation, have been suggested as the cause of death in fatal exposures to benzene vapor. Gastrointestinal effects have been noted in humans after fatal inhalation exposure (congestive gastritis), and ingestion (toxic gastritis and pyloric stenosis), of benzene.

Myelofibrosis (a form of aplastic anemia) was reported by a gasoline station attendant who had been exposed to benzene by inhalation, and probably also through dermal contact. Myalgia was also reported in steel plant workers exposed to benzene vapors. Reports of renal effects in humans after benzene exposure consist of kidney congestion after fatal inhalation exposure. Dermal and ocular effects including skin irritation and burns, and eye irritation have been reported after exposure to benzene vapors. Swelling and edema have been reported to occur in a human who swallowed benzene. Studies in animals show systemic effects after inhalation exposure, including cardiovascular effects. Oral administration of benzene to animals has yielded information concerning hepatic effects. A study conducted in rabbits lends support to the finding that benzene is irritating and damaging to the skin and also shows that it is irritating and damaging to the eyes following dermal or ocular application.

Carcinogenicity and Genotoxicity

The carcinogenicity of benzene is well documented in exposed workers. Epidemiological studies and case reports provide clear evidence of a causal relationship between occupational exposure to benzene and benzene-containing solvents and the occurrence of acute myelogenous leukemia (AML). The epidemiological studies are generally limited by confounding chemical exposures and methodological problems, including inadequate or lack of exposure monitoring and low statistical power, but a consistent excess risk of leukemia across studies indicates that benzene is the causal factor. The IARC have classified benzene as a Group 1 agent (carcinogenic).

In vivo and *in vitro* data from both humans and animals indicate that benzene and/or its metabolites are genotoxic. Chromosomal aberrations (hypo- and hyperdiploidy, deletions, breaks, and gaps) in peripheral lymphocytes and bone marrow cells are the predominant effects seen in humans.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for Benzene

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	Minimal Risk Level (MRL)	Threshold	0.0005 mg/kg/day	ATSDR (2007)	Chronic duration
Oral	Reference Dose (RfD)	Threshold	0.004 mg/kg/day	USEPA (2010)	
Oral	Slope Factor	Non Threshold	0.035 $(mg/kg/day)^{-1}$	NHMRC (2004)	Converted from unit risk of 1 x 10^{-6} per 0.001 mg/L, assuming 2 L/day water ingestion rate and 70 kg body weight.
Oral	Slope Factor	Non Threshold	0.035 $(mg/kg/day)^{-1}$	WHO (2008)	As above.
Inhalation	Minimal Risk Level (MRL)	Threshold	0.0096 mg/m^3	ATSDR (2007)	Chronic exposure.
Inhalation	Reference Concentration (RfC)	Threshold	0.03 mg/m^3	USEPA (2010)	
Inhalation	Unit Risk	Non-Threshold	5.88 x10^{-6} $(\mu g/m^3)^{-1}$	WHO (2000)	
Inhalation	Unit Risk	Non-Threshold	6 x 10^{-6} $(\mu g/m^3)^{-1}$	WHO (2000)	

Adopted Threshold Dose-Response Values

Dose-response values for threshold effects associated with oral exposure to benzene have not been published by Australian regulatory bodies or by the World Health Organization (WHO). AECOM has therefore adopted the oral reference dose of 0.0005 mg/kg/day published by the ATSDR (2007).

Dose-response values for threshold effects associated with inhalation exposure to benzene have not been published by Australian regulatory bodies or by the World Health Organization (WHO). AECOM has therefore adopted the inhalation reference concentration of 0.0096 mg/m^3 published by ATSDR (2007).

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

For assessment of potential non-threshold effects associated with oral exposure to benzene, AECOM has adopted the NHMRC (2004) value of 0.035 $(mg/kg/day)^{-1}$.

For assessment of potential non-threshold effects associated with inhalation exposure to benzene, AECOM has adopted the inhalation unit risk value of 6 x 10^{-6} $(\mu g/m^3)^{-1}$ published by the WHO (2000).

References

ATSDR, 2007. *Toxicological Profile for Benzene*. Agency for Toxic Substances and Disease Registry. August, 2007.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

NHMRC, 2004. *Australian Drinking Water Guidelines*. National Health and Medical Research Council.

USEPA, 2011. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Centre for Environmental Assessment, Office of Research and Development. Accessed May 2011.

WHO, 2000. *Air Quality Guidelines for Europe. Second Edition.* World Health Organization (WHO), Regional Office for Europe. WHO Regional Publications, European Series, No. 91. 2000.

WHO, 2008. *Guidelines for Drinking-water Quality. First and Second Addenda to the Third-Edition. Volume 1. Recommendations.* World Health Organization.

Cyanide – Toxicological profile

The following information has been taken from ATSDR (2005):

General

Cyanides are both naturally occurring and man-made and many are powerful and rapid-acting poisons. Hydrogen cyanide, sodium cyanide, and potassium cyanide are the forms of cyanide and are most likely to be in the environment as a result of industrial activities. Certain bacteria, fungi, and algae can also produce cyanide, and it is also found in a number of foods and plants.

Many of the cyanides in soil and water come from industrial processes such as metal mining, organic chemical industries, iron and steel plants or manufacturers, and publicly owned wastewater treatment facilities. Automotive exhausts are a source of cyanides, as are fumes from the incineration of municipal waste and cyanide containing pesticides.

Cyanide enters air, water, and soil from both natural processes and industrial activities. Airborne cyanide is present mainly as gaseous hydrogen cyanide and is generally far below levels that would cause concern. A small amount of cyanide in air is present as fine dust particles. This dust eventually settles over land and water and is removed from air by rain and snow. Most cyanide in surface water will form hydrogen cyanide and evaporate. Some cyanide in water will be transformed into less harmful chemicals by microorganisms or will form a complex with metals, such as iron. Cyanide in water does not build up in the bodies of fish.

Cyanides are fairly mobile in soil and can be converted to hydrogen cyanide gas or other chemical forms by microorganisms present in the soil. Cyanides usually do not seep into underground water however cyanide has been detected in underground waters of landfills and industrial waste disposal sites. At the high concentrations found in some landfill leachates and in the wastes stored in some disposal sites, cyanide becomes toxic to soil microorganisms. Because these microorganisms can no longer change cyanide to other chemical forms, cyanide is able to passes through soil into underground water.

Non-carcinogenic Health Effects

The toxicity of individual cyanide compounds is dependent on the ease with which they release cyanide anion ($CN^–$). For example, cyanide radicals have a low affinity for alkali metals and a high affinity for ferric iron (Fe^{3+}) and other metals; therefore, simple cyanide salts (for example, sodium cyanide or potassium cyanide) are toxic, whereas certain iron-containing cyanide compounds do not release $CN^–$ readily and are nearly nontoxic. Cyanide exerts its primary toxicological effects by binding to the metallic cofactor in metalloenzymes, thereby impairing enzyme and cell function. Cytochrome c oxidase is the most significant target of cyanide exposure since its inhibition prevents tissues from using oxygen causing histiotoxic hypoxia. The most vulnerable tissues are those with the highest oxygen demand and/or a deficiency in detoxifying enzymes such as rhodanese. The inhibition of oxygen use by cells causes oxygen tensions to rise in peripheral tissues; this results in a decrease in the unloading gradient for oxyhemoglobin. Thus, oxyhemoglobin is carried in the venous blood, which is one biomarker of cyanide exposure. In addition to binding to cytochrome c oxidase, cyanide inhibits enzymatic activity of a wide variety of enzymes which contribute to the signs of cyanide toxicity.

Although the entire body is affected by cyanide exposure, adverse effects on the central nervous system are of the most consequence to the organism because of the high metabolic demand for oxygen in neurons and its control of respiratory function. Initial stimulation of carotid and aortic bodies and effects on the central nervous system adversely affect the function of the respiratory system, which contributes to the global histiotoxic hypoxia leading to death. High inhalation, oral, or dermal exposure levels result in convulsions, unconsciousness, and death due to inactivation of the centers controlling respiration. Lower exposures may result in headache or dizziness.

The signs of cyanide toxicity at concentrations leading to death in humans are well described: intoxication, followed by a brief sensation of dryness and burning in the throat, suffusing warmth, and a hunger for air. Within 1 minute apnea develops and symptoms worsen with loss of consciousness and convulsions. Cardiovascular failure may also occur, although the heart may continue to beat for 3– 4 minutes after the last breath. Reported signs sometimes include a bitter almond-like odor on the breath and (in light-toned individuals) a rose-colored hue of the skin. Dermal exposure to cyanide results in comparable effects, but at higher doses.

Nonlethal exposures to hydrogen cyanide gas produces upper respiratory irritation, cough, altered sense of smell, nasal congestion, epistaxis, hemoptysis, and dyspnea in exposed workers. Workers acutely exposed to cyanogen, which dissociates into hydrogen cyanide and hydrocyanic acid, experienced nasal irritation. Other effects observed at nonlethal exposure levels include hypotension, heart palpitations, precordial pains, nausea and vomiting resulting from central nervous system stimulation or direct contact with cyanide, and albinuria. Animal studies also report bradycardia, arrhythmia, and T-wave abnormalities, vomiting, increased blood urea nitrogen, and histopathology of the renal proximal tubular epithelium and glomeruli. Hepatic effects have not been reported in humans, but have been observed in some animal studies.

Thyroid effects following cyanide exposure result from the interference of thiocyanate, a metabolite of cyanide, with iodine uptake and utilization in the thyroid gland. Enlargement of the thyroid gland and increased levels of thyroid stimulating hormone were observed in workers exposed by inhalation. No data were available for cyanide-induced neurotoxicity in humans following intermediate-duration exposures by any route, but a number of animal studies are available, none of which, systematically evaluated neurotoxicity using a neurobehavioral test battery. Following repeated inhalation exposure to cyanide, transitory neurobehavioral effects (increased response rates without encephalopathy) were observed in monkeys and more serious effects (tremors, rigidity, ataxia, atrophy of Purkinje cells, and vasodilation and hemorrhage in the brain) were observed in dogs, the most sensitive species tested. Oral exposure studies administered cyanide salts by oral gavage, in drinking water, or diet. In oral gavage studies in pigs or rats, behavioral changes (reduced activity) were observed at doses between 0.14 and 0.8 mg cyanide/kg/day and more serious effects (tremors, convulsions) were observed at 7.8 mg CN–/kg/day, a lethal dose. No encephalopathy or overt signs of neurotoxicity were observed following repeated exposure via drinking water to doses as high as 12.5 mg CN–/kg/day in rats or 28.8 mg CN–/kg/day in mice. Myelin degeneration of spinal cord tracts was observed in rats receiving 30 mg CN–/kg/day via dietary exposure.

Chronic exposure to lower cyanide concentrations in occupational settings causes a variety of symptoms from fatigue, dizziness, and headaches to ringing in the ears, paresthesias of extremities, and syncopes, or even hemiparesis and hemianopia. In addition, behavioral changes were reported following prolonged cyanide exposure with loss of memory and decreases in visual acuity, psychomotor ability, and visual learning reported in workers. It is possible, however, that during occupational exposure, such as electroplating operations, chemicals other than cyanide may have contributed to the effects observed.

Chronic neurological effects are exacerbated by nutritional deficiencies or other disorders that provide inadequate levels of thiosulfate needed to detoxify cyanide. Among those observed were hyperreflexia or spastic paraparesis of the extremities, spastic dysarthria, visual and hearing difficulties, and cerebellar signs.

Carcinogenicity and Genotoxicity

There is no evidence that cyanide exposure is correlated with carcinogenicity in humans or animals.

Cyanide has only an indirect genotoxic effect in vivo and in vitro, in that dying cells release endonucleasese into the cytosol, ultimately resulting in DNA fragmentation.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for Cyanide

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	Acceptable Daily Intake (ADI)	Threshold	0.012 mg/kg/day	NHMRC (2004)	
Oral	Acceptable Daily Intake (ADI)	Threshold	0.012 mg/kg/day	WHO (2008)	Protective for acute and long term exposure

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	Minimal Risk Level (MRL)	Threshold	0.05	ATSDR (2005)	Intermediate duration exposure
Oral	Reference Dose (RfD)	Threshold	0.02 mg/kg/day	USEPA (2011)	

Adopted Threshold Dose-Response Values

For assessment of potential threshold effects associated with oral exposure to cyanide, AECOM has adopted the acceptable daily intake (ADI) of 0.012 mg/kg/day adopted by the NHMRC (2004) for the derivation of drinking water guideline values.

To AECOM's knowledge, threshold dose-response criteria for inhalation exposure to cyanide have not been published by Australian or other regulatory bodies. AECOM has therefore adopted a route-to-route (oral to inhalation) extrapolation approach for assessment of inhalation effects of cyanide. The oral ADI of 0.012 mg/kg/day was converted to a Tolerable Concentration in air of 0.042 mg/m^3 assuming an adult body weight of 70 kg and a daily inhalation volume of 20 m^3/day. It is noted that there is substantial uncertainty associated with the use of route-to-route extrapolation, due to differences in e.g., absorption, distribution and metabolism of chemicals via the oral versus inhalation exposure routes. However, this approach has been adopted as a conservative measure in the absence of other data.

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

To AECOM's knowledge, non-threshold dose-response criteria for oral and inhalation exposure to cyanide have not been published by Australian or other regulatory bodies. Potential health effects associated with oral and inhalation exposure to cyanide have therefore been assessed on the basis of threshold dose response criteria.

References

ATSDR, 2005. *Toxicological Profile for Cyanide*. Agency for Toxic Substances and Disease Registry. August, 2005.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

USEPA, 2011. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Center for Environmental Assessment, Office of Research and Development. Accessed May 2011.

NHMRC 2004, *Australian Drinking Water Guidelines (ADWG)*. National Health and Medical Research Council , 2004.

WHO, 2008. *Guidelines for Drinking-water Quality. First and Second Addenda to the Third-Edition. Volume 1. Recommendations.* World Health Organization.

Ethylbenzene – Toxicological profile

The following information has been taken from ATSDR (2007):

General

Ethylbenzene is widely distributed in the environment and is used to manufacture styrene, and is used as a solvent in the manufacture of several organic compounds. Routine human activities, such as driving automobiles, boats, or aircraft, or using gasoline powered tools and equipment, release ethylbenzene to the environment. Environmental and background levels of ethylbenzene are generally small and therefore, have minimal impact on public health. Trace levels of ethylbenzene are found in internal combustion engine exhaust, food, soil, water, and tobacco smoke, but usually at levels well below those that have been shown to exhibit toxic effects in laboratory animals or human exposure studies.

Ethylbenzene is not considered highly persistent in the environment. It partitions primarily to air and removal via photochemically generated hydroxyl radicals is an important degradation mechanism. The half-life for this reaction in the atmosphere is approximately 1–2 days. Biodegradation under aerobic conditions and indirect photolysis are important degradation mechanisms for ethylbenzene in soil and water. Based on a vapor pressure of 9.53 mm Hg and Henry's law constant of 7.9x10-3 atm-m3/mol, volatilization from water and soil surfaces is expected to be an important environmental fate process for ethylbenzene.

The general population is primarily exposed to ethylbenzene from the inhalation of ambient air. This is due to the direct release of ethylbenzene into the air by the burning of fossil fuels or industrial processes, and partitioning into the air from other media (e.g., soil, surface water). This partitioning of ethylbenzene into the air or water would play a role in exposure to populations living near hazardous waste sites. In addition to inhalation exposure, ingestion of ethylbenzene may also occur because trace amounts have been found in water supplies and various food items.

Non-carcinogenic Health Effects

Ethylbenzene has been associated with eye irritation, hearing loss (ototoxicity), respiratory irritation/ chest constriction liver problems, with symptoms worsening as the exposure dose increased. Acute- and intermediate-duration studies provide strong evidence that ototoxicity is a sensitive effect following inhalation exposure to ethylbenzene. Initial symptoms included dizziness and vertigo however if exposure is not prolonged, complete recovery occurs. Chronic exposure has been associated with an increase in the mean number of lymphocytes and a decrease in hemoglobin levels.

Carcinogenicity and Genotoxicity

No association has been found between the occurrence of cancer in humans and occupational exposure to ethylbenzene. No cases of malignancy were observed in workers exposed to ethylbenzene monitored for 20 years. No information on ethylbenzene concentrations was reported, although an estimated concentration of 6.4 mg/m3 was derived as described above under hematological effects. However, no clear conclusions can be drawn from this study due to the lack of measured ethylbenzene concentrations. Furthermore, the low exposure concentration limited the power of this study to detect any effect. No other studies were found regarding cancer effects in humans exposed to ethylbenzene by inhalation.

Ethylbenzene showed evidence of carcinogenic activity in male rats based on increased incidences of renal tubule neoplasms, some evidence of carcinogenic activity in female rats based on increased incidences of renal tubule adenomas, some evidence of carcinogenic activity in male mice based on increased incidences of alveolar/bronchiolar neoplasms, and some evidence of carcinogenic activity in female mice based on increased incidences of hepatocellular neoplasms. However, the results of these studies suggest that an increase in the severity of nephropathy in female rats is the most sensitive end point of ethylbenzene exposure, and further assessment of inhalation carcinogenicity is therefore not considered to be required (ATSDR, 2007).

IARC (2006) has classified ethylbenzene as a Group 2B carcinogen (possibly carcinogenic to humans).

Genotoxicity studies on ethylbenzene have provided negative results in a variety of *in vitro* assays using numerous prokaryotic organisms, *S. cerevisiae*, and Chinese hamster ovary cells and rat liver epithelial cells, and in an *in vivo* assay using mouse bone marrow cells. Ethylbenzene has, however, caused a mutagenic effect in mouse lymphoma cells and has been shown to induce a marginal, yet statistically significant, increase in sister chromatid exchanges in human lymphocytes. In addition, ethylbenzene metabolites have been shown to produce DNA damage. Thus, although the majority of the data suggest that ethylbenzene is not mutagenic in most systems, the two studies that showed positive results suggest that ethylbenzene might cause an increased potential for genotoxicity in humans.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for Ethylbenzene

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	ADI	Threshold	0.097 mg/kg/day	NHMRC (2004)	
Oral	ADI	Threshold	0.097 mg/kg/day	WHO (2008)	
Oral	Minimal Risk Level (MRL)	Threshold	0.4 mg/kg/day	ATSDR (2010)	Intermediate duration exposure
Oral	Reference Dose (RfD)	Threshold	0.1 mg/kg/day	USEPA (2011)	
Inhalation	Tolerable Concentration (TC)	Threshold	22 mg/m^3	WHO (2000)	Evaluation undertaken in 1996 (Environmental Health Criteria 186).
Inhalation	Minimal Risk Level (MRL)	Threshold	0.26 mg/m^3	ATSDR (2010)	Chronic duration (converted from 0.06 ppm)
Inhalation	Reference Concentration (RfC)	Threshold	1.0 mg/m^3	USEPA (2011)	

Adopted Threshold Dose-Response Values

For assessment of potential non-threshold effects associated with oral exposure to ethylbenzene, AECOM has adopted the NHMRC (2004) ADI of 0.097 mg/kg/day used to derive drinking water criteria.

For assessment of potential non-threshold effects associated with inhalation exposure to ethylbenzene, AECOM has adopted the MRL of 0.26 mg/m^3 published by ATSDR (2010). While WHO (2000) recommended a health based guideline value of 22 mg/m^3, the recommendation is based on an old (1996) evaluation of ethylbenzene toxicity, which has not considered more recent pivotal chronic duration inhalation studies, in particular the 2-year mouse and rat chronic inhalation study undertaken by NTP (1999) upon which the ATSDR chronic inhalation MRL is based.

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

To AECOM's knowledge, non-threshold dose-response criteria for oral and inhalation exposure to ethylbenzene have not been published by Australian or other regulatory bodies. As noted above, while there is some evidence of ethylbenzene carcinogenicity in animal studies, a non-carcinogenic endpoint (increase in the severity of nephropathy) is considered to be the most sensitive endpoint of ethylbenzene exposure (ATSDR, 2007). Potential health effects associated with oral and inhalation exposure to ethylbenzene have therefore been assessed on the basis of threshold dose response criteria.

References

ATSDR, 2007. *Toxicological Profile for Ethylbenzene*. Draft for Public Comment. Agency for Toxic Substances and Disease Registry. August, 2007.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

NTP, 1999. *NTP technical report on the toxicology and carcinogenesis studies of ethylbenzene in F344/N rats and B6C3F1 mice (inhalation studies).* National Toxicology Program, U.S. Department of Health and Human Services. NTP TR 466.

USEPA, 2011. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Center for Environmental Assessment, Office of Research and Development. Accessed April 2011.

NHMRC 2004, *Australian Drinking Water Guidelines (ADWG)*. National Health and Medical Research Council , 2004.

WHO, 2000. *Guidelines for Air Quality.* World Health Organization, Geneva. 2000.

WHO, 2008. *Guidelines for Drinking-water Quality. First and Second Addenda to the Third-Edition. Volume 1. Recommendations.* World Health Organization.

Naphthalene – Toxicological profile

The following information has been taken from ATSDR (2005):

General

Naphthalene occurs naturally in fossil fuels such as petroleum and coal, and is produced when organic materials (e.g., fossil fuels, wood, tobacco) are burned. Naphthalene is also produced commercially from either coal tar or petroleum. Commercially-produced naphthalene is predominately used in the production of phthalic anhydride, which is used as an intermediate for polyvinyl chloride plasticizers such as di(2-ethylhexyl) phthalate. Other uses of naphthalene include production of naphthalene sulfonates (used in concrete additives and synthetic tanning agents), pesticides (e.g., carbaryl insecticides and moth repellents), and dye intermediates.

Naphthalene is frequently present in industrial and automobile emissions and effluents and in various media in the general environment due to its natural occurrence in coal and petroleum products and emissions, its use as an intermediate in the production of plasticizers, resins, and insecticides, and its use in a variety of consumer products such as moth repellants.

Non-carcinogenic Health Effects

Reports that establish associations between naphthalene exposure and health effects in humans are restricted to numerous reports of hemolytic anemia or cataracts following acute exposure or occupational exposure to naphthalene, either by ingestion or by inhalation of naphthalene vapors, but these reports have not identified exposure levels associated with these effects. A relationship appears to exist between an inherited deficiency in the enzyme, glucose 6-phosphate dehydrogenase (G6PD), and susceptibility to naphthalene-induced hemolysis. Newborn infants also appear to be susceptible to naphthalene-induced hemolysis presumably due to a decreased ability to conjugate and excrete naphthalene metabolites.

Results from animal studies exposed to naphthalene by oral administration, by inhalation exposure, or by parenteral administration identify several health effects of potential concern for humans, including maternal toxicity during pregnancy with acute oral exposure, decreased body weight (without lesions developing in any tissues or organs) with intermediate oral exposure, and increased incidence of nonneoplastic and neoplastic lesions in the nose (in rats and mice) and the lung (in mice only) with chronic inhalation exposure.

Carcinogenicity and Genotoxicity

The only studies of cancer in humans exposed to naphthalene are two case series reports of cancer; one report of four laryngeal cancer cases (all of whom were smokers) among workers in a naphthalene purification plant in East Germany, and another report of 23 cases of colorectal carcinoma admitted to a hospital in Nigeria. NTP, USEPA, and IARC concur that these studies provide inadequate evidence of naphthalene carcinogenicity in humans. No cohort mortality or morbidity studies or case-control studies examining possible associations between naphthalene exposure and increased risk of cancer (or other health effects) are available.

In animals, chronic inhalation studies have found increased incidences of nonneoplastic and neoplastic lesions in the nose of rats, nonneoplastic lesions in the nose of mice, and neoplastic and nonneoplastic lesions in the lungs of mice. In mice of both sexes, chronic inhalation of 10 or 30 ppm naphthalene induced inflammation of the nose and lung, metaplasia of the olfactory epithelium, and hyperplasia of the nasal respiratory epithelium. In female mice (but not male mice), exposure to 30 ppm (but not 10 ppm) increased the incidence of benign lung tumors (alveolar/bronchiolar adenomas) compared with controls. One other female mouse exposed to 30 ppm showed a malignant lung tumor (alveolar/bronchiolar carcinoma). In rats of both sexes, inhalation of 10, 30, or 60 ppm naphthalene induced nonneoplastic and neoplastic lesions only in the nasal cavity. Nonneoplastic nasal lesions included (1) hyperplasia, atrophy, chronic inflammation, and hyaline degeneration of the olfactory epithelium and (2) hyperplasia, metaplasia or degeneration of the respiratory epithelium or glands. Neoplastic lesions associated with naphthalene exposure in rats were olfactory epithelial neuroblastoma (a rare malignant tumor) and respiratory epithelial adenoma.

The mechanisms by which naphthalene causes nonneoplastic or neoplastic lesions in the respiratory tract of rodents are incompletely understood, but are thought to involve reactive metabolites of aphthalene, including 1,2-naphthalene oxide, 1,2-naphthoquinone, 1,4-naphthoquinone, and possibly 1,2-dihydroxy-3,4-epoxy-1,2,3,4-tetrahydronaphthalene.

Comparison of species susceptibility to naphthalene-induced nonneoplastic lung damage suggests that mice are much more sensitive than rats (e.g., nonneoplastic or neoplastic lung lesions were not found in chronically exposed rats in an NTP study) and that differences in rates and stereoselectivity of naphthalene metabolism to epoxide intermediates may be involved in this species difference. Acute (4-hour) inhalation exposure of mice to naphthalene concentrations as low as 2–10 ppm induced lung injury, whereas rats exposed to naphthalene concentrations as high as 110 ppm showed no signs of lung injury. Some evidence has been reported that rates and stereoselectivity of naphthalene metabolism in primate lung tissue may be more like rats than mice. In in vitro studies with microsomes from lymphoblastoid cells, which expressed recombinant human CYP2F1, metabolism of naphthalene to epoxide intermediates was demonstrated, but the predominant enantiomeric form produced (1S,2R-oxide) was different from the form (1R,2S-oxide) produced by mouse CYP2F2. Although these observations on epoxide formation may suggest that mice may be more sensitive than humans to acute naphthalene lung toxicity from epoxide intermediates, the possible role of other potentially reactive metabolites of naphthalene (e.g., the naphthoquinone metabolites) is unknown with chronic exposure scenarios. To date, mechanistic understanding of species differences in naphthalene bioactivation in the lung is too incomplete to definitively rule out the possible human relevance of naphthalene-induced lung lesions in mice.

In contrast, the olfactory epithelium and respiratory epithelium of the nose of rats and mice do not appear to differ in sensitivity to naphthalene nonneoplastic toxicity from chronic inhalation exposure.

Nonneoplastic nasal lesions were found in nearly all exposed animals of both species at the lowest exposure level, 10 ppm, in both chronic studies. CYP monooxygenases, which might be involved in naphthalene metabolism and bioactivation, have been demonstrated to exist in nasal respiratory epithelial and olfactory epithelial tissue from rodents and humans. Studies designed to specifically characterize metabolism of naphthalene in nasal tissue, however, have not been conducted, with the exception of a single study, which examined in vitro rates of metabolism of naphthalene to naphthalene oxides in postmitochondrial supernatants from mouse, rat, and hamster olfactory tissue. Metabolic rates (units of nmol/min/mg protein) showed the following order: mouse (87.1) > rat (43.5) > hamster (3.9). This order did not correspond with species differences in sensitivity to single intraperitoneal injections of naphthalene in a companion study. The lowest dose levels producing substantial necrosis and exfoliation in olfactory epithelium were 200 mg/kg in rats and 400 mg/kg in mice and hamsters. To date, mechanistic understanding of species differences in naphthalene bioactivation in the respiratory tissues is too incomplete to definitively rule out the possible human relevance of naphthalene-induced nasal lesions in rodents (nonneoplastic lesions in rats and mice and neoplastic lesions in rats).

It is unknown whether the naphthalene-induced neoplastic lesions found in mice (lung adenomas) and rats (nose respiratory epithelial adenomas and olfactory epithelial neuroblastomas) are produced via a genotoxic mode of action or a nongenotoxic mode requiring tissue damage and regenerative responses as precursor events. Results from genotoxicity tests for naphthalene have been predominately (but not completely) negative, and the general sites of neoplastic lesions, the nose in rats and the lungs in mice, show some correspondence (but not complete) with the general sites of nonneoplastic lesions. However, mechanistic understanding of naphthalene's carcinogenic mode of action is too incomplete to rule out the possibility of a genotoxic mode of action. Key issues that remain unexplained or unstudied include:

The possible significance of the few positive genotoxicity results that have been obtained, including: reverse mutations in Salmonella typhimurium by 1,2-naphthoquinone; in vitro formation of N-7 guanine adducts of DNA by 1,2-naphtoquinone; reverse mutations for luminescence in the marine bacteria, Vibrio fischeri, by naphthalene; induction of sister chromatid exchanges in Chinese hamster ovary cells by naphthalene and in human mononuclear leukocytes by 1,2- or 1,4-naphthoquinone; induction of chromosomal aberrations in Chinese hamster ovaries and preimplantation mouse embryos by naphthalene; induction of somatic mutations and recombination in Drosophila melanogaster by naphthalene; and weak (about 2-fold) induction of micronuclei in red blood cells from Pleurodeles waltl larvae by naphthalene.

The lack of a mechanistic explanation of why nearly all rats and mice develop nasal nonneoplastic lesions following chronic exposure to naphthalene at concentrations ≥10 ppm, but only some rats develop nasal tumors;

The lack of a mechanistic explanation of why both male and female mice exposed to naphthalene show similar incidences of chronic lung inflammation following chronic exposure to 10 or 30 ppm, but only female mice showed statistically significant increased incidence of lung tumors;

The lack of in vivo genotoxicity assays involving target tissues of naphthalene carcinogenicity (nose and lung); and

The lack of information on the possible threshold exposure levels for nonneoplastic nasal lesions in rats and mice at air concentrations <10 ppm.

The National Toxicology Program 11th Report on Carcinogens includes naphthalene in its list of chemicals reasonably anticipated to be human carcinogen.

International Agency for Research on Cancer concluded that naphthalene is possibly carcinogenic to humans (Group 2B) based on specific evaluations that there is inadequate evidence in humans and sufficient evidence in animals for the carcinogenicity of naphthalene. IARC considered the findings for nasal tumors in male and female rats and lung tumors in female mice in the NTP bioassays as sufficient evidence, noting that both nasal tumor types (olfactory epithelial neuroblastomas and respiratory epithelial adenomas) are rare in untreated rats.

The USEPA last assessed the carcinogenicity of naphthalene before the availability of the results from the chronic rat bioassay. In the EPA (1998) Toxicological Review on Naphthalene, it was concluded that there was inadequate evidence in humans and limited evidence in animals of naphthalene carcinogenicity (increased incidence of lung tumors in female mice). Under the EPA 1986 cancer guidelines, naphthalene was assigned to Group C—possible human carcinogen. Under the EPA 1996 proposed cancer guidelines, it was judged that the human carcinogenic potential of naphthalene via the oral or inhalation routes "cannot be determined", but it was noted that there was suggestive evidence of potential human carcinogenicity based on increased lung tumors in female mice. Currently, the EPA Integrated Risk Information System (IRIS) Office is reassessing the inhalation carcinogenicity of naphthalene.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for Naphthalene

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	Reference Dose (RfD)	Threshold	0.02 mg/kg/day	USEPA (2010)	Last revised 17 September 1998. Currently under review.
Inhalation	Reference Concentrat ion (RfC)	Threshold	0.003 mg/m^3	ATSDR (2005)	Chronic duration
Inhalation	Minimal Risk Level (MRL)	Threshold	0.003 mg/m^3	USEPA (2010)	

Adopted Threshold Dose-Response Values

Dose-response values for naphthalene have not been published by Australian regulatory bodies or by the World Health Organization (WHO), and AECOM has therefore adopted the MRL of 0.0007 ppm (0.003 mg/m^3) derived by ATSDR (2005) for assessment of chronic inhalation exposure to naphthalene. This value is similar to that published by USEPA (2010). The oral reference dose of 0.02 mg/kg/day published by USEPA (2009) has been adopted for assessment of threshold oral exposure to naphthalene.

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

While there is some evidence of naphthalene carcinogenicity based on observations of benign respiratory tumours and one carcinoma in female mice only exposed to naphthalene by inhalation (see above), non-threshold dose-response values for naphthalene based on potential carcinogenicity have not been published. It should also be noted a recent health effects review undertaken by the USEPA Office of Prevention, Pesticides and Toxic Substances (USEPA, 2008) explicitly recognises that humans are less susceptible to the respiratory effects of naphthalene than rodents. It is therefore considered likely that the inhalation reference concentration published by IRIS, which was derived from a mouse inhalation study with an applied 3000-fold uncertainty factor assuming humans are *more* sensitive than rodents, is likely to be protective of both non-carcinogenic and carcinogenic effects of naphthalene.

References

ATSDR, 2005. Toxicological Profile for Naphthalene, 1-Methylnaphthalene, and 2-Methylnaphthalene. Agency for Toxic Substances and Disease Registry. August, 2005.

enHealth, 2004. Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. June 2004.

NEPC, 1999. Schedule B(4) Guideline on Health Risk Assessment Methodology. In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

USEPA, 2010. Integrated Risk Information System (IRIS). Electronic database maintained by the United States Environmental Protection Agency National Center for Environmental Assessment, Office of Research and Development. Accessed November 2010.

Polycyclic Aromatic Hydrocarbons (PAHs) – Toxicological Profile

The following health effects information has been extracted and modified from ATSDR (1995):

General

PAHs occur ubiquitously in the environment from both synthetic and natural sources. PAHs occur in the atmosphere most commonly in the products of incomplete combustion. These products include fossil fuels; cigarette smoke; industrial processes (such as coke production and refinement of crude oil); and exhaust emissions from gasoline engines, oil-fired heating, and burnt coals. PAHs are present in groundwater, surface water, drinking water, waste water, and sludge. They are found in foods, particularly charbroiled, broiled, or pickled food items, and refined fats and oils. Individuals living in the vicinity of hazardous waste sites where PAHs have been detected at levels above background may experience exposure to these chemicals via inhalation of contaminated air or ingestion of contaminated food, soil, or water.

Within Australia, the following 16 PAHs are typically analysed for and considered as a group in contaminated site assessment work:

- acenaphthene
- acenaphthylene
- anthracene
- benz[a]anthracene
- benzo[a]pyrene
- benzo[b]fluoranthene
- benzo[g,h,i]perylene
- benzo[k]fluoranthene
- chrysene
- dibenz[a,h]anthracene
- fluoranthene
- fluorene
- naphthalene
- indeno[1,2,3-c,d]pyrene
- phenanthrene
- pyrene

These PAHs are the most commonly assessed based on the following considerations:

- More information is available on them than other PAHs.
- They are suspected to be more harmful than other PAHs, and they exhibit harmful effects that are representative of the PAHs.
- There is considered to be a greater chance of exposure to these PAHs than to the others.

The above PAHs with the exception of naphthalene are considered in this toxicity profile. The toxicity of naphthalene (if considered in this risk assessment) is discussed separately.

Non-carcinogenic Health Effects

Noncancer adverse health effects associated with PAH exposure have been observed in animals but generally not in humans (with the exception of adverse hematological and dermal effects). Animal studies demonstrate that PAHs tend to affect proliferating tissues such as bone marrow, lymphoid organs, gonads, and intestinal epithelium.

Carcinogenicity

Evidence exists to indicate that mixtures of PAHs are carcinogenic in humans. The evidence in humans comes primarily from occupational studies of workers exposed to mixtures containing PAHs as a result of their involvement in such processes as coke production, roofing, oil refining, or coal gasification (e.g., coal tar, roofing tar, soot, coke oven emissions, soot, crude oil) (Hammond et al. 1976; Lloyd 1971; Maclure and MacMahon 1980; Mazumdar et al. 1975; Redmond et al. 1976; Wynder and Hoffmann 1967). PAHs, however, have not been clearly identified as the causative agent. Cancer associated with exposure to PAH-containing mixtures in humans occurs predominantly in the lung and skin following inhalation and dermal exposure, respectively. Some ingestion of PAHs is likely because of swallowing of particles containing PAHs subsequent to mucocilliary clearance of these particulates from the lung.

Certain PAHs are carcinogenic to animals by the oral route (e.g., benz[a]anthracene, benzo[a]pyrene, and dibenz[a,h]anthracene). The results of dermal studies indicate that benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[l,2,3-c,d]pyrene are tumorigenic in mice following dermal exposure. The sensitivity of mouse skin to PAH tumorigenesis forms the basis for the extensive studies performed using dermal administration. This tumorigenicity can be enhanced or modified with concomitant exposure to more than one PAH, long straight-chain hydrocarbons (i.e., dodecane), or similar organic compounds commonly found at hazardous waste sites. Thus, humans exposed to PAHs in combination with these substances could be at risk for developing skin cancer.

For many of the carcinogenic PAHs, it appears that the site of tumor induction is influenced by the route of administration and site of absorption, i.e., forestomach tumors are observed following ingestion, lung tumors following inhalation, and skin tumors following dermal exposure. However, the observations that (1) mammary tumors are induced following intravenous injection in Sprague-Dawley rats, (2) the susceptibility to tumor development on the skin after dermal application is not similar in rats and mice, and (3) oral cavity tumors are not observed when benzo[a]pyrene is administered in the diet, suggest that the point of first contact may not always be the site of PAH-induced tumors.

Genotoxicity

Benzo[a]pyrene has been thoroughly studied in genetic toxicology test systems, and has been found to induce genetic damage in prokaryotes, eukaryotes, and mammalian cells in vitro, and to produce a wide range of genotoxic effects (gene mutations in somatic cells, chromosome damage in germinal and somatic cells, DNA adduct formation, UDS, sister chromatid exchange, and neoplastic cell transformation). In cultured human cells, benzo[a]pyrene binds to DNA and causes gene mutations, chromosome aberrations, sister chromatid exchange, and UDS.

The results of in vivo studies indicate that many of the same types of adverse effects observed in vitro were seen in mice, rats, and hamsters exposed to benzo[a]pyrene via the oral, dermal, or intraperitoneal routes. The available data also indicate that benzo[a]pyrene is genotoxic in both somatic and germinal cells of intact animals. The only study that was found regarding genotoxic effects in humans following exposure to benzo[a]pyrene reported no correlation between aluminium plant workers' exposure to PAHs, including benzo[a]pyrene, and sister chromatid exchange frequency. The findings from assays using human cells as the target, in conjunction with the data from whole animal experiments, suggest that benzo[a]pyrene would probably have similar deleterious effects on human genetic material.

Because the genotoxic activity of benzo[a]pyrene is well established, it is frequently used as a positive control to demonstrate the sensitivity of various test systems to detect the genotoxic action of unknown compounds. It also serves as the model compound for PAHs, and the available information on the formation of metabolites and structure of benzo[a]pyrene can theoretically be used to predict potential genotoxicity/carcinogenicity of other PAHs that have not been as extensively studied.

Epoxidation is thought to be the major pathway for benzo[a]pyrene metabolism pertinent to macromolecular interaction. The metabolic attack consists of the cytochrome P-450/P-448-dependent MFO system converting the benzo[a]pyrene molecule into an epoxide; the epoxide is acted upon by epoxide hydrolase to form a dihydrodiol, and a second cytochrome MFO reaction gives rise to the ultimate mutagenic/carcinogenic form, benzo[a]pyrene 7,8-diol-9,10-epoxide. One of the unique structural features of the diol epoxide is that it appears to form in the area of the PAH molecule referred to as the bay region (i.e., a deep-pocketed area formed when a single benzo ring is joined to the remainder of the multiple ring system to form a phenanthrene nucleus).

Analysis of the bay region diol epoxides and their contribution to the DNA binding, genotoxicity, and carcinogenicity of various PAHs has provided the basis for the bay region hypothesis. For example, DNA adducts formed with non-bay region diol epoxides of benzo[a]pyrene have low mutagenic potential. The hypothesis further predicts that structures with more reactive bay regions would probably be more genotoxic and more carcinogenic. The body of evidence on the mutagenic and tumorigenic activity of the PAHs that form bay region diol epoxides (benzo[a]pyrene, benz[a]anthracene, chrysene, dibenz[a,h]anthracene; benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-c,d]pyrene) supports this hypothesis.

In summary, several general conclusions can be reached for the unsubstituted PAHs evaluated in this profile. The formation of diol epoxides that covalently bind to DNA appears to be the primary mechanism of action for both genotoxicity and carcinogenicity of several of the unsubstituted PAHs that are genotoxins (benzo[a]pyrene, benz[a]anthracene, dibenz[a,h]anthracene, chrysene, benzo[b]fluoranthene, benzo[j]fluoranthene). There was insufficient evidence to draw meaningful conclusions regarding the genotoxic potential of benzo[g,h,i]perylene, although some evidence does exist.

With regard to the unsubstituted PAHs that either lack a bay region configuration (acenaphthene, acenaphthylene, anthracene, fluorene, and pyrene) or appear to have a weakly reactive bay region (phenanthrene), there is no compelling evidence to suggest that they interact with or damage DNA.

The five PAHs that appear to be exceptions to the bay region diol epoxide hypothesis are fluoranthene, benzo[k]fluoranthene, benzo[j]fluoranthene, and indeno[1,2,3-cd]pyrene (no bay region), and benzo[e]pyrene (two bay regions). The evidence does suggest, however, that fluoranthene possesses genotoxic properties while benzo[e]pyrene is either weakly mutagenic or nonmutagenic.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for PAHs

PAH	Route of Exposure	Criteria Type	Value	Source
Non-threshold Dose-Response Values				
Benzo(a)pyrene	Oral	Slope Factor	0.43 $(mg/kg/day)^{-1}$	NHMRC (2004)*
	Oral	Slope Factor	7.3 $(mg/kg/day)^{-1}$	USEPA (2010)**
	Inhalation	Unit Risk	0.087 $(\mu g/m^3)^{-1}$	WHO (2000a,b)
Threshold Dose-Response Values				
Acenaphthene	Oral	RfD	0.06 mg/kg/day	USEPA (2010)
Anthracene	Oral	RfD	0.3 mg/kg/day	USEPA (2010)
Fluoranthene	Oral	RfD	0.04 mg/kg/day	USEPA (2010)
Fluorene	Oral	RfD	0.04 mg/kg/day	USEPA (2010)
Pyrene	Oral	RfD	0.03 mg/kg/day	USEPA (2010)

NOTES:

RfD = Reference Dose
* Derived from drinking water unit risk of 1 x 10^{-6} per 0.00007 mg/L reported by NHMRC (2004), assuming 70 kg body weight and 2L/day water ingestion rate.
** Last updated November 1994.
$^{+}$ Values are the maxima of reported ranges, where relevant.

Adopted Threshold Dose-Response Values

Oral

Dose-response values for assessment of threshold health effects associated with PAHs have not been published by Australian regulatory agencies or by the World Health Organization (WHO). AECOM has therefore adopted Reference Doses published by USEPA (2010) for acenaphthene, anthracene, fluoranthene, fluorene and pyrene to assess potential threshold health effects associated with oral exposure to these compounds.

In the absence of published oral dose-response criteria for acenaphthylene and phenanthrene, a surrogate approach has been adopted; it has been assumed that the oral toxicity of these compounds is comparable to the toxicity of the other unsubstituted PAHs with either no or weakly reactive bay region (acenaphthene, anthracene, fluoranthene, fluorene pyrene). The geometric mean of oral RfDs reported for these compounds (0.06 mg/kg/day) has been adopted for both acenaphthylene and phenanthrene.

Other PAHs have been assessed based on non-threshold dose-response values (see below).

Inhalation

USEPA (2010) and other agencies have not published dose-response values for assessment of threshold health effects associated with inhalation exposure to PAHs. AECOM have therefore adopted a route-to-route (oral to inhalation) extrapolation approach for assessment of inhalation effects of non-carcinogenic PAHs. Oral RfDs were converted to Tolerable Concentrations/Reference Concentrations assuming an adult body weight of 70 kg, and a daily inhalation volume of 20 m^3. It is noted that there is substantial uncertainty associated with the use of route-to-route extrapolation, due to differences in e.g., absorption, distribution and metabolism of chemicals via the oral versus inhalation exposure routes. However, this approach has been adopted as a conservative measure in the absence of other data.

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

Oral

For assessment of potential non-threshold effects associated with oral exposure to benzo(a)pyrene, AECOM has adopted the drinking water unit risk value of 1 x 10^{-6} per 0.00007 mg/L published by NHMRC (2004). This value was converted to an oral slope factor of 0.43 $(mg/kg/day)^{-1}$ assuming a body weight of 70 kg and drinking water intake of 2 L/day.

In order to assess potential oral health effects associated with exposure to potentially carcinogenic PAHs other than benzo(a)pyrene, toxic equivalency factors (TEFs) recommended by CCME (2008) have been adopted. These TEFs were adapted from the relative potency scheme recommended by the WHO (1998) based on a detailed critical review by CCME of more than a dozen sets of TEF numbers published over the last twenty years (CCME, 2008). These TEFs represent one of the most recent reviews of relative PAH potency undertaken by an international regulatory agency. TEFs were adopted, where available, for carcinogenic PAHs considered to be genotoxic carcinogens (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene; see genotoxicity discussion above). The adopted TEFs are shown in **Table 2** below.

Table 2: Toxic Equivalency Factors Used to Derive Oral Dose-Response Criteria for Carcinogenic PAHs Relative to Benzo(a)pyrene (CCME, 2008)

Chemical	Toxic Equivalency Factor (TEF)
Benzo(a)pyrene (index compound)	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(g,h,i)perylene	0.01
Benzo(k)fluoranthene	0.1
Chrysene	0.01
Dibenzo(a,h)anthracene	1
Indeno(1,2,3-c,d)pyrene	0.1

Inhalation

For assessment of potential non-threshold effects associated with inhalation exposure to benzo(a)pyrene, AECOM has adopted the inhalation unit risk value of 8.7 x 10^{-2} per µg/m^3 published by WHO (2000a).

In order to assess potential inhalation health effects associated with exposure to potentially carcinogenic PAHs other than benzo(a)pyrene, toxic equivalency factors (TEFs) derived by Ministry of Environment and Energy (MOEE, 1997) have been applied to the adopted dose-response criteria for benzo(a)pyrene.

These TEFs have also been reviewed and applied by WHO (1998; EHC 202). TEFs were adopted, where available, only for carcinogenic PAHs considered to be genotoxic carcinogens (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene; see discussion of genotoxicity above). The adopted TEFs are shown in **Table 2** above.

References

ATSDR, 1995. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)*. Agency for Toxic Substances and Disease Registry. September, 1996.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

CCME (2008). *Canadian Soil Quality Guidelines. Carcinogenic and other Polycyclic Aromatic Hydrocarbons (PAHs) (Environmental and Human Health Effects) Scientific Supporting Document.* Canadian Council of Ministers of the Environment. PN 1401.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

NHMRC, 2004. *Australian Drinking Water Guidelines*. National Health and Medical Research Council.

USEPA, 2010. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Center for Environmental Assessment, Office of Research and Development. Accessed November 2010.

WHO, 1998. *Environmental Health Criteria 202*. *Selected Non-Heterocyclic Polycyclic Aromatic Hydrocarbons*. International Programme on Chemical Safety (IPCS). Geneva. 1998.

WHO, 2000a. *Air Quality Guidelines for Europe. Second Edition.* World Health Organization, Regional Office for Europe. WHO Regional Publications, European Series, No. 91. 2000.

WHO, 2000b. *Guidelines for Air Quality.* World Health Organization. Geneva. 2000.

Phenol– Toxicological profile

The following information has been taken from ATSDR (2008):

General

Phenol is used widely in the petroleum industry, for the manufacture of nylon, epoxy resins, herbicides, hydraulic fluids and plasticisers. Phenol may be released to the environment as a result of manufacturing processes, disposal of phenol containing waste or from automotive exhaust, cigarette smoke or burning wood.

In air phenol is degraded within 1-2 days however in water is may persist for a number of weeks. It has been detected in surface waters, rainwater, sediments, drinking water and groundwater as well as in industrial and urban runoff and at hazardous waste sites. Phenol in soil will be degraded by microorganisms or leached into groundwater.

Exposure to phenol can occur rapidly via inhalation, dermal contact or ingestion and once absorbed will be metabolised and excreted with a few days.

Non-carcinogenic Health Effects

Long-term occupational exposure to phenol has been associated with cardiovascular disease, although workers were also exposed to other chemicals and results are therefore not necessarily attributable to phenol exposure.

Ingestion of liquid products containing concentrated phenol can cause mouth sores, nausea, diarrhea and serious gastrointestinal damage and vomiting. It is associated with cardiac anomalies and upon ingestion can causes increases in respiration rate followed by breathing irregularities and death.

Dermal exposure to phenol can cause severe skin damage (burns) and can cause death. Absorption through the skin is rapid and lead to similar symptoms as phenol ingestion: respiratory depression, nausea, vomiting and possibly death.

In humans, exposure to phenol during pregnancy did not provide evidence of birth defects. Birth defects were observed in animals born to females exposed to phenol during pregnancy however this generally occurred at exposure levels that were also toxic to the mothers. There is no information on levels of phenol in human breast milk.

Laboratory animal studies have indicated that short term exposure to high levels of phenol via inhalation causes respiratory tract irritation and twitching. Longer-term exposure by animal to high levels of phenols caused damage to the heart, kidneys, liver and lungs.

Oral exposure to extremely high concentrations of phenol by animals has resulted in muscle tremors, difficulty walking and death. Short term application of phenol to the skin of laboratory animals has produced blisters and burns.

Carcinogenicity and Genotoxicity

There is no evidence that phenol causes cancer in humans. The International Agency for Research on Cancer (IARC) classification for phenol is Group 3, not classifiable with regard to its carcinogenicity to humans.

Phenol has been tested extensively for genotoxicity in a variety of *in vivo* and *in vitro* tests. The results of these assays have been equivocal. Phenol appears to be potentially genotoxic, although this may be more a result of the action of its metabolites than the parent compound. Additional genotoxicity studies of phenol do not seem to be necessary.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for Phenol

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	Reference Dose (RfD)	Threshold	0.3 mg/kg/day	USEPA (2011)	
Inhalation	Reference Concentration (RfC)	Threshold	0.2 mg/m^3	Cal EPA (2009)	Adopted by USEPA (2009) for derivation of Regional Screening Levels (RSLs)

Adopted Threshold Dose-Response Values

For assessment of potential threshold effects associated with oral exposure to phenol, AECOM has adopted the reference dose (RfD) of 0.3 mg/kg/day published by USEPA (2010).

In the absence of other published values for assessment of potential threshold effects associated with inhalation exposure to phenol, AECOM has adopted the Cal EPA reference concentration (RfC) of 0.2 mg/m^3 day. This value was used by USEPA (2009) for the derivation of Regional Screening Levels (RSLs).

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

To AECOM's knowledge, non-threshold dose-response criteria for oral and inhalation exposure to phenol have not been published by Australian or other regulatory bodies. Potential health effects associated with oral and inhalation exposure to phenol have therefore been assessed on the basis of threshold dose response criteria.

References

ATSDR, 2008. *Toxicological Profile for Phenol*. Agency for Toxic Substances and Disease Registry. September, 2008.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

USEPA, 2011. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Center for Environmental Assessment, Office of Research and Development. Accessed May 2011.

Toluene – Toxicological profile

The following information has been taken from ATSDR (2000):

General

Toluene is used in the manufacture of paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes. It enters the environment largely as a result of solvent and petroleum spills at petrol stations on in manufacturing environments. It readily volatilizes into air and readily dissolves into groundwater and surface water bodies. Toluene is broken down by soil microorganisms and evaporates from soil and water surfaces if exposed to oxygen.

Non-carcinogenic Health Effects

Adverse effects on the nervous system are the critical effects of concern from acute, intermediate, or chronic exposure to toluene. Acute exposure is associated with reversible neurological symptoms progressing from fatigue, headaches, and decreased manual dexterity to narcosis with increasing exposure levels. Reversible neurological impairment from acute exposure likely involves the direct interaction of toluene with nervous system membranes. Degenerative changes in white matter regions of the brain have been correlated with the severity of persistent neurological impairment in individuals who abused solvents and have repeatedly inhaled toluene at high exposure levels (4,000–12,000 ppm). Results from studies of groups of occupationally exposed workers suggest that chronic exposure to toluene at lower exposure levels (from about 50 to 200 ppm) can produce subtle changes in neurological functions including cognitive and neuromuscular performance, hearing, and color discrimination. Supporting data come from studies of toluene-exposed animals showing changes in behaviour, hearing loss, and subtle changes in brain structure, electrophysiology, and levels of neurotransmitters. Case reports of birth defects in children of mothers who abused toluene during pregnancy suggest that exposure to high levels of toluene may be toxic to the developing fetus. However, results from animal studies indicate that toluene is not a teratogenic agent, but can retard fetal growth and skeletal development and adversely influence behavior of offspring at exposure levels that overwhelm maternal mechanisms protecting the developing fetus from exposure. Other adverse health effects, including cancer or effects on reproductive performance, do not appear to be of concern for persons who may experience low exposures to toluene by living or working near hazardous waste sites containing toluene.

Carcinogenicity and Genotoxicity

Human and animal studies generally do not support a concern for the carcinogenicity of toluene. The only available human epidemiological studies were negative but inconclusive due to limitations in design. The validated animal inhalation bioassays were negative; however, one available oral study showed a nondose-related increase in a variety of tumors. Thus, the data do not support a firm conclusion regarding the carcinogenicity of toluene. The IARC have not classified toluene for carcinogenic effects.

Results of *in vivo* studies of exposed humans and *in vitro* microbial assays and other *in vitro* systems generally indicate that toluene is nonmutagenic and nongenotoxic.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Chronic Dose-Response Values for Toluene

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	Tolerable Daily Intake (TDI)	Threshold	0.223 mg/kg/day	NHMRC (2004)	
Oral	Tolerable Daily Intake (TDI)	Threshold	0.22 mg/kg/day	WHO (2008)	
Oral	Minimal Risk Level (MRL)	Threshold	0.02	ATSDR (2000)	Intermediate duration

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	Reference Dose (RfD)	Threshold	0.08 mg/kg/day	USEPA (2010)	
Inhalation	Reference Concentration (RfC)	Threshold	0.26 mg/m^3	WHO (2000)	
Inhalation	Minimal Risk Level (MRL)	Threshold	0.3 mg/m^3	ATSDR (2000)	Chronic duration
Inhalation	Reference Concentration (RfC)	Threshold	5 mg/m^3	USEPA (2010)	

Adopted Threshold Dose-Response Values

For assessment of potential threshold effects associated with oral exposure to toluene, AECOM has adopted the tolerable daily intake (TDI) value of 0.223 mg/kg/day used by NHMRC (2004) and WHO (2008) for the derivation of drinking water guideline values. It should be noted that USEPA (2010; based on an assessment undertaken in 2005) derived a slightly lower RfD of 0.08 mg/kg/day based on data from the same principle study as that used by WHO and NHMRC (NTP, 1990). The difference in the derived values results primarily from the application of an additional three-fold safety factor by USEPA (2010) to account for deficiencies in the toluene database. While the USEPA evaluation is therefore slightly more conservative than the WHO (2008) and NHMRC (2004) evaluations, the difference between recommended RfDs/TDIs is not significant, and AECOM has adopted the NHMRC (2004) and WHO (2008) value in accordance with the hierarchy of toxicological information sources recommended by NEPC (1999) and enHealth (2004).

For assessment of potential threshold effects associated with inhalation exposure to toluene, AECOM has adopted the RfC of 5 mg/m^3 published by USEPA (2010). This value was derived in 2005 based on a more comprehensive and recent review of available published toxicity studies than those undertaken by WHO (2000) and ATSDR (2000), and is therefore considered to be more suitable for quantitative dose-response assessment than the older WHO and ATSDR values.

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

To AECOM's knowledge, non-threshold dose-response criteria for oral and inhalation exposure to toluene have not been published by Australian or other regulatory bodies. Potential health effects associated with oral and inhalation exposure to toluene have therefore been assessed on the basis of threshold dose response criteria.

References

ATSDR, 2000. *Toxicological Profile for Toluene*. Agency for Toxic Substances and Disease Registry. September 2000.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

USEPA, 2010. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Center for Environmental Assessment, Office of Research and Development. Accessed November 2010.

NHMRC, 2004, *Australian Drinking Water Guidelines (ADWG)*. National Health and Medical Research Council , 2004.

WHO, 2000. *Air Quality Guidelines for Europe. Second Edition.* World Health Organization (WHO) Geneva, 2000.

WHO, 2008. *Guidelines for Drinking-water Quality. First and Second Addenda to the Third-Edition. Volume 1. Recommendations.* World Health Organization.

Total Petroleum Hydrocarbons (TPHs)– Toxicological profile

The following information has been taken from ATSDR (1999):

General

Total petroleum hydrocarbon (TPH) is a term used to describe a large family of several hundred chemical compounds that originally come from crude oil. Crude oil is used to make petroleum products, which can contaminate the environment. Because there are so many different chemicals in crude oil and in other petroleum products, it is not practical to measure each one separately. However, it is useful to measure the total amount of TPH at a site.

TPH is a mixture of chemicals, but they are all made mainly from hydrogen and carbon, called hydrocarbons. Scientists divide TPH into groups of petroleum hydrocarbons that act alike in soil or water. These groups are called petroleum hydrocarbon fractions. Each fraction contains many individual chemicals.

Some chemicals that may be found in TPH are hexane, jet fuels, mineral oils, benzene, toluene, xylenes, naphthalene, and fluorene, as well as other petroleum products and gasoline components. However, it is likely that samples of TPH will contain only some, or a mixture, of these chemicals.

Non-carcinogenic Health Effects

Some of the TPH compounds can affect your central nervous system. One compound can cause headaches and dizziness at high levels in the air. Another compound can cause a nerve disorder called "peripheral neuropathy," consisting of numbness in the feet and legs. Other TPH compounds can cause effects on the blood, immune system, lungs, skin, and eyes.

Animal studies have shown effects on the lungs, central nervous system, liver, and kidney from exposure to TPH compounds. Some TPH compounds have also been shown to affect reproduction and the developing fetus in animals.

Carcinogenicity

The International Agency for Research on Cancer (IARC) has determined that one TPH compound (benzene) is carcinogenic to humans. IARC has determined that other TPH compounds (benzo[a]pyrene and gasoline) are probably and possibly carcinogenic to humans. Most of the other TPH compounds are considered not to be classifiable by IARC.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for Total Petroleum Hydrocarbon Fractions

TPH Fraction	Route of Exposure	Type	Threshold or Non-Threshold	Value	Source
TPH C_6-C_9 (Aliphatic)	Oral	Reference Dose	Non-Threshold	5.0 mg/kg/day	TPHCWG (1997)

TPH Fraction	Route of Exposure	Type	Threshold or Non-Threshold	Value	Source
TPH C_{10}-C_{14} (Aliphatic)	Oral	Reference Dose	Non-Threshold	0.1 mg/kg/day	
TPH C_{15}-C_{28} (Aliphatic)	Oral	Reference Dose	Non-Threshold	2 mg/kg/day	
TPH C_{29}-C_{36} (Aliphatic)	Oral`	Reference Dose	Non-Threshold	2 mg/kg/day	
TPH C_6-C_9 (Aliphatic)	Inhalation	Reference Concentration	Non-Threshold	18.4 mg/m^3	TPHCWG (1997)
TPH C_{10}-C_{14} (Aliphatic)	Inhalation	Reference Concentration	Non-Threshold	1.0 mg/m^3	
TPH C_6-C_9 (Aromatic)	Oral	Reference Dose	Non-Threshold	0.2 mg/kg/day	TPHCWG (1997)
TPH C_{10}-C_{14} (Aromatic)	Oral	Reference Dose	Non-Threshold	0.04 mg/kg/day	
TPH C_{15}-C_{28} (Aromatic)	Oral	Reference Dose	Non-Threshold	0.03 mg/kg/day	
TPH C_{29}-C_{36} (Aromatic)	Oral	Reference Dose	Non-Threshold	0.03 mg/kg/day	
TPH C_6-C_9 (Aromatic)	Inhalation	Reference Concentration	Non-Threshold	0.4 mg/m^3	TPHCWG (1997)
TPH C_{10}-C_{14} (Aromatic)	Inhalation	Reference Concentration	Non-Threshold	0.2 mg/m^3	

Adopted Threshold Dose-Response Values

Threshold dose-response criteria for TPH fractions have not been published by Australian or other relevant international regulatory bodies, and have therefore been based on values recommended by the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). These values (oral and inhalation) are summarised in the above table.

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

Non-threshold dose-response criteria for TPH fractions have not been published by Australian or other regulatory bodies. Rather, in accordance with the hazard and toxicity assessment methodology recommended by TPHCWG (1997), specific carcinogenic indicator compounds which may be present in TPH mixtures (primarily benzene and carcinogenic PAHs) are assessed separately within the risk assessment process.

References

ATSDR, 1999. *Toxicological Profile for Total Petroleum Hydrocarbons*. Agency for Toxic Substances and Disease Registry. August, 1999.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

TPHCWG, 1997. *Total Petroleum Hydrocarbon Criteria Working Group Series Volume 4: Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH).* Total Petroleum Hydrocarbon Criteria Working Group. Amherst Scientific Publishers, Amherst.

Xylenes – Toxicological profile

The following information has been taken from ATSDR (2007):

General

Xylene is primarily a synthetic chemical composed of three isomers; *meta (m)*, *ortho (o)* and *para (p).* It is primarily used as a solvent (a liquid that can dissolve other substances) in the printing, rubber, and leather industries. Along with other solvents, xylene is also widely used as a cleaning agent, a thinner for paint, and in varnishes. Xylene is found in small amounts in airplane fuel and gasoline.

Non-carcinogenic Health Effects

Xylenes are lipophilic and are rapidly absorbed into the body by all routes of exposure. In humans, absorption has been estimated as >50% through the lungs following inhalation exposure and <50% through the gastrointestinal system and around 2% of the absorbed dose may be absorbed through the skin (via the air).

The major pathway for metabolism involves mixed function oxidases in the liver, resulting in the formation of isomers of methylhippuric acid that are eliminated in the urine. Xylenes tend not to accumulate in the body, but they may be sequestered briefly in fat tissues due to their lipophilicity; elimination of xylene is slower in individuals with a greater percentage of body fat. The primary effects of xylene exposure involve the nervous system by all routes of exposure, the respiratory tract by inhalation exposure, and, at higher oral exposure levels, hepatic, renal, and body weight effects. No adverse health effects have been associated with the background levels of xylene to which the general population is typically exposed. Isomers of xylene have similar toxicokinetic properties and elicit similar toxicological effects, with no single isomer consistently exhibiting the greatest potency, depending on the end point.

At acute-duration inhalation concentrations as low as 50 ppm, xylenes produce irritant effects on the eyes, skin, and mucous membranes; impaired respiratory function; and mild central nervous system effects, including headache and dizziness. Increases in subjective reports of eye irritation, sore throat, and neurological effects (anxiety, forgetfulness, inability to concentrate, and a sensation of intoxication) were noted following chronic-duration occupational exposure at 14 ppm. Irritation of the eye may occur from contact with xylene vapour or from direct contact with xylene liquid, in which case photophobia, redness of the conjunctiva, and partial loss of the conjunctival and corneal epithelia have been reported. Acute exposure to an estimated 10,000 ppm xylenes elicited tremors, mental confusion, and depressant effects (narcosis) on the central nervous system that caused at least one fatality due to respiratory failure. All of these effects are related to the lipophilic properties of xylenes, which interfere with the integrity of cell membranes and alter neuronal function. In addition to neurological and respiratory effects, an increase in the reporting of nausea was noted following controlled exposure to *m*-xylene at 50 ppm. Symptoms of nausea and vomiting have also been noted in workers exposed to xylene vapors.

Other effects of xylene exposure involve the liver and kidney in humans and animals and body weight effects in laboratory animals. Hepatic effects (elevated serum transaminases and hepatocellular vacuolation) were observed in a limited number of case reports describing effects of acute exposure to an estimated 700–10,000 ppm mixed xylene, but were not observed in workers with chronic occupational exposure at 14 ppm. Hepatic effects in laboratory animals exposed orally at ≥750 mg/kg/day or by inhalation at ≥300 ppm include increases in liver weight, serum enzyme levels, and cytochrome P-450 levels, but no histopathology. However, a number of authors characterized the hepatic effects in animals as adaptive rather than adverse. Information on renal effects (distal renal tubular acidemia and abnormal clinical chemistry values) of xylene in acutely exposed humans is confounded by exposure to other compounds or uncertainties as to the duration of exposure. No alterations in renal serum biochemistry values were observed in workers exposed to 14 ppm mixed xylene for several years. Renal effects in repeatedly exposed laboratory animals include increases in renal enzyme activity, cytochrome P-450 content, and increased kidney-to-body-weight ratios following inhalation exposure at 50–2,000 ppm or oral exposure and increased chronic nephropathy in rats exposed at ≥750 mg/kg/day. However, no renal effects were observed in rats exposed via inhalation to 810 ppm mixed xylenes for 13 weeks, gavage doses of 1,000 mg/kg/day 5 days/week for 13 weeks, or gavage doses of 800 mg/kg/day to *m*-or *p*-xylene for 90 consecutive days. It is not known whether the variability in induction of renal effects from mixed xylene is related to variations in the relative amounts of *o*-xylene or ethylbenzene or variations in the strains of rats tested. Decreased body weight gain has been observed in laboratory animals repeatedly exposed by inhalation at ≥700 ppm or by oral dosing or at ≥700 mg/kg/day; a 5–8% reduction in body weight gain observed in male rats exposed at 500 mg/kg during the last year of a 2-year study is not considered biologically significant. Dermal exposure of humans to xylene causes skin irritation, dryness and scaling of the skin, and vasodilation. In addition, one case report demonstrated the possibility that contact urticaria can develop after several months of occupational exposure to 100 ppm xylene vapors. Dermal effects of *m*-xylene, *o*-xylene, or mixed xylenes in laboratory animal studies included skin irritation (erythema and edema) at topical doses as low as 2.3 mg/kg and more serious effects (eschar formation in some animals and epidermal thickening) at topical doses of ≥114 mg/kg. Rat skin that developed moderate erythema after treatment with *m*-or *o*-xylene exhibited increases in transepidermal water loss and increases in pro-inflammatory cytokines (interleukin 1-alpha and tumor necrosis factor-alpha).

Available studies of developmental or reproductive toxicity from occupational exposure to xylenes are not definitive because of the small number of subjects and/or concurrent exposure to other chemicals. In general, developmental studies in animals reported adverse fetal effects only at concentrations that caused maternal toxicity. Developmental effects in laboratory animals exposed to ≥350 ppm xylenes by inhalation include delayed ossification of the skeleton at maternally toxic concentrations and reduced fetal body weight, which is also influenced by maternal body weight effects. Postnatal neurobehavioral deficits (decreased rotarod performance) have been observed in rats gestationally exposed to *m*-xylene at 500 ppm. Oral exposure to 2,060 mg/kg/day of mixed xylene has been associated with cleft plate and decreased foetal weight. Dermal exposure of rats to xylene has been associated with biochemical changes in foetal and maternal brain tissue. No reproductive effects were found in rats following inhalation of 500 ppm xylene before mating and during gestation and lactation. Histopathological examination following intermediate and chronic oral bioassays revealed no adverse effects on the reproductive organs of rats and mice dosed with mixed xylene 5 days/week at 800 and 1,000 mg/kg/day, respectively.

Carcinogenicity and Genotoxicity

There is no definitive evidence for carcinogenic effects of xylene in humans. Epidemiological studies looking for associations with xylene exposure and specific cancers either reported no cases or a limited number of cases exposed to xylene and/or reported concurrent exposure to multiple solvents. Two-year cancer bioassays in rats and mice exposed by oral gavage provided no evidence for carcinogenicity of mixed xylene. Both the IARC and USEPA have determined that xylene is not classifiable as to its carcinogenicity in humans, due to inadequate evidence for the carcinogenicity of xylenes in humans and animals.

The preponderance of data from testing *in vivo* and *in vitro* indicates that xylenes are not mutagenic and do not induce chromosomal anomalies.

Published Dose-Response Values

Available chronic dose-response values published by sources recognised and endorsed by NEPC (1999) and enHealth (2004) are summarised in the following table.

Table 1: Published Dose-Response Values for Xylenes

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Oral	Tolerable Daily Intake	Threshold	0.179 mg/kg/day	NHMRC (2004)	
Oral	Acceptable Daily Intake	Threshold	0.179 mg/kg/day	WHO (2008)	
Oral	Minimal Risk Level (MRL)	Threshold	0.2 mg/kg/day	ATSDR (2007)	Chronic exposure
Oral	Reference Dose (RfD)	Threshold	0.2 mg/kg/day	USEPA (2011)	
Inhalation	Monitoring Investigation Level	Threshold	0.87mg/m^3	NEPC (2004)	Chronic exposure

Route of Exposure	Type	Threshold or Non-Threshold	Value	Source	Notes
Inhalation	Health Based Guideline	Threshold	0.87 mg/m^3	WHO (2000)	
Inhalation	Minimal Risk Level (MRL)	Threshold	0.22 mg/m^3	ATSDR (2007)	Converted from 2 ppm.
Inhalation	Reference Concentration (RfC)	Threshold	0.1 mg/m^3	USEPA (2011	

Adopted Threshold Dose-Response Values

For assessment of potential threshold effects associated with oral exposure to xylenes, AECOM has adopted the acceptable daily intake (ADI) of 0.179 mg/kg/day adopted by NHMRC (2004) for derivation of drinking water guideline values.

For assessment of potential threshold effects associated with inhalation exposure to xylenes, AECOM has adopted the Minimal Risk Level (MRL) of 0.22 mg/m^3 published by ATSDR.

Adopted Non-Threshold (Carcinogenic) Dose-Response Values

To AECOM's knowledge, non-threshold dose-response criteria for oral and inhalation exposure to xylenes have not been published by Australian or other regulatory bodies. Potential health effects associated with oral and inhalation exposure to xylenes have therefore been assessed on the basis of threshold dose response criteria.

References

ATSDR, 2007. *Toxicological Profile for Xylene*. Agency for Toxic Substances and Disease Registry. August 2007.

enHealth, 2004. *Environmental Health Risk Assessment*, *Guidelines for Assessing Human Health Risks from Environmental Hazards.* June 2004.

NEPC, 1999. *Schedule B(4) Guideline on Health Risk Assessment Methodology.* In: National Environment Protection (Assessment of Site Contamination) Measure. National Environment Protection Council.

NEPC, 2004. *National Environmental Protection (Air Toxics) Measure.* National Environmental Protection Council.

USEPA, 2011. *Integrated Risk Information System (IRIS).* Electronic database maintained by the United States Environmental Protection Agency National Center for Environmental Assessment, Office of Research and Development. Accessed May 2011.

NHMRC, 2004, *Australian Drinking Water Guidelines (ADWG)*. National Health and Medical Research Council , 2004.

WHO, 2000. *Air Quality Guidelines for Europe. Second Edition.* World Health Organization (WHO), Regional Office for Europe. WHO Regional Publications, European Series, No. 91. 2000.

WHO, 2008. *Guidelines for Drinking-water Quality. First and Second Addenda to the Third-Edition. Volume 1. Recommendations.* World Health Organization.

Appendix G

Scenario 1 (Paved Recreation) - Odour

This page has been left blank intentionally.

AECOM

1. General Information:

Site:	Barangaroo
Address:	Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Client:	Lend Lease
Scenario:	Scenario 1 - Paved Recreation (Odour Based Calculations)

Header Colour (Defaults = Blue):

2. Select Receptor:

Recreational User

3. Select Exposure Pathways to Include:

Enter "x" in box, or select from dropdown box.

Soil Pathways	
	Incidental Ingestion of Soil
	Dermal Contact with Soil
	Inhalation of Surface Soil-Derived Dust in Indoor Air
	Inhalation of Surface Soil-Derived Dust in Outdoor Air
	Inhalation of Surface Soil-Derived Vapours in Outdoor Air
	Inhalation of Subsurface Soil-Derived Vapours in Indoor Air
x	Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air
Groundwater Pathways	
	Inhalation of Groundwater-Derived Vapours in Indoor Air
x	Inhalation of Groundwater-Derived Vapours in Outdoor Air
	Ingestion of Potable Groundwater
	Incidental Ingestion of Groundwater (Bathing or Excavation)
	Dermal Contact with Groundwater (Bathing or Excavation)
	Inhalation of Groundwater Vapours (Where GW Enters Trench)

Y	Soil RBSLs saturation limited?
Y	Groundwater RBSLs solubility limited?

4. Select Chemicals for Quantitative Assessment:	Target Hazard Index	Target Cancer Risk	5. Enter Chemical Concentrations (if only calculating RBSLs, enter 1):	
	default = 1 (or manually overwrite)	default = $1x10^{-5}$ (or manually overwrite)	**Soil (mg/kg)**	**Groundwater (mg/L)**
Acenaphthene	0.20	1.00E-05	270	4.4
Acenaphthylene	0.20	1.00E-05	1000	43
Ammonia	1.00	1.00E-05	1	348
Anthracene	0.20	1.00E-05	1200	15
Benz(a)anthracene	1	1.00E-05		
Benzene	0.25	1.00E-05	61	41
Benzo(a)pyrene	1	1.00E-05		
Benzo(b)fluoranthene	1	1.00E-05		
Benzo(g,h,i)perylene	1	1.00E-05		
Benzo(k)fluoranthene	1	1.00E-05		
Chrysene	1	1.00E-05		
Cyanide (CN-)	1	1.00E-05	1	1
Dibenz(a,h)anthracene	1	1.00E-05		
Ethylbenzene	0.25	1.00E-05	1	3
Fluoranthene	1	1.00E-05		
Fluorene	0.20	1.00E-05		21
Indeno(1,2,3-cd)pyrene	1	1.00E-05	1300	
Naphthalene	0.20	1.00E-05	8400	283
Phenanthrene	0.20	1.00E-05	3100	74
Phenol	1.00	1.00E-05	1	390
Pyrene	0.20	1.00E-05	1670	28
		Blank		
Toluene	0.25	1.00E-05	1	18
TPH C06-C09 aliphatic	0.13	1.00E-05	230	74
TPH C10-C14 aliphatic	0.13	1.00E-05	54000	1730
TPH C10-C14 aromatic	0.13	1.00E-05	54000	1730
TPH C15-C28 aliphatic	0.13	1.00E-05		
TPH C15-C28 aromatic	0.13	1.00E-05		
TPH C29-C36 aliphatic	0.13	1.00E-05		
TPH C29-C36 aromatic	0.13	1.00E-05		
Xylenes (total)	1.00	1.00E-05	1	6.7

6. Confirm/Modify Exposure Parameters:

Link to Exposure Defaults and Sources

		Default Value		Site-Specific Value (leave blank to use default value)		Value Used in Calculations	
		Adult	Child	Adult	Child	Adult	Child
General receptor parameters:	**Units**						
Body weight	kg	70	13	70	13	70	13
Exposure duration	yr	30	6	64	6	64	6
Averaging time (carcinogens)	yr	70	70	70	70	70	70
Averaging time (non-carcinogens)	yr	30	6	64	6	64	6
Incidental Soil Ingestion							
Daily soil ingestion rate	mg/day	25	100			25	100
Exposure frequency for soil ingestion	days/yr	350	350			350	350
Fraction of daily soil intake from site	unitless	0.5	0.5			0.5	0.5
Dermal Absorption of Soil							
Exposed skin surface area for soil contact	cm2	3600	2100			3600	2100
Soil to skin adherence factor	mg/cm2	0.5	0.5			0.5	0.5
Exposure frequency for dermal contact with soil	days/yr	350	350			350	350
Indoor Inhalation							
Exposure time (indoor air)	hrs/day	0	0			0	0
Exposure frequency (indoor air)	days/yr	350	350			350	350
Particulate emission factor (indoor air)	m3/kg	NA	NA			NA	NA
Outdoor Inhalation							
Exposure time (outdoor air)	hrs/day	2	2	2	2	2	2
Exposure frequency (outdoor air)	days/yr	350	350	365	365	365	365
Particulate emission factor (outdoor air)	m3/kg	1.36E+09	#######			1.36E+09	1.36E+09
Potable Water Ingestion							
Potable water intake rate	L/day	0	0			0	0
Exposure frequency for potable water intake	days/yr	350	350			350	350
Incidental Water Ingestion							
Incidental ingestion rate	L/day	NA	NA			NA	NA
Exposure frequency for incidental water ingestio	days/yr	350	350			350	350
Dermal Contact with Water							
Exposed skin surface for water contact	cm2	18150	6880			18150	6880
Exposure time for dermal water contact	hr/day	1	1			1	1
Exposure frequency for dermal water contact	days/yr	350	350			350	350

Back to User Input Sheet

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Depth to groundwater (below building, ground surface or trench)	cm	300			LGW	200	Autocalculates from layer thicknesses
Vadose Zone Layer 1							
Thickness	cm	295		173	HV	173	Groundwater assumed to be at a depth of 2 m based on groundwater data for the Site.
SCS Soil Type:				Sand (<12% fines)			The soil type above groundwater across the site consists of fill (mostly sand and gravel), thus sand has conservatively been assumed as the main soil type in this scenario.
Fraction of organic carbon	unitless	0.01		0.002	OC	0.002	
Air-filled porosity (volumetric)	cm3/cm3	0.26		0.321	VACS	0.321	
Water-filled porosity (volumetric)	cm3/cm3	0.12		0.054	vwcvz	0.054	
Total soil porosity	cm3/cm3	0.38		0.375	TPOR	0.375	
Adjustment for vadose zone biodegradation	unitless	1		10	BioA_GW	10	Adjustment for biodegradation in unpaved areas; see text
Vadose Zone Layer 2 (lens)							
Thickness	cm			10	Hvtwo	10	Assumed thickness of concrete pavings in the public open space area.
SCS Soil Type:				User Specified (Enter values in 'Soil Data' worksheet)			Porosities for concrete have been assumed to be sand (multiplied by 1%).
Air-filled porosity (volumetric)	cm3/cm3	NA		0.00321	VACS2	0.00321	
Water-filled porosity (volumetric)	cm3/cm3	NA		0.00054	vwcvz2	0.00054	
Total soil porosity	cm3/cm3	NA		0.00375	TPOR2	0.00375	
Capillary Fringe							
SCS Soil Type (aquifer unit):				Sand (<12% fines)			As above.
Thickness of capillary fringe	cm	5		17	hcap	17	
Volumetric air content in capillary fringe soils	cc/cc	0.038		0.122	VAC	0.122	
Volumetric water content in capillary fringe soils	cc/cc	0.342		0.253	vwccap	0.253	
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate)	cm/s	225	(e)	378.3	windsp	378.3	Based on the average annual 9am and 3pm windspeeds measured at Observatory Point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site).
Width of source area parallel to wind or groundwater flow direction	cm	4500	(f)	4500	WSA	4500	Conservative default.
Ambient air mixing zone height	cm	200		200	AAMZH	200	Assumes vapours mixed within 2m of ground.

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) Conservative estimate of maximum expected velocity for a sandy or gravelly aquifer (50ft/day = 13 m/day)
(d) Assumes trench is 2 m long.
(e) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(f) For construction/excavation worker, default is 600 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Back to User Input Sheet

B. Chemical-Specific Fate and Transport Parameters

Chemical	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-$H_2$0 / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	1.01E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	1.01E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	6.20E-03	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	3.28E+01	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	3.54E+02	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	2.92E-01	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	1.17E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	N
Benzo(b)fluoranthene	5.99E+05	1.20E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	N
Benzo(g,h,i)perylene	1.95E+06	3.90E+03	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	N
Benzo(k)fluoranthene	5.87E+05	1.17E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	N
Chrysene	1.81E+05	3.62E+02	2.14E-04	2.00E-03	2.48E-02	6.21E-06	2.28E+02	6.23E-09	N
Cyanide (CN-)	2.84E+00	5.68E-03	5.44E-03	1.00E+06	2.11E-01	2.46E-05	2.70E+01	7.42E+02	Y
Dibenz(a,h)anthracene	1.91E+06	3.82E+03	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	N
Ethylbenzene	4.46E+02	8.92E-01	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	1.11E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	N
Fluorene	9.16E+03	1.83E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	3.90E+03	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	N
Naphthalene	1.54E+03	3.08E+00	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	3.34E+01	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	3.74E-01	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	Y
Pyrene	5.43E+04	1.09E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
Blank	1.20E+05	2.40E+02	1.10E-05	2.70E-01	3.51E-02	3.66E-06	3.91E+02	1.42E-07	N
Toluene	2.34E+02	4.68E-01	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	8.94E+00	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	1.10E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	6.04E+00	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	6.32E+05	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	n
TPH C15-C28 aromatic	3.79E+04	7.58E+01	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	n
TPH C29-C36 aliphatic	6.31E+08	1.26E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	n
TPH C29-C36 aromatic	1.26E+05	2.52E+02	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	N
Xylenes (total)	3.83E+02	7.66E-01	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Constan	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

AECOM

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

Chemical	D_{s1} (cm^2/s)	D_{s2}	D_{s3}	D_{stot}	D_{crack} (cm^2/s)	D_{cap} (cm^2/s)	D_{ws} (cm^2/s)	Convective Factor (unitless)
Acenaphthene	8.18E-03	1.79E-05	-	3.16E-04	3.96E-03	4.07E-04	3.22E-04	3.10E+01
Acenaphthylene	7.28E-03	1.59E-05	-	2.81E-04	3.52E-03	4.00E-04	2.88E-04	3.49E+01
Ammonia	3.69E-02	8.07E-05	-	1.42E-03	1.79E-02	2.69E-03	1.48E-03	6.86E+00
Anthracene	6.31E-03	1.38E-05	-	2.43E-04	3.06E-03	5.05E-04	2.54E-04	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Benzene	1.45E-02	3.17E-05	-	5.58E-04	6.98E-03	5.81E-04	5.60E-04	1.76E+01
Benzo(a)pyrene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Chrysene	NV	NV	NV	NV	NV	NV	NV	NV
Cyanide (CN-)	3.41E-02	7.46E-05	-	1.32E-03	1.65E-02	1.69E-03	1.34E-03	7.44E+00
Dibenz(a,h)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Ethylbenzene	1.11E-02	2.42E-05	-	4.27E-04	5.35E-03	4.44E-04	4.29E-04	2.30E+01
Fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Fluorene	7.11E-03	1.56E-05	-	2.74E-04	3.45E-03	4.31E-04	2.83E-04	3.56E+01
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	NV	NV	NV
Naphthalene	9.78E-03	2.14E-05	-	3.77E-04	4.72E-03	4.24E-04	3.81E-04	2.60E+01
Phenanthrene	5.58E-03	1.22E-05	-	2.15E-04	2.72E-03	5.05E-04	2.26E-04	4.52E+01
Phenol	1.38E-02	3.02E-05	-	5.33E-04	1.10E-02	5.60E-02	5.82E-04	1.11E+01
Pyrene	4.50E-03	9.85E-06	-	1.74E-04	2.26E-03	1.27E-03	1.87E-04	5.43E+01
Blank	NV	NV	NV	NV	NV	NV	NV	NV
Toluene	1.26E-02	2.75E-05	-	4.85E-04	6.07E-03	5.04E-04	4.87E-04	2.02E+01
TPH C06-C09 aliphatic	1.62E-02	3.54E-05	-	6.24E-04	7.80E-03	6.45E-04	6.25E-04	1.57E+01
TPH C10-C14 aliphatic	1.62E-02	3.54E-05	-	6.24E-04	7.80E-03	6.45E-04	6.25E-04	1.57E+01
TPH C10-C14 aromatic	1.62E-02	3.54E-05	-	6.24E-04	7.80E-03	6.50E-04	6.26E-04	1.57E+01
TPH C15-C28 aliphatic	NV	NV	NV	NV	NV	NV	NV	NV
TPH C15-C28 aromatic	NV	NV	NV	NV	NV	NV	NV	NV
TPH C29-C36 aliphatic	NV	NV	NV	NV	NV	NV	NV	NV
TPH C29-C36 aromatic	NV	NV	NV	NV	NV	NV	NV	NV
Xylenes (total)	1.37E-02	3.00E-05	-	5.28E-04	6.61E-03	5.50E-04	5.30E-04	1.86E+01

Definition of Parameters

D_s Effective diffusion coefficient in soil based on vapor-phase concentration
D_{crack} Effective diffusion coefficient through foundation cracks
D_{cap} Effective diffusion coefficient through capillary fringe
D_{ws} Effective diffusion coefficient between groundwater and soil surface

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Back to User Input Sheet

D. Chemical-Specific Volatilisation Factors

Chemical	VF_{wesp} (mg/m^3-air / mg/L-H_2O)	VF_{wamb} (mg/m^3-air / mg/L-H_2O)	VF_{trench} (mg/m^3-air / mg/L -water)
Acenaphthene	2.63E-04	7.19E-08	4.41E-06
Acenaphthylene	1.47E-04	3.99E-08	4.41E-06
Ammonia	7.92E-05	2.90E-08	4.41E-06
Anthracene	6.41E-05	1.72E-08	4.41E-06
Benz(a)anthracene	NV	NV	NV
Benzene	1.29E-02	3.78E-06	4.41E-06
Benzo(a)pyrene	NV	NV	NV
Benzo(b)fluoranthene	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV
Chrysene	NV	NV	NV
Cyanide (CN-)	6.12E-04	2.17E-07	4.41E-06
Dibenz(a,h)anthracene	NV	NV	NV
Ethylbenzene	1.46E-02	4.10E-06	4.41E-06
Fluoranthene	NV	NV	NV
Fluorene	1.22E-04	3.31E-08	4.41E-06
Indeno(1,2,3-cd)pyrene	NV	NV	NV
Naphthalene	7.33E-04	2.04E-07	4.41E-06
Phenanthrene	4.38E-05	1.16E-08	4.41E-06
Phenol	7.99E-07	2.35E-10	4.41E-06
Pyrene	1.03E-05	2.71E-09	4.41E-06
Blank	NV	NV	NV
Toluene	1.37E-02	3.92E-06	4.41E-06
TPH C06-C09 aliphatic	3.15E+00	9.39E-04	4.41E-06
TPH C10-C14 aliphatic	3.91E+00	1.16E-03	4.41E-06
TPH C10-C14 aromatic	8.81E-03	2.62E-06	4.41E-06
TPH C15-C28 aliphatic	NV	NV	NV
TPH C15-C28 aromatic	NV	NV	NV
TPH C29-C36 aliphatic	NV	NV	NV
TPH C29-C36 aromatic	NV	NV	NV
Xylenes (total)	1.15E-02	3.34E-06	4.41E-06

Definition of Parameters

VF_{wesp1}	Volatilization factor from groundwater to enclosed-space vapors - no convective transport
VF_{wesp2}	Volatilization factor from groundwater to enclosed-space vapors - with convective transport
VF_{wamb}	Volatilization factor from groundwater to ambient (outdoor) vapors
VF_{trench}	Volatilisation factor from groundwater to trench air (where groundwater seeps into trench - this is mass limited value based on estimated rate of groundwater flow into trench)

Back to User Input Sheet

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting Shell default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Lower depth of surficial soil zone	cm	100			LDSSZ	100	
Depth to subsurface soil sources (below building, ground surface or trench	cm	100			LS	10.01	Autocalculates from layer thicknesses
Vadose Zone Layer 1 (soil type where source is)							
Thickness	cm	100		0.01	HV	0.01	Assumes that contaminated soils are located directly below concrete pavings.
SCS Soil Type:				Sand (<12% fines)			The majority of fill across the site has been identified as sand and gravel with some clay, therefore sand has been conservatively assumed in this scenario.
Fraction of organic carbon	unitless	0.01		0.002	OC	0.002	
Soil bulk density	g/cm3	1.7		1.66	sbd	1.66	
Air-filled porosity (volumetric)	cm3/cm3	0.26		0.321	VACS	0.321	
Water-filled porosity (volumetric)	cm3/cm3	0.12		0.054	vwcvz	0.054	
Total soil porosity	cm3/cm3	0.38		0.375	TPOR	0.375	
Vapour phase source partitioning adjustment	unitless	1		10	VPPA	10	Adjustment for vapour partitioning; see text.
Biodegradation adjustment	unitless	1		10	BioA	10	Conservatively assumes no soil vapour biodegradation
Vadose Zone Layer 2 (lens)							
Thickness	cm			10	Hvtwo	10	Assumed thickness of concrete pavings in the public open space area.
SCS Soil Type:				User Specified (Enter values in 'Soil Data' worksheet)			Porosities for concrete have been assumed to be sand (multiplied by 1%).
Air-filled porosity (volumetric)	cm3/cm3	NA		0.00321	VACS2	0.00321	
Water-filled porosity (volumetric)	cm3/cm3	NA		0.00054	vwcvz2	0.00054	
Total soil porosity	cm3/cm3	NA		0.00375	TPOR2	0.00375	
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate)	cm/s	225	(c)	378.3	windsp	378.3	Based on the average annual 9am and 3pm windspeeds measured at observatory point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site).
Width of source area parallel to wind or groundwater flow direction	cm	4500	(d)	4500	WSA	4500	Conservative default.
Ambient air mixing zone height	cm	200		200	AAMZH	200	Assumes vapours mixed within 2m of ground.
Other							
Averaging time for surface emission vapour flux	sec	1.89E+08	(e)		atvapor	1.89E+08	Defaults to receptor exposure duration

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(d) For construction/excavation worker, default is 400 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.
(e) Equals exposure duration for selected receptor. For residential scenario, shortest (child) exposure duration is selected for conservative purposes.

Back to User Input Sheet

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

B. Chemical-Specific Fate and Transport Parameters

CHEMICAL	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-H_2O / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	1.01E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	1.01E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	6.20E-03	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	3.28E+01	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	3.54E+02	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	2.92E-01	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	1.17E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	N
Benzo(b)fluoranthene	5.99E+05	1.20E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	N
Benzo(g,h,i)perylene	1.95E+06	3.90E+03	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	N
Benzo(k)fluoranthene	5.87E+05	1.17E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	N
Chrysene	1.81E+05	3.62E+02	2.14E-04	2.00E-03	2.48E-02	6.21E-06	2.28E+02	6.23E-09	N
Cyanide (CN-)	2.84E+00	5.68E-03	5.44E-03	1.00E+06	2.11E-01	2.46E-05	2.70E+01	7.42E+02	Y
Dibenz(a,h)anthracene	1.91E+06	3.82E+03	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	N
Ethylbenzene	4.46E+02	8.92E-01	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	1.11E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	N
Fluorene	9.16E+03	1.83E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	3.90E+03	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	N
Naphthalene	1.54E+03	3.08E+00	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	3.34E+01	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	3.74E-01	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	Y
Pyrene	5.43E+04	1.09E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
Toluene	2.34E+02	4.68E-01	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	8.94E+00	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	1.10E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	6.04E+00	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	6.32E+05	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	n
TPH C15-C28 aromatic	3.79E+04	7.58E+01	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	n
TPH C29-C36 aliphatic	6.31E+08	1.26E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	n
TPH C29-C36 aromatic	1.26E+05	2.52E+02	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	N
Xylenes (total)	3.83E+02	7.66E-01	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Constant	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

Back to User Input Sheet

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

C. Chemical-Specific Diffusion Coefficients

CHEMICAL	D_{s1}	D_{s2}	D_{s3}	D_{stot}	D_{crack}	Csat	Convective
	(cm^2/s)				(cm^2/s)	mg/kg	Factor (unitless)
Acenaphthene	8.18E-03	1.79E-05	-	1.79E-05	3.96E-03	3.94E+01	3.10E+01
Acenaphthylene	7.28E-03	1.59E-05	-	1.59E-05	3.52E-03	1.63E+02	3.49E+01
Ammonia	3.69E-02	8.07E-05	-	8.07E-05	1.79E-02	1.87E+04	6.86E+00
Anthracene	6.31E-03	1.38E-05	-	1.38E-05	3.06E-03	1.42E+00	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	3.33E+00	NV
Benzene	1.45E-02	3.17E-05	-	3.17E-05	6.98E-03	6.59E+02	1.76E+01
Benzo(a)pyrene	NV	NV	NV	NV	NV	1.90E+00	NV
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	1.80E+00	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	1.01E+00	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	9.39E-01	NV
Chrysene	NV	NV	NV	NV	NV	7.24E-01	NV
Cyanide (CN-)	3.41E-02	7.46E-05	-	7.47E-05	1.65E-02	3.93E+04	7.44E+00
Dibenz(a,h)anthracene	NV	NV	NV	NV	NV	9.51E+00	NV
Ethylbenzene	1.11E-02	2.42E-05	-	2.43E-05	5.35E-03	1.67E+02	2.30E+01
Fluoranthene	NV	NV	NV	NV	NV	2.89E+01	NV
Fluorene	7.11E-03	1.56E-05	-	1.56E-05	3.45E-03	3.10E+01	3.56E+01
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	7.41E-01	NV
Naphthalene	9.78E-03	2.14E-05	-	2.14E-05	4.72E-03	9.66E+01	2.60E+01
Phenanthrene	5.58E-03	1.22E-05	-	1.22E-05	2.72E-03	3.84E+01	4.52E+01
Phenol	1.38E-02	3.02E-05	-	3.02E-05	1.10E-02	3.37E+04	1.11E+01
Pyrene	4.50E-03	9.85E-06	-	9.86E-06	2.26E-03	1.47E+01	5.43E+01
Toluene	1.26E-02	2.75E-05	-	2.75E-05	6.07E-03	2.91E+02	2.02E+01
TPH C06-C09 aliphatic	1.62E-02	3.54E-05	-	3.54E-05	7.80E-03	2.21E+02	1.57E+01
TPH C10-C14 aliphatic	1.62E-02	3.54E-05	-	3.54E-05	7.80E-03	1.11E+02	1.57E+01
TPH C10-C14 aromatic	1.62E-02	3.54E-05	-	3.54E-05	7.80E-03	1.54E+02	1.57E+01
TPH C15-C28 aliphatic	NV	NV	NV	NV	NV	7.02E+01	NV
TPH C15-C28 aromatic	NV	NV	NV	NV	NV	8.04E+01	NV
TPH C29-C36 aliphatic	NV	NV	NV	NV	NV	3.16E+00	NV
TPH C29-C36 aromatic	NV	NV	NV	NV	NV	1.66E+00	NV
Xylenes (total)	1.37E-02	3.00E-05	-	3.00E-05	6.61E-03	8.90E+00	1.86E+01

Definition of Parameters

D_s Effective diffusion coefficient in soil based on vapor-phase concentration

D_{crack} Effective diffusion coefficient through foundation cracks

C_{sat} Soil concentration at which dissolved pore-water and vapor phases become saturated

Back to User Input Sheet

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

D. Chemical-Specific Volatilisation Factors

CHEMICAL	VF_{as1}	VF_{as2}	$VF_{p\ (indoor)}$	$VF_{p\ (outdoor)}$	VF_{samb}	VF_{sesp}
	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	/m^3-air / mg/kg-	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)
Acenaphthene	7.26E-08	5.22E-05	-	7.35E-10	7.93E-09	2.87E-06
Acenaphthylene	5.39E-08	5.22E-05	-	7.35E-10	4.37E-09	1.60E-06
Ammonia	7.35E-07	5.22E-05	-	7.35E-10	8.12E-07	2.16E-04
Anthracene	1.94E-08	5.22E-05	-	7.35E-10	5.67E-10	2.10E-07
Benz(a)anthracene	NV	NV	-	7.35E-10	NV	NV
Benzene	2.78E-06	5.22E-05	-	7.35E-10	1.16E-06	3.89E-04
Benzo(a)pyrene	NV	NV	-	7.35E-10	NV	NV
Benzo(b)fluoranthene	NV	NV	-	7.35E-10	NV	NV
Benzo(g,h,i)perylene	NV	NV	-	7.35E-10	NV	NV
Benzo(k)fluoranthene	NV	NV	-	7.35E-10	NV	NV
Chrysene	NV	NV	-	7.35E-10	NV	NV
Cyanide (CN-)	2.02E-06	5.22E-05	-	7.35E-10	6.15E-06	1.68E-03
Dibenz(a,h)anthracene	NV	NV	-	7.35E-10	NV	NV
Ethylbenzene	1.77E-06	5.22E-05	-	7.35E-10	4.70E-07	1.64E-03
Fluoranthene	NV	NV	-	7.35E-10	NV	NV
Fluorene	3.63E-08	5.22E-05	-	7.35E-10	1.98E-10	7.27E-08
Indeno(1,2,3-cd)pyrene	NV	NV	-	7.35E-10	NV	NV
Naphthalene	2.21E-07	5.22E-05	-	7.35E-10	7.35E-08	2.61E-05
Phenanthrene	1.58E-08	5.22E-05	-	7.35E-10	3.76E-11	1.41E-08
Phenol	2.00E-08	5.22E-05	-	7.35E-10	6.01E-10	2.03E-07
Pyrene	4.18E-09	5.22E-05	-	7.35E-10	2.63E-11	9.96E-09
Toluene	2.31E-06	5.22E-05	-	7.35E-10	8.02E-07	2.75E-03
TPH C06-C09 aliphatic	6.14E-06	5.22E-05	-	7.35E-10	5.67E-05	1.86E-02
TPH C10-C14 aliphatic	8.88E-07	5.22E-05	-	7.35E-10	1.18E-06	3.89E-04
TPH C10-C14 aromatic	5.69E-07	5.22E-05	-	7.35E-10	4.86E-08	1.60E-05
TPH C15-C28 aliphatic	NV	NV	-	7.35E-10	NV	NV
TPH C15-C28 aromatic	NV	NV	-	7.35E-10	NV	NV
TPH C29-C36 aliphatic	NV	NV	-	7.35E-10	NV	NV
TPH C29-C36 aromatic	NV	NV	-	7.35E-10	NV	NV
Xylenes (total)	1.73E-06	5.22E-05	-	7.35E-10	4.50E-07	1.52E-04

Definition of Parameters

VF_{as}	Volatilization factor from surficial soils to ambient air (vapors) - use lower of two values
VF_{p}	Volatilization factor from surficial soils to ambient air (particulates)
VF_{samb}	Volatilization factor from subsurface soils to ambient air
VF_{sesp1}	Volatilization factor from soil to enclosed-space vapors
VF_{trench}	Volatilisation factor from subsurface soil to trench air (where soil contamination is below base of trench)

Summary of Estimated Health Risks
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Back to User Input Sheet

Exposure Pathway	Threshold Risk Estimates		Non-Threshold Risk Estimates (Lifetime Exposure)
	Adult Exposure	Childhood Exposure	
Incidental Ingestion of Soil	-	-	-
Dermal Contact with Soil	-	-	-
Inhalation of Surface Soil-Derived Dust in Indoor Air	-	-	-
Inhalation of Surface Soil-Derived Dust in Outdoor Air	-	-	-
Inhalation of Surface Soil-Derived Vapours in Outdoor Air	-	-	-
Inhalation of Subsurface Soil-Derived Vapours in Indoor Air	-	-	-
Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air	2.3E-06	2.3E-06	-
Inhalation of Groundwater-Derived Vapours in Indoor Air	-	-	-
Inhalation of Groundwater-Derived Vapours in Outdoor Air	2.6E-06	2.6E-06	-
Inhalation of Groundwater Vapours (Where GW Enters Trench)	-	-	-
Ingestion of Potable Groundwater	-	-	-
Incidental Ingestion of Groundwater (Bathing or Excavation)	-	-	-
Dermal Contact with Groundwater (Bathing or Excavation)	-	-	-
TOTAL	**4.9E-06**	**4.9E-06**	

Health Risk Calculations - Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

					Threshold Intake and Risk Calculations						
Chemical	Soil Conc. (mg/kg)	Csat (mg/kg)	Volatilisation Factor from Subsurface Soil to Outdoor Air [(mg/m3)/(mg/kg)]	Vapour Concentration in Outdoor Air (From Subsurface Soil) (mg/m3)	Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (kg/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Child Exposure Factor (threshold) (kg/m3)	Child Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Child) (unitless)
Acenaphthene	270	3.94E+01	7.93E-09	3.12E-07	5.04E-01	6.61E-10	2.60E-08	5.16E-08	6.61E-10	2.60E-08	5.16E-08
Acenaphthylene	1000	1.63E+02	4.37E-09	7.10E-07	-	-	-	-	-	-	-
Ammonia	1	1.87E+04	8.12E-07	8.12E-07	1.80E+01	6.77E-08	6.77E-08	3.76E-09	6.77E-08	6.77E-08	3.76E-09
Anthracene	1200	1.42E+00	5.67E-10	8.08E-10	-	-	-	-	-	-	-
Benz(a)anthracene	-	-	NV	-	-	-	-	-	-	-	-
Benzene	61	6.59E+02	1.16E-06	7.08E-05	1.09E+02	9.67E-08	5.90E-06	5.41E-08	9.67E-08	5.90E-06	5.41E-08
Benzo(a)pyrene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Chrysene	-	-	NV	-	-	-	-	-	-	-	-
Cyanide (CN-)	1	3.93E+04	6.15E-06	6.15E-06	6.40E-01	5.13E-07	5.13E-07	8.00E-07	5.13E-07	5.13E-07	8.00E-07
Dibenz(a,h)anthracene	-	-	NV	-	-	-	-	-	-	-	-
Ethylbenzene	1	1.67E+02	4.70E-07	4.70E-07	2.00E+00	3.92E-08	3.92E-08	1.96E-08	3.92E-08	3.92E-08	1.96E-08
Fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	1300	7.41E-01	NV	-	-	-	-	-	-	-	-
Naphthalene	8400	9.66E+01	7.35E-08	7.10E-06	4.40E-01	6.13E-09	5.92E-07	1.34E-06	6.13E-09	5.92E-07	1.34E-06
Phenanthrene	3100	3.84E+01	3.76E-11	1.44E-09	-	-	-	-	-	-	-
Phenol	1	3.37E+04	6.01E-10	6.01E-10	1.54E-01	5.01E-11	5.01E-11	3.25E-10	5.01E-11	5.01E-11	3.25E-10
Pyrene	1670	1.47E+01	2.63E-11	3.85E-10	-	-	-	-	-	-	-
Toluene	1	2.91E+02	8.02E-07	8.02E-07	3.01E+01	6.68E-08	6.68E-08	2.22E-09	6.68E-08	6.68E-08	2.22E-09
TPH C06-C09 aliphatic	230	2.21E+02	5.67E-05	1.25E-02	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.11E+02	1.18E-06	1.32E-04	-	-	-	-	-	-	-
TPH C10-C14 aromatic	54000	1.54E+02	4.86E-08	7.50E-06	-	-	-	-	-	-	-
TPH C15-C28 aliphatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	NV	-	-	-	-	-	-	-	-
Xylenes (total)	1	8.90E+00	4.50E-07	4.50E-07	4.34E+00	3.75E-08	3.75E-08	8.65E-09	3.75E-08	3.75E-08	8.65E-09
TOTAL								**2.29E-06**			**2.29E-06**

Health Risk Calculations - Inhalation of Groundwater-Derived Vapours in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Chemical	Groundwater Concentration (mg/L)	Aqueous Solubility (mg/L)	Volatilisation Factor from Groundwater to Outdoor Air [(mg/m3)/(mg/L)]	Vapour Concentration in Outdoor Air (From Subsurface Groundwater) (mg/m3)	Threshold Intake and Risk Calculations: Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (L/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Child Exposure Factor (threshold) (L/m3)	Child Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Child) (unitless)
Acenaphthene	4.4	3.90E+00	7.19E-08	2.81E-07	5.04E-01	6.00E-09	2.34E-08	4.64E-08	6.00E-09	2.34E-08	4.64E-08
Acenaphthylene	43	1.61E+01	3.99E-08	6.42E-07	-	-	-	-	-	-	-
Ammonia	348	4.82E+05	2.90E-08	1.01E-05	1.80E+01	2.42E-09	8.41E-07	4.67E-08	2.42E-09	8.41E-07	4.67E-08
Anthracene	15	4.34E-02	1.72E-08	7.46E-10	-	-	-	-	-	-	-
Benz(a)anthracene	-	-	NV	-	-	-	-	-	-	-	-
Benzene	41	1.79E+03	3.78E-06	1.55E-04	1.09E+02	3.15E-07	1.29E-05	1.18E-07	3.15E-07	1.29E-05	1.18E-07
Benzo(a)pyrene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	NV	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Chrysene	-	-	NV	-	-	-	-	-	-	-	-
Cyanide (CN-)	1	1.00E+06	2.17E-07	2.17E-07	6.40E-01	1.81E-08	1.81E-08	2.82E-08	1.81E-08	1.81E-08	2.82E-08
Dibenz(a,h)anthracene	-	-	NV	-	-	-	-	-	-	-	-
Ethylbenzene	3	1.69E+02	4.10E-06	1.23E-05	2.00E+00	3.42E-07	1.03E-06	5.13E-07	3.42E-07	1.03E-06	5.13E-07
Fluoranthene	-	-	NV	-	-	-	-	-	-	-	-
Fluorene	21	1.69E+00	3.31E-08	5.59E-08	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	NV	-	-	-	-	-	-	-	-
Naphthalene	283	3.10E+01	2.04E-07	6.32E-06	4.40E-01	1.70E-08	5.27E-07	1.20E-06	1.70E-08	5.27E-07	1.20E-06
Phenanthrene	74	1.15E+00	1.16E-08	1.34E-08	-	-	-	-	-	-	-
Phenol	390	8.28E+04	2.35E-10	9.17E-08	1.54E-01	1.96E-11	7.64E-09	4.97E-08	1.96E-11	7.64E-09	4.97E-08
Pyrene	28	1.35E-01	2.71E-09	3.66E-10	-	-	-	-	-	-	-
Toluene	18	5.26E+02	3.92E-06	7.06E-05	3.01E+01	3.27E-07	5.88E-06	1.95E-07	3.27E-07	5.88E-06	1.95E-07
TPH C06-C09 aliphatic	74	1.18E+01	9.39E-04	1.11E-02	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	1730	9.99E-02	1.16E-03	1.16E-04	-	-	-	-	-	-	-
TPH C10-C14 aromatic	1730	2.53E+01	2.62E-06	6.64E-05	-	-	-	-	-	-	-
TPH C15-C28 aliphatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C15-C28 aromatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	NV	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	NV	-	-	-	-	-	-	-	-
Xylenes (total)	6.7	1.06E+01	3.34E-06	2.24E-05	4.34E+00	2.78E-07	1.87E-06	4.30E-07	2.78E-07	1.87E-06	4.30E-07
TOTAL								**2.62E-06**			**2.62E-06**

Soil RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity) (kg/mg)			RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Vapour Only Risk at Csat (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL	
			Vapours from Subsurface Soil Outdoors	TOTAL (All Pathways)	Vapours from Subsurface Soil Outdoors	Total Vapour Pathways	TOTAL (All Pathways)					Vapours from Subsurface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	kg/mg	kg/mg	kg/mg	mg/kg			mg/kg	%	%
Acenaphthene	270	3.94E+01	5.16E-08	5.16E-08	1.31E-09	1.31E-09	1.31E-09	1.52E+08	5.16E-08	5.16E-08	**1.52E+08**	0.00%	0.00%
Acenaphthylene	1000	1.63E+02	-	-	-		-	-	-	-	-	-	
Ammonia	1	1.87E+04	3.76E-09	3.76E-09	3.76E-09	3.76E-09	3.76E-09	2.66E+08	7.04E-05	7.04E-05	**2.66E+08**	0.01%	0.01%
Anthracene	1200	1.42E+00	-	-	-		-	-	-	-	-	-	
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	-	-	
Benzene	61	6.59E+02	5.41E-08	5.41E-08	8.87E-10	8.87E-10	8.87E-10	2.82E+08	5.85E-07	5.85E-07	**2.82E+08**	0.00%	0.00%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	-	-	
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	-	-	
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	-	-	
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	-	-	
Chrysene	-	-	-	-	-		-	-	-	-	-	-	
Cyanide (CN-)	1	3.93E+04	8.00E-07	8.00E-07	8.00E-07	8.00E-07	8.00E-07	1.25E+06	3.14E-02	3.14E-02	**1.25E+06**	3.14%	3.14%
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	-	-	
Ethylbenzene	1	1.67E+02	1.96E-08	1.96E-08	1.96E-08	1.96E-08	1.96E-08	1.28E+07	3.27E-06	3.27E-06	**1.28E+07**	0.00%	0.00%
Fluoranthene	-	-	-	-	-		-	-	-	-	-	-	
Fluorene	-	-	-	-	-		-	-	-	-	-	-	
Indeno(1,2,3-cd)pyrene	1300	7.41E-01	-	-	-		-	-	-	-	-	-	
Naphthalene	8400	9.66E+01	1.34E-06	1.34E-06	1.39E-08	1.39E-08	1.39E-08	1.44E+07	1.34E-06	1.34E-06	**1.44E+07**	0.00%	0.00%
Phenanthrene	3100	3.84E+01	-	-	-		-	-	-	-	-	-	
Phenol	1	3.37E+04	3.25E-10	3.25E-10	3.25E-10	3.25E-10	3.25E-10	3.07E+09	1.10E-05	1.10E-05	**3.07E+09**	0.00%	0.00%
Pyrene	1670	1.47E+01	-	-	-		-	-	-	-	-	-	
Toluene	1	2.91E+02	2.22E-09	2.22E-09	2.22E-09	2.22E-09	2.22E-09	1.13E+08	6.45E-07	6.45E-07	**1.13E+08**	0.00%	0.00%
TPH C06-C09 aliphatic	230	2.21E+02	-	-	-		-	-	-	-	-	-	
TPH C10-C14 aliphatic	54000	1.11E+02	-	-	-		-	-	-	-	-	-	
TPH C10-C14 aromatic	54000	1.54E+02	-	-	-		-	-	-	-	-	-	
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	-	-	
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	-	-	
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	-	-	
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	-	-	
Xylenes (total)	1	8.90E+00	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09	1.16E+08	7.70E-08	7.70E-08	**1.16E+08**	0.00%	0.00%

Soil RBSL Derivation - Child Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity) (kg/mg)			RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Vapour Only Risk at Csat (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL (%)	
			Vapours from Subsurface Soil Outdoors	TOTAL (All Pathways)	Vapours from Subsurface Soil Outdoors	Total Vapour Pathways	TOTAL (All Pathways)					Vapours from Subsurface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	kg/mg	kg/mg	kg/mg	mg/kg	HI	HI	mg/kg	%	%
Acenaphthene	270	3.94E+01	5.16E-08	5.16E-08	1.31E-09	1.31E-09	1.31E-09	1.52E+08	5.16E-08	5.16E-08	**1.52E+08**	0.00%	0.00%
Acenaphthylene	1000	1.63E+02	-	-	-		-	-	-	-	**-**	-	-
Ammonia	1	1.87E+04	3.76E-09	3.76E-09	3.76E-09	3.76E-09	3.76E-09	2.66E+08	7.04E-05	7.04E-05	**2.66E+08**	0.01%	0.01%
Anthracene	1200	1.42E+00	-	-	-		-	-	-	-	**-**	-	-
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzene	61	6.59E+02	5.41E-08	5.41E-08	8.87E-10	8.87E-10	8.87E-10	2.82E+08	5.85E-07	5.85E-07	**2.82E+08**	0.00%	0.00%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Chrysene	-	-	-	-	-		-	-	-	-	**-**	-	-
Cyanide (CN-)	1	3.93E+04	8.00E-07	8.00E-07	8.00E-07	8.00E-07	8.00E-07	1.25E+06	3.14E-02	3.14E-02	**1.25E+06**	3.14%	3.14%
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Ethylbenzene	1	1.67E+02	1.96E-08	1.96E-08	1.96E-08	1.96E-08	1.96E-08	1.28E+07	3.27E-06	3.27E-06	**1.28E+07**	0.00%	0.00%
Fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Fluorene	-	-	-	-	-		-	-	-	-	**-**	-	-
Indeno(1,2,3-cd)pyrene	1300	7.41E-01	-	-	-		-	-	-	-	**-**	-	-
Naphthalene	8400	9.66E+01	1.34E-06	1.34E-06	1.39E-08	1.39E-08	1.39E-08	1.44E+07	1.34E-06	1.34E-06	**1.44E+07**	0.00%	0.00%
Phenanthrene	3100	3.84E+01	-	-	-		-	-	-	-	**-**	-	-
Phenol	1	3.37E+04	3.25E-10	3.25E-10	3.25E-10	3.25E-10	3.25E-10	3.07E+09	1.10E-05	1.10E-05	**3.07E+09**	0.00%	0.00%
Pyrene	1670	1.47E+01	-	-	-		-	-	-	-	**-**	-	-
Toluene	1	2.91E+02	2.22E-09	2.22E-09	2.22E-09	2.22E-09	2.22E-09	1.13E+08	6.45E-07	6.45E-07	**1.13E+08**	0.00%	0.00%
TPH C06-C09 aliphatic	230	2.21E+02	-	-	-		-	-	-	-	**-**	-	-
TPH C10-C14 aliphatic	54000	1.11E+02	-	-	-		-	-	-	-	**-**	-	-
TPH C10-C14 aromatic	54000	1.54E+02	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-
Xylenes (total)	1	8.90E+00	8.65E-09	8.65E-09	8.65E-09	8.65E-09	8.65E-09	1.16E+08	7.70E-08	7.70E-08	**1.16E+08**	0.00%	0.00%

Groundwater RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

			Risk at Input Groundwater Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity)							Pathway Contributions to Total Estimated Risk at RBSL	
	Cgw	Solubility	GW to Outdoor Vapour	TOTAL (All Pathways)	GW to Outdoor Vapour	Total Vapour Pathways	TOTAL (All Pathways)	RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Vapour Only Risk at Sol (if necessary)	Adopted RBSL	GW to Outdoor Vapour	TOTAL
Chemical	mg/L	mg/L	unitless	unitless	L/mg	L/mg	L/mg	mg/L			mg/L	%	%
Acenaphthene	4.4	3.90E+00	4.64E-08	4.64E-08	1.19E-08	1.19E-08	1.19E-08	1.68E+07	4.64E-08	4.64E-08	**1.68E+07**	0.00%	0.00%
Acenaphthylene	43	1.61E+01	-	-	-		-	-	-	-	**-**	-	-
Ammonia	348	4.82E+05	4.67E-08	4.67E-08	1.34E-10	1.34E-10	1.34E-10	7.45E+09	6.47E-05	6.47E-05	**7.45E+09**	0.01%	0.01%
Anthracene	15	4.34E-02	-	-	-		-	-	-	-	**-**	-	-
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzene	41	1.79E+03	1.18E-07	1.18E-07	2.89E-09	2.89E-09	2.89E-09	8.65E+07	5.17E-06	5.17E-06	**8.65E+07**	0.00%	0.00%
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	**-**	-	-
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Chrysene	-	-	-	-	-		-	-	-	-	**-**	-	-
Cyanide (CN-)	1	1.00E+06	2.82E-08	2.82E-08	2.82E-08	2.82E-08	2.82E-08	3.54E+07	2.82E-02	2.82E-02	**3.54E+07**	2.82%	2.82%
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	**-**	-	-
Ethylbenzene	3	1.69E+02	5.13E-07	5.13E-07	1.71E-07	1.71E-07	1.71E-07	1.46E+06	2.89E-05	2.89E-05	**1.46E+06**	0.01%	0.01%
Fluoranthene	-	-	-	-	-		-	-	-	-	**-**	-	-
Fluorene	21	1.69E+00	-	-	-		-	-	-	-	**-**	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-		-	-	-	-	**-**	-	-
Naphthalene	283	3.10E+01	1.20E-06	1.20E-06	3.86E-08	3.86E-08	3.86E-08	5.18E+06	1.20E-06	1.20E-06	**5.18E+06**	0.00%	0.00%
Phenanthrene	74	1.15E+00	-	-	-		-	-	-	-	**-**	-	-
Phenol	390	8.28E+04	4.97E-08	4.97E-08	1.27E-10	1.27E-10	1.27E-10	7.85E+09	1.05E-05	1.05E-05	**7.85E+09**	0.00%	0.00%
Pyrene	28	1.35E-01	-	-	-		-	-	-	-	**-**	-	-
Toluene	18	5.26E+02	1.95E-07	1.95E-07	1.08E-08	1.08E-08	1.08E-08	2.30E+07	5.71E-06	5.71E-06	**2.30E+07**	0.00%	0.00%
TPH C06-C09 aliphatic	74	1.18E+01	-	-	-		-	-	-	-	**-**	-	-
TPH C10-C14 aliphatic	1730	9.99E-02	-	-	-		-	-	-	-	**-**	-	-
TPH C10-C14 aromatic	1730	2.53E+01	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	**-**	-	-
Xylenes (total)	6.7	1.06E+01	4.30E-07	4.30E-07	6.42E-08	6.42E-08	6.42E-08	1.56E+07	6.81E-07	6.81E-07	**1.56E+07**	0.00%	0.00%

Groundwater RBSL Derivation - Child Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Chemical	Cgw	Solubility	Risk at Input Groundwater Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity)			RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Vapour Only Risk at Sol (if necessary)	Adopted RBSL
			GW to Outdoor Vapour	TOTAL (All Pathways)	GW to Outdoor Vapour	Total Vapour Pathways	TOTAL (All Pathways)				
	mg/L	mg/L	unitless	unitless	L/mg	L/mg	L/mg	mg/L			mg/L
Acenaphthene	4.4	3.90E+00	4.64E-08	4.64E-08	1.19E-08	1.19E-08	1.19E-08	1.68E+07	4.64E-08	4.64E-08	**1.68E+07**
Acenaphthylene	43	1.61E+01	-	-	-		-	-	-	-	**-**
Ammonia	348	4.82E+05	4.67E-08	4.67E-08	1.34E-10	1.34E-10	1.34E-10	7.45E+09	6.47E-05	6.47E-05	**7.45E+09**
Anthracene	15	4.34E-02	-	-	-		-	-	-	-	**-**
Benz(a)anthracene	-	-	-	-	-		-	-	-	-	**-**
Benzene	41	1.79E+03	1.18E-07	1.18E-07	2.89E-09	2.89E-09	2.89E-09	8.65E+07	5.17E-06	5.17E-06	**8.65E+07**
Benzo(a)pyrene	-	-	-	-	-		-	-	-	-	**-**
Benzo(b)fluoranthene	-	-	-	-	-		-	-	-	-	**-**
Benzo(g,h,i)perylene	-	-	-	-	-		-	-	-	-	**-**
Benzo(k)fluoranthene	-	-	-	-	-		-	-	-	-	**-**
Chrysene	-	-	-	-	-		-	-	-	-	**-**
Cyanide (CN-)	1	1.00E+06	2.82E-08	2.82E-08	2.82E-08	2.82E-08	2.82E-08	3.54E+07	2.82E-02	2.82E-02	**3.54E+07**
Dibenz(a,h)anthracene	-	-	-	-	-		-	-	-	-	**-**
Ethylbenzene	3	1.69E+02	5.13E-07	5.13E-07	1.71E-07	1.71E-07	1.71E-07	1.46E+06	2.89E-05	2.89E-05	**1.46E+06**
Fluoranthene	-	-	-	-	-		-	-	-	-	**-**
Fluorene	21	1.69E+00	-	-	-		-	-	-	-	**-**
Indeno(1,2,3-cd)pyrene	-	-	-	-	-		-	-	-	-	**-**
Naphthalene	283	3.10E+01	1.20E-06	1.20E-06	3.86E-08	3.86E-08	3.86E-08	5.18E+06	1.20E-06	1.20E-06	**5.18E+06**
Phenanthrene	74	1.15E+00	-	-	-		-	-	-	-	**-**
Phenol	390	8.28E+04	4.97E-08	4.97E-08	1.27E-10	1.27E-10	1.27E-10	7.85E+09	1.05E-05	1.05E-05	**7.85E+09**
Pyrene	28	1.35E-01	-	-	-		-	-	-	-	**-**
Toluene	18	5.26E+02	1.95E-07	1.95E-07	1.08E-08	1.08E-08	1.08E-08	2.30E+07	5.71E-06	5.71E-06	**2.30E+07**
TPH C06-C09 aliphatic	74	1.18E+01	-	-	-		-	-	-	-	**-**
TPH C10-C14 aliphatic	1730	9.99E-02	-	-	-		-	-	-	-	**-**
TPH C10-C14 aromatic	1730	2.53E+01	-	-	-		-	-	-	-	**-**
TPH C15-C28 aliphatic	-	-	-	-	-		-	-	-	-	**-**
TPH C15-C28 aromatic	-	-	-	-	-		-	-	-	-	**-**
TPH C29-C36 aliphatic	-	-	-	-	-		-	-	-	-	**-**
TPH C29-C36 aromatic	-	-	-	-	-		-	-	-	-	**-**
Xylenes (total)	6.7	1.06E+01	4.30E-07	4.30E-07	6.42E-08	6.42E-08	6.42E-08	1.56E+07	6.81E-07	6.81E-07	**1.56E+07**

Groundwater RBSL Derivation - Child Threshold
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Baranga
Scenario 1 - Paved Recreation (Odour Based Ca

Chemical	Cgw	Solubility	Pathway Contributions to Total Estimated Risk at RBSL	
			GW to Outdoor Vapour	TOTAL
	mg/L	mg/L	%	%
Acenaphthene	4.4	3.90E+00	0.00%	0.00%
Acenaphthylene	43	1.61E+01	-	-
Ammonia	348	4.82E+05	0.01%	0.01%
Anthracene	15	4.34E-02	-	-
Benz(a)anthracene	-	-	-	-
Benzene	41	1.79E+03	0.00%	0.00%
Benzo(a)pyrene	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-
Chrysene	-	-	-	-
Cyanide (CN-)	1	1.00E+06	2.82%	2.82%
Dibenz(a,h)anthracene	-	-	-	-
Ethylbenzene	3	1.69E+02	0.01%	0.01%
Fluoranthene	-	-	-	-
Fluorene	21	1.69E+00	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-
Naphthalene	283	3.10E+01	0.00%	0.00%
Phenanthrene	74	1.15E+00	-	-
Phenol	390	8.28E+04	0.00%	0.00%
Pyrene	28	1.35E-01	-	-
Toluene	18	5.26E+02	0.00%	0.00%
TPH C06-C09 aliphatic	74	1.18E+01	-	-
TPH C10-C14 aliphatic	1730	9.99E-02	-	-
TPH C10-C14 aromatic	1730	2.53E+01	-	-
TPH C15-C28 aliphatic	-	-	-	-
TPH C15-C28 aromatic	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-
Xylenes (total)	6.7	1.06E+01	0.00%	0.00%

Summary of Derived RBSLs
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 1 - Paved Recreation (Odour Based Calculations) Scenario

Back to User Input Sheet

	Soil RBSLs (mg/kg)						Groundwater RBSLs (mg/L)					
Chemical	Adult Threshold	Child Threshold	Non-Threshold (Lifetime)	Adopted RBSL (Lowest)	Saturation Limited?	Site Concentration	Adult Threshold	Child Threshold	Non-Threshold (Lifetime)	Adopted RBSL (Lowest)	Solubility Limited?	Site Concentration
Acenaphthene	1.52E+08	1.52E+08	-	**1.52E+08**	>Sat	2.70E+02	1.68E+07	1.68E+07	-	**1.68E+07**	>Sol	4.40E+00
Acenaphthylene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Ammonia	2.66E+08	2.66E+08	-	**2.66E+08**	>Sat	1.00E+00	7.45E+09	7.45E+09	-	**7.45E+09**	>Sol	3.48E+02
Anthracene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Benz(a)anthracene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Benzene	2.82E+08	2.82E+08	-	**2.82E+08**	>Sat	6.10E+01	8.65E+07	8.65E+07	-	**8.65E+07**	>Sol	4.10E+01
Benzo(a)pyrene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Benzo(b)fluoranthene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Benzo(g,h,i)perylene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Benzo(k)fluoranthene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Chrysene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Cyanide (CN-)	1.25E+06	1.25E+06	-	**1.25E+06**	>Sat	1.00E+00	3.54E+07	3.54E+07	-	**3.54E+07**	>Sol	1.00E+00
Dibenz(a,h)anthracene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Ethylbenzene	1.28E+07	1.28E+07	-	**1.28E+07**	>Sat	1.00E+00	1.46E+06	1.46E+06	-	**1.46E+06**	>Sol	3.00E+00
Fluoranthene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Fluorene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Naphthalene	1.44E+07	1.44E+07	-	**1.44E+07**	>Sat	8.40E+03	5.18E+06	5.18E+06	-	**5.18E+06**	>Sol	2.83E+02
Phenanthrene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Phenol	3.07E+09	3.07E+09	-	**3.07E+09**	>Sat	1.00E+00	7.85E+09	7.85E+09	-	**7.85E+09**	>Sol	3.90E+02
Pyrene	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Toluene	1.13E+08	1.13E+08	-	**1.13E+08**	>Sat	1.00E+00	2.30E+07	2.30E+07	-	**2.30E+07**	>Sol	1.80E+01
TPH C06-C09 aliphatic	-	-	-	**-**	-	-	-	-	-	**-**	-	-
TPH C10-C14 aliphatic	-	-	-	**-**	-	-	-	-	-	**-**	-	-
TPH C10-C14 aromatic	-	-	-	**-**	-	-	-	-	-	**-**	-	-
TPH C15-C28 aliphatic	-	-	-	**-**	-	-	-	-	-	**-**	-	-
TPH C15-C28 aromatic	-	-	-	**-**	-	-	-	-	-	**-**	-	-
TPH C29-C36 aliphatic	-	-	-	**-**	-	-	-	-	-	**-**	-	-
TPH C29-C36 aromatic	-	-	-	**-**	-	-	-	-	-	**-**	-	-
Xylenes (total)	1.16E+08	1.16E+08	-	**1.16E+08**	>Sat	1.00E+00	1.56E+07	1.56E+07	-	**1.56E+07**	>Sol	6.70E+00

Pathways included in derivation of Soil RBSL:

x Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air

Pathways included in derivation of Groundwater RBSL:

x Inhalation of Groundwater-Derived Vapours in Outdoor Air

Appendix H

Scenario 2 (Intrusive Maintenance) - Odour

This page has been left blank intentionally.

AECOM

1. General Information:

Site:	Barangaroo
Address:	Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Client:	Lend Lease
Scenario:	Scenario 2 - Intrusive Maintenance (Odour Based Calculations)

Header Colour (Defaults = Blue):

2. Select Receptor:

Construction/Excavation Worker

3. Select Exposure Pathways to Include:

Enter "x" in box, or select from dropdown box.

Soil Pathways	
	Incidental Ingestion of Soil
	Dermal Contact with Soil
	Inhalation of Surface Soil-Derived Dust in Indoor Air
x	Inhalation of Surface Soil-Derived Dust in Outdoor Air
x	Inhalation of Surface Soil-Derived Vapours in Outdoor Air
	Inhalation of Subsurface Soil-Derived Vapours in Indoor Air
	Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air
Groundwater Pathways	
	Inhalation of Groundwater-Derived Vapours in Indoor Air
	Inhalation of Groundwater-Derived Vapours in Outdoor Air
	Ingestion of Potable Groundwater
	Incidental Ingestion of Groundwater (Bathing or Excavation)
	Dermal Contact with Groundwater (Bathing or Excavation)
x	Inhalation of Groundwater Vapours (Where GW Enters Trench)

	Soil RBSLs saturation limited?
Y	Groundwater RBSLs solubility limited?

4. Select Chemicals for Quantitative Assessment:	Target Hazard Index	Target Cancer Risk	5. Enter Chemical Concentrations (if only calculating RBSLs, enter 1):	
	default = 1 (or manually overwrite)	default = 1x10^{-5} (or manually overwrite)	**Soil (mg/kg)**	**Groundwater (mg/L)**
Acenaphthene	0.2	1.00E-05	270	0.91
Acenaphthylene	0.2	1.00E-05	1000	6.2
Ammonia	1	1.00E-05	1	210
Anthracene	0.2	1.00E-05	1200	3
Benz(a)anthracene	0	0.00E+00	910	2.4
Benzene	0.25	1.00E-05	61	11
Benzo(a)pyrene	1	1.00E-05	650	1.8
Benzo(b)fluoranthene	1	1.00E-05	820	3.7
Benzo(g,h,i)perylene	1	1.00E-05	310	0.74
Benzo(k)fluoranthene	1	1.00E-05	320	1.6
Chrysene	1	1.00E-05	630	1.8
Cyanide (CN-)	1	1.00E-05	1	1
Dibenz(a,h)anthracene	1	1.00E-05	73	0.82
Ethylbenzene	0.25	1.00E-05	1	3
Fluoranthene	0.2	1.00E-05	2100	26
Fluorene	0.2	1.00E-05	1300	21
Indeno(1,2,3-cd)pyrene	1	1.00E-05	250	3.1
Naphthalene	0.2	1.00E-05	8400	280
Phenanthrene	0.2	1.00E-05	3100	74
Phenol	1	1.00E-05	1	390
Pyrene	0.2	1.00E-05	1700	28
		Blank		
Toluene	0.25	1.00E-05	1	18
TPH C06-C09 aliphatic	0.125	1.00E-05		74
TPH C10-C14 aliphatic	0.125	1.00E-05	54000	1700
TPH C10-C14 aromatic	0.125	1.00E-05	54000	1700
TPH C15-C28 aliphatic	0.125	1.00E-05	72000	1520
TPH C15-C28 aromatic	0.125	1.00E-05	72000	1520
TPH C29-C36 aliphatic	0.125	1.00E-05		330
TPH C29-C36 aromatic	0.125	1.00E-05		330
Xylenes (total)	0.25	1.00E-05	1	6.7

6. Confirm/Modify Exposure Parameters:

Link to Exposure Defaults and Sources

		Default Value		Site-Specific Value (leave blank to use default value)		Value Used in Calculations		
		Adult	Child	Adult	Child	Adult	Child	
General receptor parameters:	**Units**							
Body weight	kg	70	N/A	70		70	N/A	
Exposure duration	yr	1	N/A	1		1	N/A	
Averaging time (carcinogens	yr	70	N/A	70		70	N/A	
Averaging time (non-carcinogens	yr	1	N/A	1		1	N/A	
Incidental Soil Ingestion								
Daily soil ingestion rate	mg/day	200	N/A			200	N/A	*
Exposure frequency for soil ingestion	days/yr	240	N/A			240	N/A	
Fraction of daily soil intake from site	unitless	1	N/A			1	N/A	
Dermal Absorption of Soil								
Exposed skin surface area for soil contac	cm2	5000	N/A			5000	N/A	#
Soil to skin adherence factor	mg/cm2	0.5	N/A			0.5	N/A	
Exposure frequency for dermal contact with so	days/yr	240	N/A			240	N/A	
Indoor Inhalation								
Exposure time (indoor air	hrs/day	NA	N/A			NA	N/A	
Exposure frequency (indoor air)	days/yr	240	N/A			240	N/A	
Particulate emission factor (indoor air)	m3/kg	NA	N/A			NA	N/A	
Outdoor Inhalation								
Exposure time (outdoor air)	hrs/day	8	N/A	8		8	N/A	
Exposure frequency (outdoor air)	days/yr	240	N/A	15		15	N/A	
Particulate emission factor (outdoor air)	m3/kg	1.00E+05	N/A	3.60E+07		3.60E+07	N/A	*
Potable Water Ingestion								
Potable water intake rate	L/day	0	N/A			0	N/A	
Exposure frequency for potable water intake	days/yr	240	N/A			240	N/A	
Incidental Water Ingestion								
Incidental ingestion rate	L/day	0.05	N/A			0.05	N/A	
Exposure frequency for incidental water ingestion	days/yr	240	N/A			240	N/A	
Dermal Contact with Water								
Exposed skin surface for water contac	cm2	6510	N/A			6510	N/A	**
Exposure time for dermal water contac	hr/day	8	N/A			8	N/A	
Exposure frequency for dermal water contac	days/yr	240	N/A			240	N/A	

* USEPA (2002)
\# USEPA (1997) (Exposure factors handbook) - based on assumption that head, forearms and hands will be exposed. 50th percentile data
** USEPA (1997) (Exposure factors handbook) - based on assumption that lower legs and feet only would be contacting water. 50th percent

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Depth to groundwater (below building, ground surface or trench)	cm	300			LGW	300	Autocalculates from layer thicknesses
Vadose Zone Layer 1							
Thickness	cm	295			HV	295	
SCS Soil Type:							
Fraction of organic carbon	unitless	0.01			OC	0.01	
Air-filled porosity (volumetric)	cm3/cm3	0.26			VACS	0.26	
Water-filled porosity (volumetric)	cm3/cm3	0.12			vwcvz	0.12	
Total soil porosity	cm3/cm3	0.38			TPOR	0.38	
Vadose Zone Layer 2 (lens)							
Thickness	cm				Hvtwo		
SCS Soil Type:							
Air-filled porosity (volumetric)	cm3/cm3	NA			VACS2	NA	
Water-filled porosity (volumetric)	cm3/cm3	NA			vwcvz2	NA	
Total soil porosity	cm3/cm3	NA			TPOR2	NA	
Convective vapour flow term							
Calculate convective flow term? (ENTER Y or N)		Y			Conv	Y	
Convective flow rate (if specified directly)	cm3/sec						
Convective flow through slab (calculated)	cm3/sec	10.88			Qs	10.88	
Slab Area	cm2	700000			Ab	700000	
Areal fraction of cracks in foundations/walls	cm^2-cracks/cm^2-total area	0.0019			Nuc	0.0019	
Soil vapour permeability	cm^2	1.00E-08			kv	1.00E-08	
Indoor-outdoor pressure differential	$g/cm\text{-}s^2$	40			dP	40	
Slab perimeter	cm	3400			Xcrack	3400	
Depth to bottom of slab	cm	15			Zcrack	15	
Viscosity of air	g/cm-s	1.81E-04			uair	1.81E-04	Viscosity of air at 20 deg C.
Additional Trench Characteristics (for GW level above base of trench, i.e., assumes groundwater flows into trench)							
Groundwater seepage velocity (into trench)	cm/sec	1.50E-04	(c)	1.50E-02	Vgw	0.015	Default for permeable fill (max expected for sandy/gravelly aquifer).
Depth of groundwater in trench	cm	50		50	Dgw	50	Assumes gw may be present at 2 mbgl (on average) and trench depth of 1.5 mbgl.
Dimension of trench (length or width) perpendicular to GW flow	cm	200	(d)	200	WSAtrench	200	Maximum assumed trench dimension.
Flow rate of groundwater in trench	cm3/sec				Qgw	150	Calculated from above three parameters.
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriat	cm/s	22.5	(e)	37.8	windsp	37.8	Based on the average annual 9am and 3pm windspeeds measured at observatory point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site), divided by 10.
Width of source area parallel to wind or groundwater flow direction	cm	600	(f)	600	WSA	600	2 m deep and 2 m long trench.
Ambient air mixing zone height	cm	200		200	AAMZH	200	Assumes all vapours mixed w/in trench.

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) Conservative estimate of maximum expected velocity for a sandy or gravelly aquifer (50ft/day = 13 m/day)
(d) Assumes trench is 2 m long.
(e) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(f) For construction/excavation worker, default is 600 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

B. Chemical-Specific Fate and Transport Parameters

Chemical	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-H_2O / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	5.03E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	5.03E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	3.10E-02	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	1.64E+02	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	1.77E+03	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	1.46E+00	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	5.87E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	Y
Benzo(b)fluoranthene	5.99E+05	5.99E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	Y
Benzo(g,h,i)perylene	1.95E+06	1.95E+04	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	Y
Benzo(k)fluoranthene	5.87E+05	5.87E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	Y
Chrysene	1.81E+05	1.81E+03	2.14E-04	2.00E-03	2.48E-02	6.21E-06	2.28E+02	6.23E-09	Y
Cyanide (CN-)	2.84E+00	2.84E-02	5.44E-03	1.00E+06	2.11E-01	2.46E-05	2.70E+01	7.42E+02	Y
Dibenz(a,h)anthracene	1.91E+06	1.91E+04	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	Y
Ethylbenzene	4.46E+02	4.46E+00	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	5.55E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	Y
Fluorene	9.16E+03	9.16E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	1.95E+04	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	Y
Naphthalene	1.54E+03	1.54E+01	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	1.67E+02	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	1.87E+00	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	Y
Pyrene	5.43E+04	5.43E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
Toluene	2.34E+02	2.34E+00	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	4.47E+01	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	5.50E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	3.02E+01	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	3.16E+06	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	Y
TPH C15-C28 aromatic	3.79E+04	3.79E+02	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	Y
TPH C29-C36 aliphatic	6.31E+08	6.31E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	Y
TPH C29-C36 aromatic	1.26E+05	1.26E+03	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	Y
Xylenes (total)	3.83E+02	3.83E+00	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Consta	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

AECOM

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

Chemical	D_{s1} (cm²/s)	D_{s2}	D_{s3}	D_{stot}	D_{crack} (cm²/s)	D_{cap} (cm²/s)	D_{ws} (cm²/s)	Convective Factor (unitless)
Acenaphthene	3.96E-03	-	-	3.96E-03	3.96E-03	2.22E-04	3.09E-03	3.10E+01
Acenaphthylene	3.52E-03	-	-	3.52E-03	3.52E-03	2.97E-04	2.98E-03	3.49E+01
Ammonia	1.79E-02	-	-	1.79E-02	1.79E-02	3.28E-03	1.67E-02	6.86E+00
Anthracene	3.06E-03	-	-	3.06E-03	3.06E-03	6.77E-04	2.89E-03	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Benzene	6.98E-03	-	-	6.98E-03	6.98E-03	2.04E-05	1.04E-03	1.76E+01
Benzo(a)pyrene	6.22E-03	-	-	6.22E-03	6.22E-03	9.36E-02	6.31E-03	1.97E+01
Benzo(b)fluoranthene	2.99E-03	-	-	2.99E-03	2.99E-03	4.02E-02	3.04E-03	4.10E+01
Benzo(g,h,i)perylene	6.27E-03	-	-	6.27E-03	6.27E-03	8.01E-02	6.37E-03	1.96E+01
Benzo(k)fluoranthene	3.15E-03	-	-	3.15E-03	3.15E-03	4.52E-02	3.20E-03	3.90E+01
Chrysene	2.11E-03	-	-	2.11E-03	2.11E-03	5.65E-03	2.13E-03	5.82E+01
Cyanide (CN-)	1.65E-02	-	-	1.65E-02	1.65E-02	9.06E-04	1.28E-02	7.44E+00
Dibenz(a,h)anthracene	6.97E-03	-	-	6.97E-03	6.97E-03	1.77E-01	7.08E-03	1.76E+01
Ethylbenzene	5.35E-03	-	-	5.35E-03	5.35E-03	1.40E-05	7.26E-04	2.30E+01
Fluoranthene	2.46E-03	-	-	2.46E-03	2.46E-03	3.41E-03	2.47E-03	4.99E+01
Fluorene	3.45E-03	-	-	3.45E-03	3.45E-03	3.96E-04	3.05E-03	3.56E+01
Indeno(1,2,3-cd)pyrene	3.64E-03	-	-	3.64E-03	3.64E-03	6.04E-02	3.70E-03	3.37E+01
Naphthalene	4.72E-03	-	-	4.72E-03	4.72E-03	9.83E-05	2.65E-03	2.60E+01
Phenanthrene	2.72E-03	-	-	2.72E-03	2.72E-03	7.56E-04	2.60E-03	4.52E+01
Phenol	1.10E-02	-	-	1.10E-02	1.10E-02	1.47E-01	1.12E-02	1.11E+01
Pyrene	2.26E-03	-	-	2.26E-03	2.26E-03	2.90E-03	2.27E-03	5.43E+01
Toluene	6.07E-03	-	-	6.07E-03	6.07E-03	1.66E-05	8.60E-04	2.02E+01
TPH C06-C09 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.30E-05	7.08E-04	1.57E+01
TPH C10-C14 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.08E-04	1.57E+01
TPH C10-C14 aromatic	7.80E-03	-	-	7.80E-03	7.80E-03	2.67E-05	1.33E-03	1.57E+01
TPH C15-C28 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.07E-04	1.57E+01
TPH C15-C28 aromatic	7.82E-03	-	-	7.82E-03	7.82E-03	4.10E-04	6.01E-03	1.57E+01
TPH C29-C36 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.07E-04	1.57E+01
TPH C29-C36 aromatic	1.13E-02	-	-	1.13E-02	1.13E-02	1.14E-01	1.15E-02	1.09E+01
Xylenes (total)	6.61E-03	-	-	6.61E-03	6.61E-03	2.00E-05	1.02E-03	1.86E+01

Definition of Parameters

D_s Effective diffusion coefficient in soil based on vapor-phase concentration
D_{crack} Effective diffusion coefficient through foundation cracks
D_{cap} Effective diffusion coefficient through capillary fringe
D_{ws} Effective diffusion coefficient between groundwater and soil surface

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

D. Chemical-Specific Volatilisation Factors

Chemical	VF_{wesp} (mg/m^3-air / mg/L-H_2O)	VF_{wamb} (mg/m^3-air / mg/L-H_2O)	VF_{trench} (mg/m^3-air / mg/L -water)
Acenaphthene	1.12E-03	6.15E-06	3.31E-02
Acenaphthylene	6.78E-04	3.68E-06	3.31E-02
Ammonia	1.92E-04	2.90E-06	3.31E-02
Anthracene	3.24E-04	1.74E-06	3.31E-02
Benz(a)anthracene	NV	NV	NV
Benzene	1.55E-02	6.27E-05	3.31E-02
Benzo(a)pyrene	4.01E-06	3.12E-08	3.31E-02
Benzo(b)fluoranthene	3.96E-06	2.16E-08	3.31E-02
Benzo(g,h,i)perylene	2.91E-06	2.27E-08	3.31E-02
Benzo(k)fluoranthene	3.63E-06	2.02E-08	3.31E-02
Chrysene	2.50E-05	1.21E-07	3.31E-02
Cyanide (CN-)	1.49E-03	1.84E-05	3.31E-02
Dibenz(a,h)anthracene	1.30E-06	1.08E-08	3.31E-02
Ethylbenzene	1.62E-02	6.18E-05	3.31E-02
Fluoranthene	4.68E-05	2.37E-07	3.31E-02
Fluorene	5.80E-04	3.17E-06	3.31E-02
Indeno(1,2,3-cd)pyrene	2.34E-06	1.39E-08	3.31E-02
Naphthalene	2.43E-03	1.26E-05	3.31E-02
Phenanthrene	2.31E-04	1.19E-06	3.31E-02
Phenol	3.58E-06	4.02E-08	3.31E-02
Pyrene	5.94E-05	2.92E-07	3.31E-02
Toluene	1.57E-02	6.16E-05	3.31E-02
TPH C06-C09 aliphatic	2.48E+00	9.46E-03	3.31E-02
TPH C10-C14 aliphatic	3.08E+00	1.17E-02	3.31E-02
TPH C10-C14 aromatic	1.17E-02	4.97E-05	3.31E-02
TPH C15-C28 aliphatic	4.06E+00	1.55E-02	3.31E-02
TPH C15-C28 aromatic	1.03E-03	7.79E-06	3.31E-02
TPH C29-C36 aliphatic	4.18E+00	1.59E-02	3.31E-02
TPH C29-C36 aromatic	4.51E-06	5.16E-08	3.31E-02
Xylenes (total)	1.42E-02	5.72E-05	3.31E-02

Definition of Parameters

VF_{wesp1}	Volatilization factor from groundwater to enclosed-space vapors - no convective transport
VF_{wesp2}	Volatilization factor from groundwater to enclosed-space vapors - with convective transport
VF_{wamb}	Volatilization factor from groundwater to ambient (outdoor) vapors
VF_{trench}	Volatilisation factor from groundwater to trench air (where groundwater seeps into trench - this is mass limited value based on estimated rate of groundwater flow into trench)

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting Shell default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Lower depth of surficial soil zone	cm	100		2000	LDSSZ	2000	Large value assumed in order to eliminate mass limiting in surface soil emission model.
Depth to subsurface soil sources (below building, ground surface or trench)	cm	100			LS	100	Autocalculates from layer thicknesses
Vadose Zone Layer 1 (soil type where source is)							
Thickness	cm	100			HV	100	
SCS Soil Type:				Sand and gravel (<12% fines)			The majority of fill across the site has been identified as sand and gravel with some clay.
Fraction of organic carbon	unitless	0.01		0.002	OC	0.002	
Soil bulk density	g/cm3	1.7		1.66	sbd	1.66	
Air-filled porosity (volumetric)	cm3/cm3	0.26		0.321	VACS	0.321	
Water-filled porosity (volumetric)	cm3/cm3	0.12		0.054	vwcvz	0.054	
Total soil porosity	cm3/cm3	0.38		0.375	TPOR	0.375	
Vapour phase source partitioning adjustment	unitless	1		10	VPPA	10	Adjustment for vapour partitioning; see text.
Biodegradation adjustment	unitless	1		1	BioA	1	Conservatively assumes no soil vapour biodegradation
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate)	cm/s	22.5	(c)	37.8	windsp	37.8	Based on the average annual 9am and 3pm windspeeds measured at observatory point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site), divided by 10.
Width of source area parallel to wind or groundwater flow direction	cm	600	(d)	600	WSA	600	2 m deep and 2 m long trench.
Ambient air mixing zone height	cm	200		200	AAMZH	200	Assumes all vapours mixed w/in trench.
Other							
Averaging time for surface emission vapour flux	sec	3.15E+07	(e)		atvapor	3.15E+07	Defaults to receptor exposure duration

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(d) For construction/excavation worker, default is 400 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.
(e) Equals exposure duration for selected receptor. For residential scenario, shortest (child) exposure duration is selected for conservative purposes.

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

B. Chemical-Specific Fate and Transport Parameters

CHEMICAL	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-$H_2$0 / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	1.01E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	1.01E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	6.20E-03	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	3.28E+01	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	3.54E+02	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzo(b)fluoranthene	5.99E+05	1.20E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	Y
Benzo(g,h,i)perylene	1.95E+06	3.90E+03	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	Y
Benzo(k)fluoranthene	5.87E+05	1.17E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	Y
Chrysene	1.81E+05	3.62E+02	2.14E-04	2.00E-03	2.48E-02	6.21E-06	2.28E+02	6.23E-09	Y
Cyanide (CN-)	2.84E+00	5.68E-03	5.44E-03	1.00E+06	2.11E-01	2.46E-05	2.70E+01	7.42E+02	Y
Dibenz(a,h)anthracene	1.91E+06	3.82E+03	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	Y
Ethylbenzene	4.46E+02	8.92E-01	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Naphthalene	1.54E+03	3.08E+00	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenol	1.87E+02	3.74E-01	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	Y
Pyrene	5.43E+04	1.09E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
Toluene	2.34E+02	4.68E-01	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	8.94E+00	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	1.10E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	6.04E+00	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	6.32E+05	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	Y
TPH C15-C28 aromatic	3.79E+04	7.58E+01	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	Y
TPH C29-C36 aliphatic	6.31E+08	1.26E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	Y
TPH C29-C36 aromatic	1.26E+05	2.52E+02	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	Y
Xylenes (total)	3.83E+02	7.66E-01	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Constant	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

CHEMICAL	D_{s1} (cm²/s)	D_{s2}	D_{s3}	D_{stot}	D_{crack} (cm²/s)	Csat mg/kg	Convective Factor (unitless)
Acenaphthene	8.18E-03	-	-	8.18E-03	3.96E-03	3.94E+01	3.10E+01
Acenaphthylene	7.28E-03	-	-	7.28E-03	3.52E-03	1.63E+02	3.49E+01
Ammonia	3.69E-02	-	-	3.69E-02	1.79E-02	1.87E+04	6.86E+00
Anthracene	6.31E-03	-	-	6.31E-03	3.06E-03	1.42E+00	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	3.33E+00	NV
Benzene	1.45E-02	-	-	1.45E-02	6.98E-03	6.59E+02	1.76E+01
Benzo(a)pyrene	7.16E-03	-	-	7.16E-03	6.22E-03	1.90E+00	1.97E+01
Benzo(b)fluoranthene	3.74E-03	-	-	3.74E-03	2.99E-03	1.80E+00	4.10E+01
Benzo(g,h,i)perylene	8.10E-03	-	-	8.10E-03	6.27E-03	1.01E+00	1.96E+01
Benzo(k)fluoranthene	3.75E-03	-	-	3.75E-03	3.15E-03	9.39E-01	3.90E+01
Chrysene	4.02E-03	-	-	4.02E-03	2.11E-03	7.24E-01	5.82E+01
Cyanide (CN-)	3.41E-02	-	-	3.41E-02	1.65E-02	3.93E+04	7.44E+00
Dibenz(a,h)anthracene	3.62E-03	-	-	3.62E-03	6.97E-03	9.51E+00	1.76E+01
Ethylbenzene	1.11E-02	-	-	1.11E-02	5.35E-03	1.67E+02	2.30E+01
Fluoranthene	4.89E-03	-	-	4.89E-03	2.46E-03	2.89E+01	4.99E+01
Fluorene	7.11E-03	-	-	7.11E-03	3.45E-03	3.10E+01	3.56E+01
Indeno(1,2,3-cd)pyrene	3.85E-03	-	-	3.85E-03	3.64E-03	7.41E-01	3.37E+01
Naphthalene	9.78E-03	-	-	9.78E-03	4.72E-03	9.66E+01	2.60E+01
Phenanthrene	5.58E-03	-	-	5.58E-03	2.72E-03	3.84E+01	4.52E+01
Phenol	1.38E-02	-	-	1.38E-02	1.10E-02	3.37E+04	1.11E+01
Pyrene	4.50E-03	-	-	4.50E-03	2.26E-03	1.47E+01	5.43E+01
Toluene	1.26E-02	-	-	1.26E-02	6.07E-03	2.91E+02	2.02E+01
TPH C06-C09 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	2.21E+02	1.57E+01
TPH C10-C14 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	1.11E+02	1.57E+01
TPH C10-C14 aromatic	1.62E-02	-	-	1.62E-02	7.80E-03	1.54E+02	1.57E+01
TPH C15-C28 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	7.02E+01	1.57E+01
TPH C15-C28 aromatic	1.62E-02	-	-	1.62E-02	7.82E-03	8.04E+01	1.57E+01
TPH C29-C36 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	3.16E+00	1.57E+01
TPH C29-C36 aromatic	1.64E-02	-	-	1.64E-02	1.13E-02	1.66E+00	1.09E+01
Xylenes (total)	1.37E-02	-	-	1.37E-02	6.61E-03	8.90E+00	1.86E+01

Definition of Parameters

D_s Effective diffusion coefficient in soil based on vapor-phase concentration

D_{crack} Effective diffusion coefficient through foundation cracks

C_{sat} Soil concentration at which dissolved pore-water and vapor phases become saturated

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

D. Chemical-Specific Volatilisation Factors

CHEMICAL	VF_{as1}	VF_{as2}	$VF_{p\ (indoor)}$	$VF_{p\ (outdoor)}$	VF_{samb}	VF_{sesp}
	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	g/m^3-air / mg/kg-s	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)
Acenaphthene	5.07E-05	8.36E-03	-	2.78E-08	4.84E-06	2.34E-04
Acenaphthylene	3.77E-05	8.36E-03	-	2.78E-08	2.67E-06	1.42E-04
Ammonia	5.13E-04	8.36E-03	-	2.78E-08	4.95E-04	6.07E-03
Anthracene	1.36E-05	8.36E-03	-	2.78E-08	3.46E-07	2.07E-05
Benz(a)anthracene	NV	NV	-	2.78E-08	NV	NV
Benzene	1.94E-03	8.36E-03	-	2.78E-08	7.07E-04	2.08E-02
Benzo(a)pyrene	2.19E-07	8.36E-03	-	2.78E-08	9.05E-11	4.88E-10
Benzo(b)fluoranthene	1.88E-07	8.36E-03	-	2.78E-08	6.67E-11	5.92E-09
Benzo(g,h,i)perylene	1.09E-07	8.36E-03	-	2.78E-08	2.22E-11	1.08E-10
Benzo(k)fluoranthene	1.80E-07	8.36E-03	-	2.78E-08	6.06E-11	5.37E-09
Chrysene	1.00E-06	8.36E-03	-	2.78E-08	1.89E-09	1.59E-07
Cyanide (CN-)	1.41E-03	8.36E-03	-	2.78E-08	3.75E-03	4.95E-02
Dibenz(a,h)anthracene	4.80E-08	8.36E-03	-	2.78E-08	4.33E-12	3.94E-10
Ethylbenzene	1.24E-03	8.36E-03	-	2.78E-08	2.87E-04	1.07E-01
Fluoranthene	2.59E-06	8.36E-03	-	2.78E-08	1.27E-08	9.23E-08
Fluorene	2.54E-05	8.36E-03	-	2.78E-08	1.21E-06	6.55E-06
Indeno(1,2,3-cd)pyrene	7.70E-08	8.36E-03	-	2.78E-08	1.11E-11	9.68E-11
Naphthalene	1.54E-04	8.36E-03	-	2.78E-08	4.48E-05	1.86E-03
Phenanthrene	1.10E-05	8.36E-03	-	2.78E-08	2.29E-07	1.51E-06
Phenol	1.40E-05	8.36E-03	-	2.78E-08	3.67E-07	1.12E-05
Pyrene	2.92E-06	8.36E-03	-	2.78E-08	1.60E-08	1.24E-06
Toluene	1.61E-03	8.36E-03	-	2.78E-08	4.89E-04	1.63E-01
TPH C06-C09 aliphatic	4.29E-03	8.36E-03	-	2.78E-08	3.46E-02	9.17E-01
TPH C10-C14 aliphatic	6.20E-04	8.36E-03	-	2.78E-08	7.22E-04	1.92E-02
TPH C10-C14 aromatic	3.97E-04	8.36E-03	-	2.78E-08	2.97E-04	7.87E-04
TPH C15-C28 aliphatic	2.99E-05	8.36E-03	-	2.78E-08	1.68E-06	4.45E-05
TPH C15-C28 aromatic	2.10E-05	8.36E-03	-	2.78E-08	8.29E-07	2.20E-05
TPH C29-C36 aliphatic	2.14E-05	8.36E-03	-	2.78E-08	8.64E-07	2.29E-05
TPH C29-C36 aromatic	6.84E-07	8.36E-03	-	2.78E-08	8.79E-10	2.30E-09
Xylenes (total)	1.21E-03	8.36E-03	-	2.78E-08	2.74E-04	8.46E-03

Definition of Parameters

VF_{as}	Volatilization factor from surficial soils to ambient air (vapors) - use lower of two values
VF_{p}	Volatilization factor from surficial soils to ambient air (particulates)
VF_{samb}	Volatilization factor from subsurface soils to ambient air
VF_{sesp1}	Volatilization factor from soil to enclosed-space vapors
VF_{trench}	Volatilisation factor from subsurface soil to trench air (where soil contamination is below base of trench)

Summary of Estimated Health Risks
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

Exposure Pathway	Threshold Risk Estimates		Non-Threshold Risk Estimates (Lifetime Exposure)
	Adult Exposure	Childhood Exposure	
Incidental Ingestion of Soil	-	-	-
Dermal Contact with Soil	-	-	-
Inhalation of Surface Soil-Derived Dust in Indoor Air	-	-	-
Inhalation of Surface Soil-Derived Dust in Outdoor Air	7.5E-06	-	-
Inhalation of Surface Soil-Derived Vapours in Outdoor Air	5.7E-04	-	-
Inhalation of Subsurface Soil-Derived Vapours in Indoor Air	-	-	-
Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air	-	-	-
Inhalation of Groundwater-Derived Vapours in Indoor Air	-	-	-
Inhalation of Groundwater-Derived Vapours in Outdoor Air	-	-	-
Inhalation of Groundwater Vapours (Where GW Enters Trench)	1.2E+00	-	-
Ingestion of Potable Groundwater	-	-	-
Incidental Ingestion of Groundwater (Bathing or Excavation)	-	-	-
Dermal Contact with Groundwater (Bathing or Excavation)	-	-	-
TOTAL	**1.2E+00**		

Health Risk Calculations - Inhalation of Soil-Derived Particulates in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Chemical	Soil Conc (mg/kg)	Particulate Concentration in Outdoor Air (From Surface Soil) (m3/kg)	Threshold Intake and Risk Calculations			
			Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (kg/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)
Acenaphthene	270	2.78E-08	5.04E-01	3.81E-10	1.03E-07	2.04E-07
Acenaphthylene	1000	2.78E-08	-	-	-	-
Ammonia	1	2.78E-08	1.80E+01	3.81E-10	3.81E-10	2.11E-11
Anthracene	1200	2.78E-08	-	-	-	-
Benz(a)anthracene	910	2.78E-08	-	-	-	-
Benzene	61	2.78E-08	1.09E+02	3.81E-10	2.32E-08	2.13E-10
Benzo(a)pyrene	650	2.78E-08	-	-	-	-
Benzo(b)fluoranthene	820	2.78E-08	-	-	-	-
Benzo(g,h,i)perylene	310	2.78E-08	-	-	-	-
Benzo(k)fluoranthene	320	2.78E-08	-	-	-	-
Chrysene	630	2.78E-08	-	-	-	-
Cyanide (CN-)	1	2.78E-08	6.40E-01	3.81E-10	3.81E-10	5.94E-10
Dibenz(a,h)anthracene	73	2.78E-08	-	-	-	-
Ethylbenzene	1	2.78E-08	2.00E+00	3.81E-10	3.81E-10	1.90E-10
Fluoranthene	2100	2.78E-08	-	-	-	-
Fluorene	1300	2.78E-08	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	2.78E-08	-	-	-	-
Naphthalene	8400	2.78E-08	4.40E-01	3.81E-10	3.20E-06	7.26E-06
Phenanthrene	3100	2.78E-08	-	-	-	-
Phenol	1	2.78E-08	1.54E-01	3.81E-10	3.81E-10	2.47E-09
Pyrene	1700	2.78E-08	-	-	-	-
Toluene	1	2.78E-08	3.01E+01	3.81E-10	3.81E-10	1.26E-11
TPH C06-C09 aliphatic	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	2.78E-08	-	-	-	-
TPH C10-C14 aromatic	54000	2.78E-08	-	-	-	-
TPH C15-C28 aliphatic	72000	2.78E-08	-	-	-	-
TPH C15-C28 aromatic	72000	2.78E-08	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-
Xylenes (total)	1	2.78E-08	4.34E+00	3.81E-10	3.81E-10	8.78E-11
TOTAL						**7.47E-06**

AECOM

Health Risk Calculations - Inhalation of Surface Soil-Derived Vapours in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Chemical	Soil Conc. (mg/kg)	Csat (mg/kg)	Volatilisation Factor from Subsurface Soil to Outdoor Air [(mg/m3)/(mg/kg)]	Vapour Concentration in Outdoor Air (From Surface Soil) (mg/m3)	Threshold Intake and Risk Calculations: Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (kg/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)
Acenaphthene	270	3.94E+01	5.07E-05	2.00E-03	5.04E-01	6.95E-07	2.74E-05	5.43E-05
Acenaphthylene	1000	1.63E+02	3.77E-05	6.12E-03	-	-	-	-
Ammonia	1	1.87E+04	5.13E-04	5.13E-04	1.80E+01	7.03E-06	7.03E-06	3.91E-07
Anthracene	1200	1.42E+00	1.36E-05	1.93E-05	-	-	-	-
Benz(a)anthracene	910	3.33E+00	NV	-	-	-	-	-
Benzene	61	6.59E+02	1.94E-03	1.18E-01	1.09E+02	2.66E-05	1.62E-03	1.49E-05
Benzo(a)pyrene	650	1.90E+00	2.19E-07	4.17E-07	-	-	-	-
Benzo(b)fluoranthene	820	1.80E+00	1.88E-07	3.39E-07	-	-	-	-
Benzo(g,h,i)perylene	310	1.01E+00	1.09E-07	1.10E-07	-	-	-	-
Benzo(k)fluoranthene	320	9.39E-01	1.80E-07	1.69E-07	-	-	-	-
Chrysene	630	7.24E-01	1.00E-06	7.26E-07	-	-	-	-
Cyanide (CN-)	1	3.93E+04	1.41E-03	1.41E-03	6.40E-01	1.94E-05	1.94E-05	3.02E-05
Dibenz(a,h)anthracene	73	9.51E+00	4.80E-08	4.57E-07	-	-	-	-
Ethylbenzene	1	1.67E+02	1.24E-03	1.24E-03	2.00E+00	1.69E-05	1.69E-05	8.46E-06
Fluoranthene	2100	2.89E+01	-	-	-	-	-	-
Fluorene	1300	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	-	-	-	-	-	-	-
Naphthalene	8400	9.66E+01	1.54E-04	1.49E-02	4.40E-01	2.12E-06	2.04E-04	4.65E-04
Phenanthrene	3100	3.84E+01	-	-	-	-	-	-
Phenol	1	3.37E+04	1.40E-05	1.40E-05	1.54E-01	1.91E-07	1.91E-07	1.24E-06
Pyrene	1700	1.47E+01	2.92E-06	4.28E-05	-	-	-	-
Toluene	1	2.91E+02	1.61E-03	1.61E-03	3.01E+01	2.21E-05	2.21E-05	7.33E-07
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.11E+02	6.20E-04	6.89E-02	-	-	-	-
TPH C10-C14 aromatic	54000	1.54E+02	3.97E-04	6.13E-02	-	-	-	-
TPH C15-C28 aliphatic	72000	7.02E+01	2.99E-05	2.10E-03	-	-	-	-
TPH C15-C28 aromatic	72000	8.04E+01	2.10E-05	1.69E-03	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-
Xylenes (total)	1	-	-	-	4.34E+00	-	-	-
TOTAL								**5.75E-04**

Health Risk Calculations - Inhalation of Groundwater-Derived Vapours in Trench Air (where groundwater enters trench)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Chemical	Groundwater Concentration (mg/L)	Aqueous Solubility (mg/L)	Volatilisation Factor from Groundwater to Trench Air (where GW enters trench) [(mg/m3)/(mg/L)]	Vapour Concentration in Trench Air (from GW within trench) (mg/m3)	Threshold Intake and Risk Calculations: Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (L/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)
Acenaphthene	0.91	3.90E+00	3.31E-02	3.01E-02	5.04E-01	4.53E-04	4.12E-04	8.18E-04
Acenaphthylene	6.2	1.61E+01	3.31E-02	2.05E-01	-	-	-	-
Ammonia	210	4.82E+05	3.31E-02	6.94E+00	1.80E+01	4.53E-04	9.51E-02	5.28E-03
Anthracene	3	4.34E-02	3.31E-02	1.44E-03	-	-	-	-
Benz(a)anthracene	2.4	9.40E-03	NV	-	-	-	-	-
Benzene	11	1.79E+03	3.31E-02	3.64E-01	1.09E+02	4.53E-04	4.98E-03	4.57E-05
Benzo(a)pyrene	1.8	1.62E-03	3.31E-02	5.36E-05	-	-	-	-
Benzo(b)fluoranthene	3.7	1.50E-03	3.31E-02	4.96E-05	-	-	-	-
Benzo(g,h,i)perylene	0.74	2.60E-04	3.31E-02	8.60E-06	-	-	-	-
Benzo(k)fluoranthene	1.6	8.00E-04	3.31E-02	2.65E-05	-	-	-	-
Chrysene	1.8	2.00E-03	3.31E-02	6.61E-05	-	-	-	-
Cyanide (CN-)	1	1.00E+06	3.31E-02	3.31E-02	6.40E-01	4.53E-04	4.53E-04	7.07E-04
Dibenz(a,h)anthracene	0.82	2.49E-03	3.31E-02	8.23E-05	-	-	-	-
Ethylbenzene	3	1.69E+02	3.31E-02	9.92E-02	2.00E+00	4.53E-04	1.36E-03	6.79E-04
Fluoranthene	26	2.60E-01	3.31E-02	8.60E-03	-	-	-	-
Fluorene	21	1.69E+00	3.31E-02	5.59E-02	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	1.90E-04	3.31E-02	6.28E-06	-	-	-	-
Naphthalene	280	3.10E+01	3.31E-02	1.03E+00	4.40E-01	4.53E-04	1.40E-02	3.19E-02
Phenanthrene	74	1.15E+00	3.31E-02	3.80E-02	-	-	-	-
Phenol	390	8.28E+04	3.31E-02	1.29E+01	1.54E-01	4.53E-04	1.77E-01	1.15E+00
Pyrene	28	1.35E-01	3.31E-02	4.46E-03	-	-	-	-
Toluene	18	5.26E+02	3.31E-02	5.95E-01	3.01E+01	4.53E-04	8.15E-03	2.71E-04
TPH C06-C09 aliphatic	74	1.18E+01	3.31E-02	3.90E-01	-	-	-	-
TPH C10-C14 aliphatic	1700	9.99E-02	3.31E-02	3.30E-03	-	-	-	-
TPH C10-C14 aromatic	1700	2.53E+01	3.31E-02	8.37E-01	-	-	-	-
TPH C15-C28 aliphatic	1520	1.11E-04	3.31E-02	3.67E-06	-	-	-	-
TPH C15-C28 aromatic	1520	1.06E+00	3.31E-02	3.51E-02	-	-	-	-
TPH C29-C36 aliphatic	330	2.50E-06	3.31E-02	8.27E-08	-	-	-	-
TPH C29-C36 aromatic	330	6.60E-03	3.31E-02	2.18E-04	-	-	-	-
Xylenes (total)	6.7	1.06E+01	3.31E-02	2.22E-01	4.34E+00	4.53E-04	3.04E-03	7.00E-04
TOTAL								**1.19E+00**

Soil RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (Hazard Index)			Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity) (kg/mg)					RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Vapour Only Risk at Csat (if necessary)	Revised RBSL (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL		
			Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL (All Pathways)	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL (All Pathways)						Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	unitless	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	mg/kg			mg/kg	mg/kg	%	%	%
Acenaphthene	270	3.94E+01	2.04E-07	5.43E-05	5.45E-05	7.55E-10	1.38E-06	7.55E-10	1.38E-06	1.38E-06	1.45E+05	1.64E-04	5.43E-05	2.65E+08	**2.65E+08**	99.97%	0.03%	100.00%
Acenaphthylene	1000	1.63E+02	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Ammonia	1	1.87E+04	2.11E-11	3.91E-07	3.91E-07	2.11E-11	3.91E-07	2.11E-11	3.91E-07	3.91E-07	2.56E+06	7.37E-03	7.32E-03	4.70E+10	**4.70E+10**	99.27%	0.73%	100.00%
Anthracene	1200	1.42E+00	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Benz(a)anthracene	910	3.33E+00	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Benzene	61	6.59E+02	2.13E-10	1.49E-05	1.49E-05	3.49E-12	2.44E-07	3.49E-12	2.44E-07	2.44E-07	1.03E+06	1.64E-04	1.61E-04	7.16E+10	**7.16E+10**	99.94%	0.06%	100.00%
Benzo(a)pyrene	650	1.90E+00	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Benzo(b)fluoranthene	820	1.80E+00	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Benzo(g,h,i)perylene	310	1.01E+00	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Benzo(k)fluoranthene	320	9.39E-01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Chrysene	630	7.24E-01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Cyanide (CN-)	1	3.93E+04	5.94E-10	3.02E-05	3.02E-05	5.94E-10	3.02E-05	5.94E-10	3.02E-05	3.02E-05	3.31E+04	1.00E+00	-	-	**3.31E+04**	0.00%	100.00%	100.00%
Dibenz(a,h)anthracene	73	9.51E+00	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Ethylbenzene	1	1.67E+02	1.90E-10	8.46E-06	8.46E-06	1.90E-10	8.46E-06	1.90E-10	8.46E-06	8.46E-06	2.95E+04	1.42E-03	1.41E-03	1.31E+09	**1.31E+09**	99.44%	0.56%	100.00%
Fluoranthene	2100	2.89E+01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Fluorene	1300	3.10E+01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Indeno(1,2,3-cd)pyrene	250	7.41E-01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Naphthalene	8400	9.66E+01	7.26E-06	4.65E-04	4.72E-04	8.65E-10	4.81E-06	8.65E-10	4.81E-06	4.81E-06	4.16E+04	5.01E-04	4.65E-04	2.31E+08	**2.31E+08**	99.77%	0.23%	100.00%
Phenanthrene	3100	3.84E+01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Phenol	1	3.37E+04	2.47E-09	1.24E-06	1.25E-06	2.47E-09	1.24E-06	2.47E-09	1.24E-06	1.25E-06	8.03E+05	4.38E-02	4.18E-02	3.88E+08	**3.88E+08**	95.82%	4.18%	100.00%
Pyrene	1700	1.47E+01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Toluene	1	2.91E+02	1.26E-11	7.33E-07	7.33E-07	1.26E-11	7.33E-07	1.26E-11	7.33E-07	7.33E-07	3.41E+05	2.18E-04	2.13E-04	1.98E+10	**1.98E+10**	99.91%	0.09%	100.00%
TPH C06-C09 aliphatic	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
TPH C10-C14 aliphatic	54000	1.11E+02	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
TPH C10-C14 aromatic	54000	1.54E+02	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
TPH C15-C28 aliphatic	72000	7.02E+01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
TPH C15-C28 aromatic	72000	8.04E+01	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
TPH C29-C36 aliphatic	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
TPH C29-C36 aromatic	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	
Xylenes (total)	1	8.90E+00	8.78E-11	-	8.78E-11	8.78E-11	-	8.78E-11		8.78E-11	2.85E+09	2.50E-01	-	-	**2.85E+09**	100.00%	-	100.00%

Groundwater RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

			Risk at Input Groundwater Concentration (Hazard Index)		Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity)							Pathway Contributions to Total Estimated Risk at RBSL	
	Cgw	Solubility	GW to Trench Vapour	TOTAL (All Pathways)	GW to Trench Vapour	Total Vapour Pathways	TOTAL (All Pathways)	RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Vapour Only Risk at Sol (if necessary)	Adopted RBSL	GW to Trench Vapour	TOTAL
Chemical	mg/L	mg/L	unitless	unitless	L/mg	L/mg	L/mg	mg/L			mg/L	%	%
Acenaphthene	0.91	3.90E+00	8.18E-04	8.18E-04	8.99E-04	8.99E-04	8.99E-04	2.22E+02	3.51E-03	3.51E-03	**2.22E+02**	1.75%	1.75%
Acenaphthylene	6.2	1.61E+01	-	-	-		-	-	-	-	**-**	-	-
Ammonia	210	4.82E+05	5.28E-03	5.28E-03	2.52E-05	2.52E-05	2.52E-05	3.97E+04	1.00E+00	-	**3.97E+04**	100.00%	100.00%
Anthracene	3	4.34E-02	-	-	-		-	-	-	-	**-**	-	-
Benz(a)anthracene	2.4	9.40E-03	-	-	-		-	-	-	-	**-**	-	-
Benzene	11	1.79E+03	4.57E-05	4.57E-05	4.16E-06	4.16E-06	4.16E-06	6.02E+04	7.44E-03	7.44E-03	**6.02E+04**	2.98%	2.98%
Benzo(a)pyrene	1.8	1.62E-03	-	-	-		-	-	-	-	**-**	-	-
Benzo(b)fluoranthene	3.7	1.50E-03	-	-	-		-	-	-	-	**-**	-	-
Benzo(g,h,i)perylene	0.74	2.60E-04	-	-	-		-	-	-	-	**-**	-	-
Benzo(k)fluoranthene	1.6	8.00E-04	-	-	-		-	-	-	-	**-**	-	-
Chrysene	1.8	2.00E-03	-	-	-		-	-	-	-	**-**	-	-
Cyanide (CN-)	1	1.00E+06	7.07E-04	7.07E-04	7.07E-04	7.07E-04	7.07E-04	1.41E+03	1.00E+00	-	**1.41E+03**	100.00%	100.00%
Dibenz(a,h)anthracene	0.82	2.49E-03	-	-	-		-	-	-	-	**-**	-	-
Ethylbenzene	3	1.69E+02	6.79E-04	6.79E-04	2.26E-04	2.26E-04	2.26E-04	1.10E+03	3.83E-02	3.83E-02	**1.10E+03**	15.31%	15.31%
Fluoranthene	26	2.60E-01	-	-	-		-	-	-	-	**-**	-	-
Fluorene	21	1.69E+00	-	-	-		-	-	-	-	**-**	-	-
Indeno(1,2,3-cd)pyrene	3.1	1.90E-04	-	-	-		-	-	-	-	**-**	-	-
Naphthalene	280	3.10E+01	3.19E-02	3.19E-02	1.03E-03	1.03E-03	1.03E-03	1.94E+02	3.19E-02	3.19E-02	**1.94E+02**	15.96%	15.96%
Phenanthrene	74	1.15E+00	-	-	-		-	-	-	-	**-**	-	-
Phenol	390	8.28E+04	1.15E+00	1.15E+00	2.94E-03	2.94E-03	2.94E-03	3.40E+02	1.00E+00	-	**3.40E+02**	100.00%	100.00%
Pyrene	28	1.35E-01	-	-	-		-	-	-	-	**-**	-	-
Toluene	18	5.26E+02	2.71E-04	2.71E-04	1.50E-05	1.50E-05	1.50E-05	1.66E+04	7.91E-03	7.91E-03	**1.66E+04**	3.16%	3.16%
TPH C06-C09 aliphatic	74	1.18E+01	-	-	-		-	-	-	-	**-**	-	-
TPH C10-C14 aliphatic	1700	9.99E-02	-	-	-		-	-	-	-	**-**	-	-
TPH C10-C14 aromatic	1700	2.53E+01	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aliphatic	1520	1.11E-04	-	-	-		-	-	-	-	**-**	-	-
TPH C15-C28 aromatic	1520	1.06E+00	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aliphatic	330	2.50E-06	-	-	-		-	-	-	-	**-**	-	-
TPH C29-C36 aromatic	330	6.60E-03	-	-	-		-	-	-	-	**-**	-	-
Xylenes (total)	6.7	1.06E+01	7.00E-04	7.00E-04	1.04E-04	1.04E-04	1.04E-04	2.39E+03	1.11E-03	1.11E-03	**2.39E+03**	0.44%	0.44%

Summary of Derived RBSLs
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Odour Based Calculations) Scenario

Back to User Input Sheet

Chemical	Soil RBSLs (mg/kg)				Groundwater RBSLs (mg/L)			
	Adult Threshold	Adopted RBSL (Lowest)	Saturation Limited?	Site Concentration	Adult Threshold	Adopted RBSL (Lowest)	Solubility Limited?	Site Concentration
Acenaphthene	2.65E+08	**2.65E+08**	-	2.70E+02	2.22E+02	**2.22E+02**	>Sol	9.10E-01
Acenaphthylene	-	**-**	-	-	-	**-**	-	-
Ammonia	4.70E+10	**4.70E+10**	-	1.00E+00	3.97E+04	**3.97E+04**	-	2.10E+02
Anthracene	-	**-**	-	-	-	**-**	-	-
Benz(a)anthracene	-	**-**	-	-	-	**-**	-	-
Benzene	7.16E+10	**7.16E+10**	-	6.10E+01	6.02E+04	**6.02E+04**	>Sol	1.10E+01
Benzo(a)pyrene	-	**-**	-	-	-	**-**	-	-
Benzo(b)fluoranthene	-	**-**	-	-	-	**-**	-	-
Benzo(g,h,i)perylene	-	**-**	-	-	-	**-**	-	-
Benzo(k)fluoranthene	-	**-**	-	-	-	**-**	-	-
Chrysene	-	**-**	-	-	-	**-**	-	-
Cyanide (CN-)	3.31E+04	**3.31E+04**	-	1.00E+00	1.41E+03	**1.41E+03**	-	1.00E+00
Dibenz(a,h)anthracene	-	**-**	-	-	-	**-**	-	-
Ethylbenzene	1.31E+09	**1.31E+09**	-	1.00E+00	1.10E+03	**1.10E+03**	>Sol	3.00E+00
Fluoranthene	-	**-**	-	-	-	**-**	-	-
Fluorene	-	**-**	-	-	-	**-**	-	-
Indeno(1,2,3-cd)pyrene	-	**-**	-	-	-	**-**	-	-
Naphthalene	2.31E+08	**2.31E+08**	-	8.40E+03	1.94E+02	**1.94E+02**	>Sol	2.80E+02
Phenanthrene	-	**-**	-	-	-	**-**	-	-
Phenol	3.88E+08	**3.88E+08**	-	1.00E+00	3.40E+02	**3.40E+02**	-	3.90E+02
Pyrene	-	**-**	-	-	-	**-**	-	-
Toluene	1.98E+10	**1.98E+10**	-	1.00E+00	1.66E+04	**1.66E+04**	>Sol	1.80E+01
TPH C06-C09 aliphatic	-	**-**	-	-	-	**-**	-	-
TPH C10-C14 aliphatic	-	**-**	-	-	-	**-**	-	-
TPH C10-C14 aromatic	-	**-**	-	-	-	**-**	-	-
TPH C15-C28 aliphatic	-	**-**	-	-	-	**-**	-	-
TPH C15-C28 aromatic	-	**-**	-	-	-	**-**	-	-
TPH C29-C36 aliphatic	-	**-**	-	-	-	**-**	-	-
TPH C29-C36 aromatic	-	**-**	-	-	-	**-**	-	-
Xylenes (total)	2.85E+09	**2.85E+09**	-	1.00E+00	2.39E+03	**2.39E+03**	>Sol	6.70E+00

Pathways included in derivation of Soil RBSL:

x Inhalation of Soil-Derived Dust in Outdoor Air
x Inhalation of Surface Soil-Derived Vapours in Outdoor Air

Pathways included in derivation of Groundwater RBSL:

x Inhalation of Groundwater Vapours (Where GW Enters Trench)

Appendix I

Laboratory Letter

This page has been left blank intentionally.

28th[th] April 2011

AECOM

Level 11, 44 Market Street Sydney, NSW 2000.

ATTENTION: Ms Amanda Lee

Dear Amanda

RE: <u>Soil and Groundwater Samples: Review of Chromatograms</u>

I have examined available semivolatile scan mode chromatograms for samples indicated below and have also scrutinized other sample results in order to make some deductions from the distribution of PAHs and/or phenolic compounds.

We have located 8 instrument runs performed in scan mode and these have been examined in detail.

In general, across the representative soil and water samples run in scan mode for semivolatiles analysis, we see the complex chemistry associated with coal tar contamination.

The profiles variously include BTEX, various alkylated benzenes, Phenol, alkylated phenols (particularly C1 to C3 substituted), PAHs, alkylated PAHs (particularly C1 to C3 Naphthalenes, the same for fluorenes, and to a lesser extent phenanthrenes). The alkylated phenols are more predominant in the water samples and can also be associated with the lighter end aklylated PAHs and to some extent, hydroxylated versions of these.

In addition, target compound analysis have indicated the presence benzothiophene and carbazole and additional alkylated versions of these may also be present.

My summary of individual samples follows. Please note that some of the samples identified were not associated with the indicated ALS work orders.

VMP Area – Hickson Road

ES1004308-003-, BH53_4.0-4.4

Scan data available semivolatiles. Priority PAHs have pattern consistent with coal tar. However, the bulk of the material present seems to be substituted aromatics including polyaromatics (alkyl PAHs). Benzothiophene and Carbazole are also present.

The sum of PAHs will fall considerably short of the total aggregate aromatics in this sample.

ES1004308-008-, BH53_4.0-4.4

SIM GCMS in SV only. Pattern of PAH/Phenol consistent with coal tar. VOC run may yield more, non-target aromotics (C3 and C4 alkyl benzenes) – not examined.

VMP Area – Blocks 3,4 and 5.

ES1003672-033, BH42_3.2-3.3

Scan data available. Priority PAHs have coal tar profile. Numerous substituted aromatics (inc. PAHs) contribute to the totals.

ES1003390, BH54_1.0_1.4

Cannot locate this sample in ES1003390

ES1003971-001, BH55-1.0-1.2

Only SIM PAH data available plus VOC plus TPH. As the sum of TPH is 3 x larger than sum of priority PAHs this is an indicator of significant quantities of non-target analytes.

The presence of target phenol, cresols and dimethyl phenol indicate a relationship to coal tar as does the positive BTEX results.

Blocks 1-3

ES1003391-015, BH37_22.2-Augur

No data located but run in scan mode so observation is made from SVOC results.

Interesting absence of phenol, cresols and dimethyl phenol. No data on volatile aromatics but the high naphthalene and methyl naphthalene might indicate that more volatile aromatics are present. Relatively high B(a)p, dibenzofuran and carbazole present are indicators of coal tar.

Depth of sample might suggest no natural attenuation hence the absence of the phenolics. If this were leached by water the naphthalene would also go.

ES1019455-032, BH320_6.0-6.5

PAH SIM only, TPH. Based only on the relatively high B(a)P, assume coal tar-like character, Phenolics not requested but a small amount of phenol (8 ppm) only present. TPH results seem a little at odds with reported PAH – I would have expected the sums to be a little closer.

VMP Area Blocks 3,4&5

ES1005244-012, MW205

SV scan run available. This has been run as a water, although it may have been a dilute and shoot. This sample consists predominantly of alkylated phenols, many of which are non-target compounds. TPH Chromatogram consistent with these observations.

ES1004956-001, MW200

Sample is massively impacted with alkylated phenols (C2 and C3 substituted), alkyl benzenes (less), naphthalene, alkylated naphthalenes and some hydroxylated naphthalenes e.g. 2-methyl-1-naphthalenol or other isomer.

TPH chromatogram supports observation.

ES1005244-003, MW54

Scan run available. Alkylated phenols, naphthalene. Later eluting peaks appear to be hydroxylated aromatics (natural attenuation?) TPH Chromatogram consistent with these observations.

VMP Area – Downgradient

ES1004782-003, MW15

Very similar to above sample. TPH chromatogram supports the observations.

ES1005244-013, MW60

Again, a similar distribution of alkyl phenol, naphthalene and alkylated aromatics. TPH chromatogram supports the observations.

Blocks 1 - 3

ES1003746-007, MW08

PAH (SIM) and TPH analysis performed. Distribution of PAHs biasing towards the lighter end suggests a similar extract to the samples immediately above. There is 131 ppb of unrequested and unreported 2,4idimethyphenol that suggests that the sample may contain more alkylated phenols.

TPH chromatogram supports observations

ES1003658-001, MW21

Sample has a bit of naphthalene and nothing else. Phenolics, not requested but part of run, all <LOR. TPH <LOR – chromatogram supports observation

ES1003658-004, 17

Nothing much here. No phenolics. The small amounts of fluoranthene and pyrene are the most abundant of the priority 16 PAHs both in tars and combustion PAHs. This may be an artefact of soil particulates.

TPH <LOR – chromatogram supports observation.

Public Domain South

ES1004714-001, MW20

Sample has been run for conventional PAH in SIM mode and ultra trace. In the ultra-trace, B(a)P seems to be somewhat overabundant relative to other priority 16 PAHs.

We are unable to examine un-reported ultra-trace phenolics because, when PAHs only are requested, samples are not acetylated for trace phenolics.

General Commentary

The samples examined show, not surprisingly characteristics of coal tar products well documented elsewhere and supported in the library search reports supplied to you separately. US EPA priority 16 PAHs commence at an equivalent chain length to n-docecane (C12) with the last, benzo(g,h,i)perylene with an ECL around C32. The area between C10 and C12 is, for soils, comprises of alkylated monoaromatics, indanes and indene whilst, in waters, this region comprises alkylated phenolic compounds.

In my opinion, the differences between waters and soils reflect, not only the differing tendencies to partition into water but also some indications of natural attenuation manifested as the appearance of relate hydroxylated compounds in water extracts.

Consistent with the probable soruce, the general character of these samples appears far more aromatic than a typical fresh petroleum hydrocarbon product as the aliphatic component, even of the soil samples appears negligible. From a laboratory reporting point of view, target compound analysis for semivolatile organic compounds covers only a small set of the actual compounds present which form a significant part of the total concentration of the contaminants in the samples.

I am unable to asses the aliphatic/aromatic distribution of the samples (even those we have run in scan mode) as the HRAF method is an empirical fractionation and it might be hard to predict the fraction in which alkylated PAHs, for example, may elute.

As to the distribution of target to non-target compounds, this might best be gauged by enumerating the difference between, for example, sum of 16 Priority PAHs and sum of C10 to C36 TPH.

Yours sincerely

Marc Centner

NATIONAL TECHNICAL MANAGER - AUSTRALIA
ALS | Environmental Division

Appendix J

Sensitivity Analysis

This page has been left blank intentionally.

AECOM

1. General Information:

Site:	Barangaroo
Address:	Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Client:	Lend Lease
Scenario:	Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks)
Header Colour (Defaults = Blue):	

2. Select Receptor:

Construction/Excavation Worker

3. Select Exposure Pathways to Include:

Enter "x" in box, or select from dropdown box.

Soil Pathways	
x	Incidental Ingestion of Soil
x	Dermal Contact with Soil
	Inhalation of Surface Soil-Derived Dust in Indoor Air
x	Inhalation of Surface Soil-Derived Dust in Outdoor Air
x	Inhalation of Surface Soil-Derived Vapours in Outdoor Air
	Inhalation of Subsurface Soil-Derived Vapours in Indoor Air
	Inhalation of Subsurface Soil-Derived Vapours in Outdoor Air
Groundwater Pathways	
	Inhalation of Groundwater-Derived Vapours in Indoor Air
	Inhalation of Groundwater-Derived Vapours in Outdoor Air
	Ingestion of Potable Groundwater
x	Incidental Ingestion of Groundwater (Bathing or Excavation)
x	Dermal Contact with Groundwater (Bathing or Excavation)
x	Inhalation of Groundwater Vapours (Where GW Enters Trench)

	Soil RBSLs saturation limited?
	Groundwater RBSLs solubility limited?

4. Select Chemicals for Quantitative Assessment / 5. Enter Chemical Concentrations (if only calculating RBSLs, enter 1):

4. Select Chemicals for Quantitative Assessment:	Target Hazard Index	Target Cancer Risk	Soil (mg/kg)	Groundwater (mg/L)
	default = 1 (or manually overwrite)	default = $1x10^{-5}$ (or manually overwrite)		
Acenaphthene	0.2	1.00E-05	270	4.4
Acenaphthylene	0.2	1.00E-05	1000	43
Ammonia	1	1.00E-05		350
Anthracene	0.2	1.00E-05	1200	15
Benz(a)anthracene			910	13
Benzene	0.25	1.00E-05	61	41
Benzo(a)pyrene	1	1.00E-05	650	9.3
Benzo(b)fluoranthene			820	8.3
Benzo(g,h,i)perylene			310	4.2
Benzo(k)fluoranthene			320	3.7
~ Blank				
Dibenz(a,h)anthracene			73	0.82
Ethylbenzene	0.25	1.00E-05		3.02
Fluoranthene	0.2	1.00E-05	2130	26
Fluorene	0.2	1.00E-05	1300	21
Indeno(1,2,3-cd)pyrene			250	3.1
Naphthalene	0.2	1.00E-05	8400	283
Phenanthrene	0.2	1.00E-05	3100	74
Phenol	1	1.00E-05		390
Pyrene	0.2	1.00E-05	1700	28
Toluene	0.25	1.00E-05		18
TPH C06-C09 aliphatic	0.125	1.00E-05		74
TPH C10-C14 aliphatic	0.125	1.00E-05	54000	1730
TPH C10-C14 aromatic	0.125	1.00E-05	54000	1730
TPH C15-C28 aliphatic	0.125	1.00E-05	72000	1520
TPH C15-C28 aromatic	0.125	1.00E-05	72000	1520
TPH C29-C36 aliphatic	0.125	1.00E-05		332
TPH C29-C36 aromatic	0.125	1.00E-05		332
Xylenes (total)	0.25	1.00E-05		6.7

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

6. Confirm/Modify Exposure Parameters:

Link to Exposure Defaults and Sources

	Units	Default Value Adult	Default Value Child	Site-Specific Value (leave blank to use default value) Adult	Site-Specific Value Child	Value Used in Calculations Adult	Value Used in Calculations Child	
General receptor parameters:								
Body weight	kg	70	N/A	70		70	N/A	
Exposure duration	yr	1	N/A	1		1	N/A	
Averaging time (carcinogens)	yr	70	N/A	70		70	N/A	
Averaging time (non-carcinogens)	yr	1	N/A	1		1	N/A	
Incidental Soil Ingestion								
Daily soil ingestion rate	mg/day	200	N/A	330		330	N/A	
Exposure frequency for soil ingestion	days/yr	240	N/A	15		15	N/A	
Fraction of daily soil intake from site	unitless	1	N/A	1		1	N/A	
Dermal Absorption of Soil								
Exposed skin surface area for soil contact	cm2	5000	N/A	3600		3600	N/A	
Soil to skin adherence factor	mg/cm2	0.5	N/A	1.5		1.5	N/A	
Exposure frequency for dermal contact with soil	days/yr	240	N/A	15		15	N/A	
Indoor Inhalation								
Exposure time (indoor air)	hrs/day	NA	N/A			NA	N/A	
Exposure frequency (indoor air)	days/yr	240	N/A			240	N/A	
Particulate emission factor (indoor air)	m3/kg	NA	N/A			NA	N/A	
Outdoor Inhalation								
Exposure time (outdoor air)	hrs/day	8	N/A	8		8	N/A	
Exposure frequency (outdoor air)	days/yr	240	N/A	15		15	N/A	
Particulate emission factor (outdoor air)	m3/kg	1.00E+05	N/A	3.60E+07		3.60E+07	N/A	*
Potable Water Ingestion								
Potable water intake rate	L/day	0	N/A			0	N/A	
Exposure frequency for potable water intake	days/yr	240	N/A			240	N/A	
Incidental Water Ingestion								
Incidental ingestion rate	L/day	0.05	N/A	0.005		0.005	N/A	
Exposure frequency for incidental water ingestion	days/yr	240	N/A	15		15	N/A	
Dermal Contact with Water								
Exposed skin surface for water contact	cm2	6510	N/A	3870		3870	N/A	**
Exposure time for dermal water contact	hr/day	8	N/A	1		1	N/A	
Exposure frequency for dermal water contact	days/yr	240	N/A	15		15	N/A	

* USEPA (2002)
# USEPA (1997) (Exposure factors handbook) - based on assumption that head, forearms and hands will be exposed. 50th percentile data for
** USEPA (1997) (Exposure factors handbook) - based on assumption that lower legs and feet only would be contacting water. 50th percentile
~Chomium (III) and Chromium (VI) concentrations are total chromium concentrations detected in groundwater

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Back to User Input Sheet

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Depth to groundwater (below building, ground surface or trench)	cm	300			LGW	300	Autocalculates from layer thicknesses
Vadose Zone Layer 1							
Thickness	cm	295			HV	295	
SCS Soil Type:							
Fraction of organic carbon	unitless	0.01			OC	0.01	
Air-filled porosity (volumetric)	cm3/cm3	0.26			VACS	0.26	
Water-filled porosity (volumetric)	cm3/cm3	0.12			vwcvz	0.12	
Total soil porosity	cm3/cm3	0.38			TPOR	0.38	
Convective vapour flow term							
Calculate convective flow term? (ENTER Y or N)		Y			Conv	Y	
Convective flow rate (if specified directly)	cm3/sec						
Convective flow through slab (calculated)	cm3/sec	10.88			Qs	10.88	
Slab Area	cm2	700000			Ab	700000	
Areal fraction of cracks in foundations/walls	cm^2-cracks/cm^2-total area	0.0019			Nuc	0.0019	
Soil vapour permeability	cm^2	1.00E-08			kv	1.00E-08	
Indoor-outdoor pressure differential	$g/cm\text{-}s^2$	40			dP	40	
Slab perimeter	cm	3400			Xcrack	3400	
Depth to bottom of slab	cm	15			Zcrack	15	
Viscosity of air	g/cm-s	1.81E-04			uair	1.81E-04	Viscosity of air at 20 deg C.
Additional Trench Characteristics (for GW level above base of trench, i.e., assumes groundwater flows into trench)							
Groundwater seepage velocity (into trench)	cm/sec	1.50E-04	(c)	1.50E-04	Vgw	0.00015	default for permeable fill (max expected for
Depth of groundwater in trench	cm	50		50	Dgw	50	assumes gw may be present at 2 mbgl (on average) and
Dimension of trench (length or width) perpendicular to GW flow	cm	200	(d)	200	WSAtrench	200	maximum assumed trench dimension
Flow rate of groundwater in trench	cm3/sec				Qgw	1.5	Calculated from above three parameters
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate	cm/s	22.5	(e)	37.8	windsp	37.8	Based on the average annual 9am and 3pm windspeeds measured at observatory point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site), divided by 10
Width of source area parallel to wind or groundwater flow direction	cm	600	(f)	600	WSA	600	2 m deep and 2 m long trench
Ambient air mixing zone height	cm	200		200	AAMZH	200	assumes all vapours mixed w/in trench

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) Conservative estimate of maximum expected velocity for a sandy or gravelly aquifer (50ft/day = 13 m/day)
(d) Assumes trench is 2 m long.
(e) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(f) For construction/excavation worker, default is 600 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.

AECOM

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Back to User Input Sheet

B. Chemical-Specific Fate and Transport Parameters

Chemical	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-H_20 / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	5.03E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	5.03E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	3.10E-02	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
Anthracene	1.64E+04	1.64E+02	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	1.77E+03	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	1.46E+00	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	5.87E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	N
Benzo(b)fluoranthene	5.99E+05	5.99E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	N
Benzo(g,h,i)perylene	1.95E+06	1.95E+04	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	N
Benzo(k)fluoranthene	5.87E+05	5.87E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	N
Dibenz(a,h)anthracene	1.91E+06	1.91E+04	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	N
Ethylbenzene	4.46E+02	4.46E+00	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	5.55E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	N
Fluorene	9.16E+03	9.16E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	1.95E+04	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	N
Naphthalene	1.54E+03	1.54E+01	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	1.67E+02	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	1.87E+00	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	N
Pyrene	5.43E+04	5.43E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
Toluene	2.34E+02	2.34E+00	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	4.47E+01	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	5.50E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	3.02E+01	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	3.16E+06	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	Y
TPH C15-C28 aromatic	3.79E+04	3.79E+02	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	Y
TPH C29-C36 aliphatic	6.31E+08	6.31E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	Y
TPH C29-C36 aromatic	1.26E+05	1.26E+03	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	N
Xylenes (total)	3.83E+02	3.83E+00	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Consta	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

Chemical	D_{s1} (cm^2/s)	D_{s2}	D_{s3}	D_{stot}	D_{crack} (cm^2/s)	D_{cap} (cm^2/s)	D_{ws} (cm^2/s)	Convective Factor (unitless)
Acenaphthene	3.96E-03	-	-	3.96E-03	3.96E-03	2.22E-04	3.09E-03	3.10E+01
Acenaphthylene	3.52E-03	-	-	3.52E-03	3.52E-03	2.97E-04	2.98E-03	3.49E+01
Ammonia	1.79E-02	-	-	1.79E-02	1.79E-02	3.28E-03	1.67E-02	6.86E+00
Anthracene	3.06E-03	-	-	3.06E-03	3.06E-03	6.77E-04	2.89E-03	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Benzene	6.98E-03	-	-	6.98E-03	6.98E-03	2.04E-05	1.04E-03	1.76E+01
Benzo(a)pyrene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Dibenz(a,h)anthracene	NV	NV	NV	NV	NV	NV	NV	NV
Ethylbenzene	5.35E-03	-	-	5.35E-03	5.35E-03	1.40E-05	7.26E-04	2.30E+01
Fluoranthene	NV	NV	NV	NV	NV	NV	NV	NV
Fluorene	3.45E-03	-	-	3.45E-03	3.45E-03	3.96E-04	3.05E-03	3.56E+01
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	NV	NV	NV
Naphthalene	4.72E-03	-	-	4.72E-03	4.72E-03	9.83E-05	2.65E-03	2.60E+01
Phenanthrene	2.72E-03	-	-	2.72E-03	2.72E-03	7.56E-04	2.60E-03	4.52E+01
Phenol	NV	NV	NV	NV	NV	NV	NV	NV
Pyrene	2.26E-03	-	-	2.26E-03	2.26E-03	2.90E-03	2.27E-03	5.43E+01
Toluene	6.07E-03	-	-	6.07E-03	6.07E-03	1.66E-05	8.60E-04	2.02E+01
TPH C06-C09 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.30E-05	7.08E-04	1.57E+01
TPH C10-C14 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.08E-04	1.57E+01
TPH C10-C14 aromatic	7.80E-03	-	-	7.80E-03	7.80E-03	2.67E-05	1.33E-03	1.57E+01
TPH C15-C28 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.07E-04	1.57E+01
TPH C15-C28 aromatic	7.82E-03	-	-	7.82E-03	7.82E-03	4.10E-04	6.01E-03	1.57E+01
TPH C29-C36 aliphatic	7.80E-03	-	-	7.80E-03	7.80E-03	1.29E-05	7.07E-04	1.57E+01
TPH C29-C36 aromatic	NV	NV	NV	NV	NV	NV	NV	NV
Xylenes (total)	6.61E-03	-	-	6.61E-03	6.61E-03	2.00E-05	1.02E-03	1.86E+01

Definition of Parameters

D_s	Effective diffusion coefficient in soil based on vapor-phase concentration
D_{crack}	Effective diffusion coefficient through foundation cracks
D_{cap}	Effective diffusion coefficient through capillary fringe
D_{ws}	Effective diffusion coefficient between groundwater and soil surface

Back to User Input Sheet

Vapour Modelling - Groundwater to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

D. Chemical-Specific Volatilisation Factors

Chemical	VF_{wesp} (mg/m^3-air / mg/L-H_2O)	VF_{wamb} (mg/m^3-air / mg/L-H_2O)	VF_{trench} (mg/m^3-air / mg/L -water)
Acenaphthene	1.12E-03	6.15E-06	3.31E-04
Acenaphthylene	6.78E-04	3.68E-06	3.31E-04
Ammonia	1.92E-04	2.90E-06	3.31E-04
	-	-	-
Anthracene	3.24E-04	1.74E-06	3.31E-04
Benz(a)anthracene	NV	NV	NV
Benzene	1.55E-02	6.27E-05	3.31E-04
Benzo(a)pyrene	NV	NV	NV
Benzo(b)fluoranthene	NV	NV	NV
Benzo(g,h,i)perylene	NV	NV	NV
Benzo(k)fluoranthene	NV	NV	NV
	-	-	-
	-	-	-
	-	-	-
	-	-	-
Dibenz(a,h)anthracene	NV	NV	NV
	-	-	-
	-	-	-
Ethylbenzene	1.62E-02	6.18E-05	3.31E-04
Fluoranthene	NV	NV	NV
Fluorene	5.80E-04	3.17E-06	3.31E-04
Indeno(1,2,3-cd)pyrene	NV	NV	NV
	-	-	-
Naphthalene	2.43E-03	1.26E-05	3.31E-04
Phenanthrene	2.31E-04	1.19E-06	3.31E-04
Phenol	NV	NV	NV
Pyrene	5.94E-05	2.92E-07	3.31E-04
	-	-	-
Toluene	1.57E-02	6.16E-05	3.31E-04
TPH C06-C09 aliphatic	2.48E+00	9.46E-03	3.31E-04
TPH C10-C14 aliphatic	3.08E+00	1.17E-02	3.31E-04
TPH C10-C14 aromatic	1.17E-02	4.97E-05	3.31E-04
TPH C15-C28 aliphatic	4.06E+00	1.55E-02	3.31E-04
TPH C15-C28 aromatic	1.03E-03	7.79E-06	3.31E-04
TPH C29-C36 aliphatic	4.18E+00	1.59E-02	3.31E-04
TPH C29-C36 aromatic	NV	NV	NV
	-	-	-
Xylenes (total)	1.42E-02	5.72E-05	3.31E-04

Definition of Parameters

VF_{wesp1}	Volatilization factor from groundwater to enclosed-space vapors - no convective transport
VF_{wesp2}	Volatilization factor from groundwater to enclosed-space vapors - with convective transport
VF_{wamb}	Volatilization factor from groundwater to ambient (outdoor) vapors
VF_{trench}	Volatilisation factor from groundwater to trench air (where groundwater seeps into trench - this is mass limited value based on estimated rate of groundwater flow into trench)

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Back to User Input Sheet

A. Model Input Parameters

Parameter Definition	Units	Default Value (Shell 2007 unless otherwise noted)	Notes	Site-Specific Value (leave blank if adopting Shell default)	Label	Adopted Value for Model	Justification for Site-specific value, if applicable
Lower depth of surficial soil zone	cm	100		2000	LDSSZ	2000	large value to eliminate mass limiting in surface soil
Depth to subsurface soil sources (below building, ground surface or trench)	cm	100			LS	100	Autocalculates from layer thicknesses
Vadose Zone Layer 1 (soil type where source is)							
Thickness	cm	100			HV	100	
SCS Soil Type:				Sand and gravel (<12% fines)			The majority of fill across the site has been identified as sand and gravel with some clay
Fraction of organic carbon	unitless	0.01		0.002	OC	0.002	
Soil bulk density	g/cm3	1.7		1.66	sbd	1.66	
Air-filled porosity (volumetric)	cm3/cm3	0.26		0.321	VACS	0.321	
Water-filled porosity (volumetric)	cm3/cm3	0.12		0.054	vwcvz	0.054	
Total soil porosity	cm3/cm3	0.38		0.375	TPOR	0.375	
Vapour phase source partitioning adjustment	unitless	1		10	VPPA	10	Adjustment for vapour partitioning; see text.
Biodegradation adjustment	unitless	1		1	BioA	1	Conservatively assumes no soil vapour biodegradation
Vadose Zone Layer 2 (lens)							
Thickness	cm				Hvtwo		
SCS Soil Type:							
Air-filled porosity (volumetric)	cm3/cm3	NA			VACS2	NA	
Water-filled porosity (volumetric)	cm3/cm3	NA			vwcvz2	NA	
Total soil porosity	cm3/cm3	NA			TPOR2	NA	
Convective vapour flow term							
Calculate convective flow term?		Y			Conv	Y	
Convective flow rate (if specified directly)	cm3/sec						
Convective flow through slab (calculated)	cm3/sec	10.88			Qs	10.88	
Slab Area	cm2	700000			Ab	700000	
Areal fraction of cracks in foundations/walls	cm^2-cracks/cm^2-total area	0.0019			Nuc		
Soil vapour permeability	cm^2	1.00E-08			kv	1.00E-08	
Indoor-outdoor pressure differential	g/cm-s^2	40			dP	40	
Slab perimeter	cm	3400			Xcrack	3400	
Depth to bottom of slab	cm	15			Zcrack	15	
Viscosity of air	g/cm-s	1.81E-04			uair	1.81E-04	
Outdoor Air Characteristics							
Wind speed in outdoor mixing zone (ambient air or trench, as appropriate)	cm/s	22.5	(c)	37.8	windsp	37.8	Based on the average annual 9am and 3pm windspeeds measured at observatory point in Sydney (note that this is the closest Bureau of Meteorology wind recording location to the Site), divided by 10
Width of source area parallel to wind or groundwater flow direction	cm	600	(d)	600	WSA	600	2 m deep and 2 m long trench
Ambient air mixing zone height	cm	200		200	AAMZH	200	assumes all vapours mixed w/in trench
Other							
Averaging time for surface emission vapour flux	sec	3.15E+07	(e)		atvapor	3.15E+07	Defaults to receptor exposure duration

(a) Building Code of Australia minimum ceiling height for habitable dwelling.
(b) USEPA (2004) upper limit of range for slab on grade foundation.
(c) If receptor is construction/excavation worker, wind speed is default wind speed of 225 cm/s reduced by factor of 10 to account for reduced wind circulation within excavation. For other receptors, wind speed is default of 225 cm/s.
(d) For construction/excavation worker, default is 400 cm (assumes trench is 2 m long and 2 m deep, and vapours enter through both walls and floor). For other receptors, Shell (2007) default of 4500 cm is assumed.
(e) Equals exposure duration for selected receptor. For residential scenario, shortest (child) exposure duration is selected for conservative purposes.

AECOM

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Back to User Input Sheet

B. Chemical-Specific Fate and Transport Parameters

CHEMICAL	Koc	Kd	H'	S	D^{air}	D^{wat}	MW	VP	Volatile?
	(cm^3/g)	(cm^3/g)	(cc-H_2O / cc-air)	(mg/l-water)	(cm^2/s)	(cm^2/s)	(g/mol)	(mmHg)	
Acenaphthene	5.03E+03	1.01E+01	7.52E-03	3.90E+00	5.06E-02	8.33E-06	1.54E+02	2.15E-03	Y
Acenaphthylene	5.03E+03	1.01E+01	4.66E-03	1.61E+01	4.50E-02	6.98E-06	1.52E+02	6.68E-03	Y
Ammonia	3.10E+00	6.20E-03	6.58E-04	4.82E+05	2.28E-01	1.10E-05	1.70E+01	-	Y
	-	-	-	-	-	-	-	-	-
Anthracene	1.64E+04	3.28E+01	2.27E-03	4.34E-02	3.90E-02	7.85E-06	1.78E+02	6.53E-06	Y
Benz(a)anthracene	1.77E+05	3.54E+02	1.37E-04	9.40E-03	5.10E-02	9.00E-06	2.28E+02	2.10E-07	N
Benzene	1.46E+02	2.92E-01	2.27E-01	1.79E+03	8.95E-02	1.03E-05	7.81E+01	9.48E+01	Y
Benzo(a)pyrene	5.87E+05	1.17E+03	1.87E-05	1.62E-03	4.30E-02	9.00E-06	2.52E+02	5.49E-09	N
Benzo(b)fluoranthene	5.99E+05	1.20E+03	2.69E-05	1.50E-03	2.26E-02	5.56E-06	2.52E+02	5.00E-07	N
Benzo(g,h,i)perylene	1.95E+06	3.90E+03	1.35E-05	2.60E-04	4.90E-02	5.56E-06	2.76E+02	1.00E-10	N
Benzo(k)fluoranthene	5.87E+05	1.17E+03	2.39E-05	8.00E-04	2.26E-02	5.56E-06	2.52E+02	9.65E-10	N
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	1.91E+06	3.82E+03	5.76E-06	2.49E-03	2.00E-02	5.24E-06	2.78E+02	9.55E-10	N
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Ethylbenzene	4.46E+02	8.92E-01	3.22E-01	1.69E+02	6.85E-02	8.46E-06	1.06E+02	9.60E+00	Y
Fluoranthene	5.55E+04	1.11E+02	3.62E-04	2.60E-01	3.02E-02	6.35E-06	2.02E+02	9.22E-06	N
Fluorene	9.16E+03	1.83E+01	3.93E-03	1.69E+00	4.40E-02	7.89E-06	1.66E+02	6.00E-04	Y
Indeno(1,2,3-cd)pyrene	1.95E+06	3.90E+03	1.42E-05	1.90E-04	2.30E-02	4.41E-06	2.76E+02	1.25E-10	N
	-	-	-	-	-	-	-	-	-
Naphthalene	1.54E+03	3.08E+00	1.80E-02	3.10E+01	6.05E-02	8.38E-06	1.28E+02	8.50E-02	Y
Phenanthrene	1.67E+04	3.34E+01	1.73E-03	1.15E+00	3.45E-02	6.69E-06	1.78E+02	1.21E-04	Y
Phenol	1.87E+02	3.74E-01	1.36E-05	8.28E+04	8.34E-02	1.03E-05	9.41E+01	3.50E-01	N
Pyrene	5.43E+04	1.09E+02	4.87E-04	1.35E-01	2.78E-02	7.25E-06	2.02E+02	4.50E-06	Y
	-	-	-	-	-	-	-	-	-
Toluene	2.34E+02	4.68E-01	2.71E-01	5.26E+02	7.78E-02	9.20E-06	9.21E+01	2.84E+01	Y
TPH C06-C09 aliphatic	4.47E+03	8.94E+00	5.05E+01	1.18E+01	1.00E-01	1.00E-05	1.03E+02	9.16E+01	Y
TPH C10-C14 aliphatic	5.50E+05	1.10E+03	6.26E+01	9.99E-02	1.00E-01	1.00E-05	1.70E+02	1.16E+00	Y
TPH C10-C14 aromatic	3.02E+03	6.04E+00	1.41E-01	2.53E+01	1.00E-01	1.00E-05	1.36E+02	1.16E+00	Y
TPH C15-C28 aliphatic	3.16E+08	6.32E+05	8.27E+01	1.11E-04	1.00E-01	1.00E-05	2.60E+02	5.93E-03	Y
TPH C15-C28 aromatic	3.79E+04	7.58E+01	4.90E-03	1.06E+00	1.00E-01	1.00E-05	2.09E+02	5.51E-03	Y
TPH C29-C36 aliphatic	6.31E+08	1.26E+06	8.50E+01	2.50E-06	1.00E-01	1.00E-05	2.70E+02	8.36E-04	Y
TPH C29-C36 aromatic	1.26E+05	2.52E+02	1.70E-05	6.60E-03	1.00E-01	1.00E-05	2.40E+02	3.34E-07	N
	-	-	-	-	-	-	-	-	-
Xylenes (total)	3.83E+02	7.66E-01	2.12E-01	1.06E+01	8.47E-02	9.90E-06	1.06E+02	7.99E+00	Y

Definition of Parameters

Koc	Organic carbon partition coefficient	D^{air}	Diffusion coefficient in air
Kd	Soil-water partition coefficient	D^{wat}	Diffusion coefficient in water
H'	Dimensionless Henry's Law Constant	MW	Molecular weight
S	Solubility	VP	Vapopur pressure

AECOM

Vapour Modelling - Soil to Outdoor and Indoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Back to User Input Sheet

C. Chemical-Specific Diffusion Coefficients

CHEMICAL	D_{s1}	D_{s2}	D_{s3}	D_{stot}	D_{crack}	Csat	Convective
	(cm^2/s)				(cm^2/s)	mg/kg	Factor (unitless)
Acenaphthene	8.18E-03	-	-	8.18E-03	3.96E-03	3.94E+01	3.10E+01
Acenaphthylene	7.28E-03	-	-	7.28E-03	3.52E-03	1.63E+02	3.49E+01
Ammonia	3.69E-02	-	-	3.69E-02	1.79E-02	1.87E+04	6.86E+00
Anthracene	6.31E-03	-	-	6.31E-03	3.06E-03	1.42E+00	4.00E+01
Benz(a)anthracene	NV	NV	NV	NV	NV	3.33E+00	NV
Benzene	1.45E-02	-	-	1.45E-02	6.98E-03	6.59E+02	1.76E+01
Benzo(a)pyrene	NV	NV	NV	NV	NV	1.90E+00	NV
Benzo(b)fluoranthene	NV	NV	NV	NV	NV	1.80E+00	NV
Benzo(g,h,i)perylene	NV	NV	NV	NV	NV	1.01E+00	NV
Benzo(k)fluoranthene	NV	NV	NV	NV	NV	9.39E-01	NV
Dibenz(a,h)anthracene	NV	NV	NV	NV	NV	9.51E+00	NV
Ethylbenzene	1.11E-02	-	-	1.11E-02	5.35E-03	1.67E+02	2.30E+01
Fluoranthene	NV	NV	NV	NV	NV	2.89E+01	NV
Fluorene	7.11E-03	-	-	7.11E-03	3.45E-03	3.10E+01	3.56E+01
Indeno(1,2,3-cd)pyrene	NV	NV	NV	NV	NV	7.41E-01	NV
Naphthalene	9.78E-03	-	-	9.78E-03	4.72E-03	9.66E+01	2.60E+01
Phenanthrene	5.58E-03	-	-	5.58E-03	2.72E-03	3.84E+01	4.52E+01
Phenol	NV	NV	NV	NV	NV	3.37E+04	NV
Pyrene	4.50E-03	-	-	4.50E-03	2.26E-03	1.47E+01	5.43E+01
Toluene	1.26E-02	-	-	1.26E-02	6.07E-03	2.91E+02	2.02E+01
TPH C06-C09 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	2.21E+02	1.57E+01
TPH C10-C14 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	1.11E+02	1.57E+01
TPH C10-C14 aromatic	1.62E-02	-	-	1.62E-02	7.80E-03	1.54E+02	1.57E+01
TPH C15-C28 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	7.02E+01	1.57E+01
TPH C15-C28 aromatic	1.62E-02	-	-	1.62E-02	7.82E-03	8.04E+01	1.57E+01
TPH C29-C36 aliphatic	1.62E-02	-	-	1.62E-02	7.80E-03	3.16E+00	1.57E+01
TPH C29-C36 aromatic	NV	NV	NV	NV	NV	1.66E+00	NV
Xylenes (total)	1.37E-02	-	-	1.37E-02	6.61E-03	8.90E+00	1.86E+01

Definition of Parameters

D_s	Effective diffusion coefficient in soil based on vapor-phase concentration
D_{crack}	Effective diffusion coefficient through foundation cracks
C_{sat}	Soil concentration at which dissolved pore-water and vapor phases become saturated

Vapour Modelling - Soil to Outdoor and Indoor Air

Barangaroo

Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000

Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Back to User Input Sheet

D. Chemical-Specific Volatilisation Factors

CHEMICAL	VF_{ss1}	VF_{ss2}	$VF_{p\,(indoor)}$	$VF_{p\,(outdoor)}$	VF_{samb}	VF_{sesp}
	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)	(mg/m^3-air / mg/kg-soil)
Acenaphthene	5.07E-05	8.36E-03	-	2.78E-08	4.84E-06	2.34E-04
Acenaphthylene	3.77E-05	8.36E-03	-	2.78E-08	2.67E-06	1.42E-04
Ammonia	5.13E-04	8.36E-03	-	2.78E-08	4.95E-04	6.07E-03
Anthracene	1.36E-05	8.36E-03	-	2.78E-08	3.46E-07	2.07E-05
Benz(a)anthracene	NV	NV	-	2.78E-08	NV	NV
Benzene	1.94E-04	8.36E-03	-	2.78E-08	7.07E-04	2.08E-02
Benzo(a)pyrene	NV	NV	-	2.78E-08	NV	NV
Benzo(b)fluoranthene	NV	NV	-	2.78E-08	NV	NV
Benzo(g,h,i)perylene	NV	NV	-	2.78E-08	NV	NV
Benzo(k)fluoranthene	NV	NV	-	2.78E-08	NV	NV
Dibenz(a,h)anthracene	NV	NV	-	2.78E-08	NV	NV
Ethylbenzene	1.24E-04	8.36E-03	-	2.78E-08	2.87E-04	1.07E-02
Fluoranthene	NV	NV	-	2.78E-08	NV	NV
Fluorene	2.54E-05	8.36E-03	-	2.78E-08	1.21E-06	6.55E-05
Indeno(1,2,3-cd)pyrene	NV	NV	-	2.78E-08	NV	NV
Naphthalene	1.54E-04	8.36E-03	-	2.78E-08	4.48E-05	1.86E-04
Phenanthrene	1.10E-05	8.36E-03	-	2.78E-08	2.29E-07	1.51E-05
Phenol	NV	NV	-	2.78E-08	NV	NV
Pyrene	2.92E-06	8.36E-03	-	2.78E-08	1.60E-08	1.24E-06
Toluene	1.61E-04	8.36E-03	-	2.78E-08	4.89E-04	1.63E-02
TPH C06-C09 aliphatic	4.29E-04	8.36E-03	-	2.78E-08	3.46E-03	9.17E-02
TPH C10-C14 aliphatic	6.20E-05	8.36E-03	-	2.78E-08	7.22E-05	1.92E-03
TPH C10-C14 aromatic	3.97E-05	8.36E-03	-	2.78E-08	2.97E-05	7.87E-04
TPH C15-C28 aliphatic	2.99E-05	8.36E-03	-	2.78E-08	1.68E-06	4.45E-05
TPH C15-C28 aromatic	2.10E-05	8.36E-03	-	2.78E-08	8.29E-07	2.20E-05
TPH C29-C36 aliphatic	2.14E-05	8.36E-03	-	2.78E-08	8.64E-07	2.29E-05
TPH C29-C36 aromatic	NV	NV	-	2.78E-08	NV	NV
Xylenes (total)	1.21E-04	8.36E-03	-	2.78E-08	2.74E-04	8.46E-03

Definition of Parameters

VF_{ss} Volatilization factor from surficial soils to ambient air (vapors) - use lower of two values

VF_p Volatilization factor from surficial soils to ambient air (particulates)

VF_{samb} Volatilization factor from subsurface soils to ambient air

VF_{sesp1} Volatilization factor from soil to enclosed-space vapors

VF_{trench} Volatilisation factor from subsurface soil to trench air (where soil contamination is below base of trench)

Health Risk Calculations - Incidental Soil Ingestion
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

			Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Soil Concentration (mg/kg)	Oral Soil Bioavailability Factor (unitless)	Oral RfD (mg/kg/day)	Adult Intake Factor (threshold) (kg/kg/day)	Adult Intake (threshold) (mg/kg/day)	Hazard Index (Adult) (unitless)	Oral CSF (mg/kg/day)-1	Adult Intake Factor (non-threshold) (kg/kg/day)	Lifetime Intake Factor (non-threshold) (kg/kg/day)	Lifetime Intake (non-threshold) (mg/kg/day)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	270	1.00E+00	6.00E-02	1.94E-07	5.23E-05	8.72E-04	-	-	-	-	-
Acenaphthylene	1000	1.00E+00	6.00E-02	1.94E-07	1.94E-04	3.23E-03	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	1.00E+00	3.00E-01	1.94E-07	2.32E-04	7.75E-04	-	-	-	-	-
Benz(a)anthracene	910	1.00E+00	-	-	-	-	4.30E-02	2.77E-09	2.77E-09	2.52E-06	1.08E-07
Benzene	61	1.00E+00	5.00E-04	1.94E-07	1.18E-05	2.36E-02	3.50E-02	2.77E-09	2.77E-09	1.69E-07	5.91E-09
Benzo(a)pyrene	650	1.00E+00	-	-	-	-	4.30E-01	2.77E-09	2.77E-09	1.80E-06	7.74E-07
Benzo(b)fluoranthene	820	1.00E+00	-	-	-	-	4.30E-02	2.77E-09	2.77E-09	2.27E-06	9.76E-08
Benzo(g,h,i)perylene	310	1.00E+00	-	-	-	-	4.30E-03	2.77E-09	2.77E-09	8.58E-07	3.69E-09
Benzo(k)fluoranthene	320	1.00E+00	-	-	-	-	4.30E-02	2.77E-09	2.77E-09	8.86E-07	3.81E-08
Dibenz(a,h)anthracene	73	1.00E+00	-	-	-	-	4.30E-01	2.77E-09	2.77E-09	2.02E-07	8.69E-08
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	2130	1.00E+00	4.00E-02	1.94E-07	4.13E-04	1.03E-02	-	-	-	-	-
Fluorene	1300	1.00E+00	4.00E-02	1.94E-07	2.52E-04	6.30E-03	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	1.00E+00	-	-	-	-	4.30E-02	2.77E-09	2.77E-09	6.92E-07	2.98E-08
Naphthalene	8400	1.00E+00	2.00E-02	1.94E-07	1.63E-03	8.14E-02	-	-	-	-	-
Phenanthrene	3100	1.00E+00	6.00E-02	1.94E-07	6.01E-04	1.00E-02	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-
Pyrene	1700	1.00E+00	3.00E-02	1.94E-07	3.29E-04	1.10E-02	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-	-	-
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.00E+00	1.00E-01	1.94E-07	1.05E-02	1.05E-01	-	-	-	-	-
TPH C10-C14 aromatic	54000	1.00E+00	4.00E-02	1.94E-07	1.05E-02	2.62E-01	-	-	-	-	-
TPH C15-C28 aliphatic	72000	1.00E+00	2.00E+00	1.94E-07	1.39E-02	6.97E-03	-	-	-	-	-
TPH C15-C28 aromatic	72000	1.00E+00	3.00E-02	1.94E-07	1.39E-02	4.65E-01	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-	-	-	-
Xylenes (total)	-	-	-	-	-	-	-	-	-	-	-
TOTAL						**9.86E-01**					**1.14E-06**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

AECOM

Health Risk Calculations - Dermal Contact with Soil
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

			Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Soil Concentration (mg/kg)	Dermal Absorption Factor (DAF) (unitless)	Dermal RfD (mg/kg/day)	Adult Intake Factor (threshold) (kg/kg/day)	Adult Intake (threshold) (mg/kg/day)	Hazard Index (Adult) (unitless)	Dermal CSF (mg/kg/day)-1	Adult Intake Factor (non-threshold) (kg/kg/day)	Lifetime Intake Factor (non-threshold) (kg/kg/day)	Lifetime Intake (non-threshold) (mg/kg/day)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	270	0.13	6.00E-02	4.12E-07	1.11E-04	1.85E-03	-	-	-	-	-
Acenaphthylene	1000	0.13	6.00E-02	4.12E-07	4.12E-04	6.87E-03	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	0.13	3.00E-01	4.12E-07	4.95E-04	1.65E-03	-	-	-	-	-
Benz(a)anthracene	910	0.13	-	-	-	-	4.30E-02	5.89E-09	5.89E-09	5.36E-06	2.30E-07
Benzene	61	-	5.00E-04	-	-	-	3.50E-02	-	-	-	-
Benzo(a)pyrene	650	0.13	-	-	-	-	2.50E+01	5.89E-09	5.89E-09	3.83E-06	9.57E-05
Benzo(b)fluoranthene	820	0.13	-	-	-	-	4.30E-02	5.89E-09	5.89E-09	4.83E-06	2.08E-07
Benzo(g,h,i)perylene	310	0.13	-	-	-	-	4.30E-03	5.89E-09	5.89E-09	1.83E-06	7.85E-09
Benzo(k)fluoranthene	320	0.13	-	-	-	-	4.30E-02	5.89E-09	5.89E-09	1.88E-06	8.10E-08
Dibenz(a,h)anthracene	73	0.13	-	-	-	-	4.30E-01	5.89E-09	5.89E-09	4.30E-07	1.85E-07
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	2130	0.13	4.00E-02	4.12E-07	8.78E-04	2.19E-02	-	-	-	-	-
Fluorene	1300	0.13	4.00E-02	4.12E-07	5.36E-04	1.34E-02	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	0.13	-	-	-	-	4.30E-02	5.89E-09	5.89E-09	1.47E-06	6.33E-08
Naphthalene	8400	0.13	2.00E-02	4.12E-07	3.46E-03	1.73E-01	-	-	-	-	-
Phenanthrene	3100	0.13	6.00E-02	4.12E-07	1.28E-03	2.13E-02	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-
Pyrene	1700	0.13	3.00E-02	4.12E-07	7.01E-04	2.34E-02	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-	-	-
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	-	1.00E-01	-	-	-	-	-	-	-	-
TPH C10-C14 aromatic	54000	-	4.00E-02	-	-	-	-	-	-	-	-
TPH C15-C28 aliphatic	72000	0.1	2.00E+00	3.17E-07	2.28E-02	1.14E-02	-	-	-	-	-
TPH C15-C28 aromatic	72000	0.1	3.00E-02	3.17E-07	2.28E-02	7.61E-01	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-	-	-	-
Xylenes (total)	-	-	-	-	-	-	-	-	-	-	-
TOTAL						**1.04E+00**					**9.64E-05**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Health Risk Calculations - Inhalation of Soil-Derived Particulates in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

			Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Soil Conc (mg/kg)	Particulate Concentration in Outdoor Air (From Surface Soil) (m3/kg)	Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (kg/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Inhalation Unit Risk (ug/m3)-1	Adult Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Adjusted Air Concentration (non-threshold) (mg/m3)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	270	2.78E-08	2.10E-01	3.81E-10	1.03E-07	4.89E-07	-	-	-	-	-
Acenaphthylene	1000	2.78E-08	2.10E-01	3.81E-10	3.81E-07	1.81E-06	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	2.78E-08	1.05E+00	3.81E-10	4.57E-07	4.35E-07	-	-	-	-	-
Benz(a)anthracene	910	2.78E-08	-	-	-	-	8.70E-03	5.44E-12	5.44E-12	4.95E-09	4.30E-08
Benzene	61	2.78E-08	9.60E-03	3.81E-10	2.32E-08	2.42E-06	6.00E-06	5.44E-12	5.44E-12	3.32E-10	1.99E-12
Benzo(a)pyrene	650	2.78E-08	-	-	-	-	8.70E-02	5.44E-12	5.44E-12	3.53E-09	3.07E-07
Benzo(b)fluoranthene	820	2.78E-08	-	-	-	-	8.70E-03	5.44E-12	5.44E-12	4.46E-09	3.88E-08
Benzo(g,h,i)perylene	310	2.78E-08	-	-	-	-	8.70E-04	5.44E-12	5.44E-12	1.69E-09	1.47E-09
Benzo(k)fluoranthene	320	2.78E-08	-	-	-	-	8.70E-03	5.44E-12	5.44E-12	1.74E-09	1.51E-08
Dibenz(a,h)anthracene	73	2.78E-08	-	-	-	-	8.70E-02	5.44E-12	5.44E-12	3.97E-10	3.45E-08
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	2130	2.78E-08	1.40E-01	3.81E-10	8.11E-07	5.79E-06	-	-	-	-	-
Fluorene	1300	2.78E-08	1.40E-01	3.81E-10	4.95E-07	3.53E-06	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	2.78E-08	-	-	-	-	8.70E-03	5.44E-12	5.44E-12	1.36E-09	1.18E-08
Naphthalene	8400	2.78E-08	3.00E-03	3.81E-10	3.20E-06	1.07E-03	-	-	-	-	-
Phenanthrene	3100	2.78E-08	2.10E-01	3.81E-10	1.18E-06	5.62E-06	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-
Pyrene	1700	2.78E-08	1.05E-01	3.81E-10	6.47E-07	6.16E-06	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-	-	-
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	2.78E-08	1.00E+00	3.81E-10	2.05E-05	2.05E-05	-	-	-	-	-
TPH C10-C14 aromatic	54000	2.78E-08	2.00E-01	3.81E-10	2.05E-05	1.03E-04	-	-	-	-	-
TPH C15-C28 aliphatic	72000	2.78E-08	7.00E+00	3.81E-10	2.74E-05	3.91E-06	-	-	-	-	-
TPH C15-C28 aromatic	72000	2.78E-08	1.05E-01	3.81E-10	2.74E-05	2.61E-04	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-	-	-	-
Xylenes (total)	-	-	-	-	-	-	-	-	-	-	-
TOTAL						**1.48E-03**					**4.52E-07**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Health Risk Calculations - Inhalation of Surface Soil-Derived Vapours in Outdoor Air
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

					Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Soil Conc. (mg/kg)	Csat (mg/kg)	Volatilisation Factor from Subsurface Soil to Outdoor Air [(mg/m3)/(mg/kg)]	Vapour Concentration in Outdoor Air (From Surface Soil) (mg/m3)	Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (kg/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Inhalation Unit Risk (ug/m3)-1	Adult Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Factor (non-threshold) (kg/m3)	Lifetime Exposure Adjusted Air Concentration (non-threshold) (mg/m3)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	270	3.94E+01	5.07E-05	2.00E-03	2.10E-01	6.95E-07	2.74E-05	1.30E-04	-	-	-	-	-
Acenaphthylene	1000	1.63E+02	3.77E-05	6.12E-03	2.10E-01	5.16E-07	8.38E-05	3.99E-04	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	1200	1.42E+00	1.36E-05	1.93E-05	1.05E+00	1.86E-07	2.65E-07	2.52E-07	-	-	-	-	-
Benz(a)anthracene	910	3.33E+00	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Benzene	61	6.59E+02	1.94E-04	1.18E-02	9.60E-03	2.66E-06	1.62E-04	1.69E-02	6.00E-06	3.80E-08	3.80E-08	2.32E-06	1.39E-08
Benzo(a)pyrene	650	1.90E+00	NV	-	-	-	-	-	8.70E-02	-	-	-	-
Benzo(b)fluoranthene	820	1.80E+00	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Benzo(g,h,i)perylene	310	1.01E+00	NV	-	-	-	-	-	8.70E-04	-	-	-	-
Benzo(k)fluoranthene	320	9.39E-01	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Dibenz(a,h)anthracene	73	9.51E+00	NV	-	-	-	-	-	8.70E-02	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	2130	2.89E+01	NV	-	1.40E-01	-	-	-	-	-	-	-	-
Fluorene	1300	3.10E+01	2.54E-05	7.87E-04	1.40E-01	3.47E-07	1.08E-05	7.70E-05	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	7.41E-01	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Naphthalene	8400	9.66E+01	1.54E-04	1.49E-02	3.00E-03	2.12E-06	2.04E-04	6.81E-02	-	-	-	-	-
Phenanthrene	3100	3.84E+01	1.10E-05	4.25E-04	2.10E-01	1.51E-07	5.82E-06	2.77E-05	-	-	-	-	-
Phenol	-	-	NV	-	-	-	-	-	-	-	-	-	-
Pyrene	1700	1.47E+01	2.92E-06	4.28E-05	1.05E-01	4.00E-08	5.86E-07	5.59E-06	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.11E+02	6.20E-05	6.89E-03	1.00E+00	8.49E-07	9.44E-05	9.44E-05	-	-	-	-	-
TPH C10-C14 aromatic	54000	1.54E+02	3.97E-05	6.13E-03	2.00E-01	5.44E-07	8.40E-05	4.20E-04	-	-	-	-	-
TPH C15-C28 aliphatic	72000	7.02E+01	2.99E-05	2.10E-03	7.00E+00	4.09E-07	2.87E-05	4.10E-06	-	-	-	-	-
TPH C15-C28 aromatic	72000	8.04E+01	2.10E-05	1.69E-03	1.05E-01	2.88E-07	2.31E-05	2.20E-04	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	-	-	NV	-	-	-	-	-	-	-	-	-	-
Xylenes (total)	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL								**8.64E-02**					**1.39E-08**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Health Risk Calculations - Incidental Ingestion of Groundwater (bathing or excavation)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

		Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Groundwater Concentration (mg/L)	Oral RfD (mg/kg/day)	Adult Intake Factor (threshold) (L/kg/day)	Adult Intake (threshold) (mg/kg/day)	Hazard Index (Adult) (unitless)	Oral CSF (mg/kg/day)-1	Adult Intake Factor (non-threshold) (L/kg/day)	Lifetime Intake Factor (non-threshold) (L/kg/day)	Lifetime Intake (non-threshold) (mg/kg/day)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	4.4	6.00E-02	2.94E-06	1.29E-05	2.15E-04	-	-	-	-	-
Acenaphthylene	43	6.00E-02	2.94E-06	1.26E-04	2.10E-03	-	-	-	-	-
Ammonia	350	-	-	-	-	-	-	-	-	-
Anthracene	15	3.00E-01	2.94E-06	4.40E-05	1.47E-04	-	-	-	-	-
Benz(a)anthracene	13	-	-	-	-	4.30E-02	4.19E-08	4.19E-08	5.45E-07	2.34E-08
Benzene	41	5.00E-04	2.94E-06	1.20E-04	2.41E-01	3.50E-02	4.19E-08	4.19E-08	1.72E-06	6.02E-08
Benzo(a)pyrene	9.3	-	-	-	-	4.30E-01	4.19E-08	4.19E-08	3.90E-07	1.68E-07
Benzo(b)fluoranthene	8.3	-	-	-	-	4.30E-02	4.19E-08	4.19E-08	3.48E-07	1.50E-08
Benzo(g,h,i)perylene	4.2	-	-	-	-	4.30E-03	4.19E-08	4.19E-08	1.76E-07	7.57E-10
Benzo(k)fluoranthene	3.7	-	-	-	-	4.30E-02	4.19E-08	4.19E-08	1.55E-07	6.67E-09
Dibenz(a,h)anthracene	0.82	-	-	-	-	4.30E-01	4.19E-08	4.19E-08	3.44E-08	1.48E-08
Ethylbenzene	3.02	9.71E-02	2.94E-06	8.86E-06	9.13E-05	-	-	-	-	-
Fluoranthene	26	4.00E-02	2.94E-06	7.63E-05	1.91E-03	-	-	-	-	-
Fluorene	21	4.00E-02	2.94E-06	6.16E-05	1.54E-03	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	-	-	-	-	4.30E-02	4.19E-08	4.19E-08	1.30E-07	5.59E-09
Naphthalene	283	2.00E-02	2.94E-06	8.31E-04	4.15E-02	-	-	-	-	-
Phenanthrene	74	6.00E-02	2.94E-06	2.17E-04	3.62E-03	-	-	-	-	-
Phenol	390	3.00E-01	2.94E-06	1.14E-03	3.82E-03	-	-	-	-	-
Pyrene	28	3.00E-02	2.94E-06	8.22E-05	2.74E-03	-	-	-	-	-
Toluene	18	2.23E-01	2.94E-06	5.28E-05	2.37E-04	-	-	-	-	-
TPH C06-C09 aliphatic	74	5.00E+00	2.94E-06	2.17E-04	4.34E-05	-	-	-	-	-
TPH C10-C14 aliphatic	1730	1.00E-01	2.94E-06	5.08E-03	5.08E-02	-	-	-	-	-
TPH C10-C14 aromatic	1730	4.00E-02	2.94E-06	5.08E-03	1.27E-01	-	-	-	-	-
TPH C15-C28 aliphatic	1520	2.00E+00	2.94E-06	4.46E-03	2.23E-03	-	-	-	-	-
TPH C15-C28 aromatic	1520	3.00E-02	2.94E-06	4.46E-03	1.49E-01	-	-	-	-	-
TPH C29-C36 aliphatic	332	2.00E+00	2.94E-06	9.75E-04	4.87E-04	-	-	-	-	-
TPH C29-C36 aromatic	332	3.00E-02	2.94E-06	9.75E-04	3.25E-02	-	-	-	-	-
Xylenes (total)	6.7	1.79E-01	2.94E-06	1.97E-05	1.10E-04	-	-	-	-	-
TOTAL					**6.60E-01**					**2.94E-07**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Health Risk Calculations - Dermal Contact with Groundwater (bathing or excavation)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

			Threshold Intake and Risk Calculations				Non-Threshold Intake and Risk Calculations				
Chemical	Groundwater Concentration (mg/L)	Dermal Permeability Constant (kp) (cm/hr)	Dermal RfD (mg/kg/day)	Adult Intake Factor (threshold) (L/kg/day)	Adult Intake (threshold) (mg/kg/day)	Hazard Index (Adult) (unitless)	Dermal CSF (mg/kg/day)-1	Adult Intake Factor (non-threshold) (L/kg/day)	Lifetime Intake Factor (non-threshold) (L/kg/day)	Lifetime Intake (non-threshold) (mg/kg/day)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	4.4	0.086	6.00E-02	1.95E-04	8.60E-04	1.43E-02	-	-	-	-	-
Acenaphthylene	43	0.0911	6.00E-02	2.07E-04	8.90E-03	1.48E-01	-	-	-	-	-
Ammonia	350	0.001	-	-	-	-	-	-	-	-	-
Anthracene	15	0.142	3.00E-01	3.23E-04	4.84E-03	1.61E-02	-	-	-	-	-
Benz(a)anthracene	13	0.552	-	-	-	-	4.30E-02	1.79E-05	1.79E-05	2.33E-04	1.00E-05
Benzene	41	0.0149	5.00E-04	3.39E-05	1.39E-03	2.78E+00	3.50E-02	4.84E-07	4.84E-07	1.98E-05	6.94E-07
Benzo(a)pyrene	9.3	0.713	-	-	-	-	2.50E+01	2.31E-05	2.31E-05	2.15E-04	5.38E-03
Benzo(b)fluoranthene	8.3	0.417	-	-	-	-	4.30E-02	1.35E-05	1.35E-05	1.12E-04	4.83E-06
Benzo(g,h,i)perylene	4.2	1.12	-	-	-	-	4.30E-03	3.64E-05	3.64E-05	1.53E-04	6.57E-07
Benzo(k)fluoranthene	3.7	0.691	-	-	-	-	4.30E-02	2.24E-05	2.24E-05	8.30E-05	3.57E-06
Dibenz(a,h)anthracene	0.82	0.953	-	-	-	-	4.30E-01	3.09E-05	3.09E-05	2.54E-05	1.09E-05
Ethylbenzene	3.02	0.0493	9.71E-02	1.12E-04	3.38E-04	3.48E-03	-	-	-	-	-
Fluoranthene	26	0.308	4.00E-02	7.00E-04	1.82E-02	4.55E-01	-	-	-	-	-
Fluorene	21	0.11	4.00E-02	2.50E-04	5.25E-03	1.31E-01	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	1.24	-	-	-	-	4.30E-02	4.02E-05	4.02E-05	1.25E-04	5.36E-06
Naphthalene	283	0.0466	2.00E-02	1.06E-04	3.00E-02	1.50E+00	-	-	-	-	-
Phenanthrene	74	0.144	6.00E-02	3.27E-04	2.42E-02	4.04E-01	-	-	-	-	-
Phenol	390	0.00434	3.00E-01	9.86E-06	3.85E-03	1.28E-02	-	-	-	-	-
Pyrene	28	0.201	3.00E-02	4.57E-04	1.28E-02	4.26E-01	-	-	-	-	-
Toluene	18	0.0311	2.23E-01	7.07E-05	1.27E-03	5.70E-03	-	-	-	-	-
TPH C06-C09 aliphatic	74	0.196	5.00E+00	4.45E-04	3.30E-02	6.59E-03	-	-	-	-	-
TPH C10-C14 aliphatic	1730	1.29	1.00E-01	2.93E-03	5.07E+00	5.07E+01	-	-	-	-	-
TPH C10-C14 aromatic	1730	0.128	4.00E-02	2.91E-04	5.03E-01	1.26E+01	-	-	-	-	-
TPH C15-C28 aliphatic	1520	0.506	2.00E+00	1.15E-03	1.75E+00	8.74E-01	-	-	-	-	-
TPH C15-C28 aromatic	1520	0.356	3.00E-02	8.09E-04	1.23E+00	4.10E+01	-	-	-	-	-
TPH C29-C36 aliphatic	332	0.444	2.00E+00	1.01E-03	3.35E-01	1.67E-01	-	-	-	-	-
TPH C29-C36 aromatic	332	0.655	3.00E-02	1.49E-03	4.94E-01	1.65E+01	-	-	-	-	-
Xylenes (total)	6.7	0.0471	1.79E-01	1.07E-04	7.17E-04	4.01E-03	-	-	-	-	-
Bold denotes soil/ groundwater SSTC has been proposed (see text for details)											
TOTAL						**1.28E+02**					**5.42E-03**

AECOM

Health Risk Calculations - Inhalation of Groundwater-Derived Vapours in Trench Air (where groundwater enters trench)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Chemical	Groundwater Concentration (mg/L)	Aqueous Solubility (mg/L)	Volatilisation Factor from Groundwater to Trench Air (where GW enters trench) [(mg/m3)/(mg/L)]	Vapour Concentration in Trench Air (from GW within trench) (mg/m3)	Threshold Intake and Risk Calculations: Inhalation RfC (mg/m3)	Adult Exposure Factor (threshold) (L/m3)	Adult Exposure Adjusted Air Concentration (threshold) (mg/m3)	Hazard Index (Adult) (unitless)	Non-Threshold Intake Risk Calculations: Inhalation Unit Risk (ug/m3)-1	Adult Exposure Factor (non-threshold) (L/m3)	Lifetime Exposure Factor (non-threshold) (L/m3)	Lifetime Exposure Adjusted Air Concentration (non-threshold) (mg/m3)	Lifetime Excess Cancer Risk (unitless)
Acenaphthene	4.4	3.90E+00	3.31E-04	1.29E-03	2.10E-01	4.53E-06	1.77E-05	8.41E-05	-	-	-	-	-
Acenaphthylene	43	1.61E+01	3.31E-04	5.32E-03	2.10E-01	4.53E-06	7.29E-05	3.47E-04	-	-	-	-	-
Ammonia	350	4.82E+05	3.31E-04	1.16E-01	6.95E-02	4.53E-06	1.59E-03	2.28E-02	-	-	-	-	-
Anthracene	15	4.34E-02	3.31E-04	1.44E-05	1.05E+00	4.53E-06	1.97E-07	1.87E-07	-	-	-	-	-
Benz(a)anthracene	13	9.40E-03	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Benzene	41	1.79E+03	3.31E-04	1.36E-02	9.60E-03	4.53E-06	1.86E-04	1.93E-02	6.00E-06	6.47E-08	6.47E-08	2.65E-06	1.59E-08
Benzo(a)pyrene	9.3	1.62E-03	NV	-	-	-	-	-	8.70E-02	-	-	-	-
Benzo(b)fluoranthene	8.3	1.50E-03	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Benzo(g,h,i)perylene	4.2	2.60E-04	NV	-	-	-	-	-	8.70E-04	-	-	-	-
Benzo(k)fluoranthene	3.7	8.00E-04	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Dibenz(a,h)anthracene	0.82	2.49E-03	NV	-	-	-	-	-	8.70E-02	-	-	-	-
Ethylbenzene	3.02	1.69E+02	3.31E-04	9.99E-04	1.30E+00	4.53E-06	1.37E-05	1.05E-05	-	-	-	-	-
Fluoranthene	26	2.60E-01	NV	-	1.40E-01	-	-	-	-	-	-	-	-
Fluorene	21	1.69E+00	3.31E-04	5.59E-04	1.40E-01	4.53E-06	7.66E-06	5.47E-05	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	1.90E-04	NV	-	-	-	-	-	8.70E-03	-	-	-	-
Naphthalene	283	3.10E+01	3.31E-04	1.03E-02	3.00E-03	4.53E-06	1.40E-04	4.68E-02	-	-	-	-	-
Phenanthrene	74	1.15E+00	3.31E-04	3.80E-04	2.10E-01	4.53E-06	5.21E-06	2.48E-05	-	-	-	-	-
Phenol	390	8.28E+04	NV	-	2.00E-01	-	-	-	-	-	-	-	-
Pyrene	28	1.35E-01	3.31E-04	4.46E-05	1.05E-01	4.53E-06	6.12E-07	5.82E-06	-	-	-	-	-
Toluene	18	5.26E+02	3.31E-04	5.95E-03	5.00E+00	4.53E-06	8.15E-05	1.63E-05	-	-	-	-	-
TPH C06-C09 aliphatic	74	1.18E+01	3.31E-04	3.90E-03	1.84E+01	4.53E-06	5.35E-05	2.91E-06	-	-	-	-	-
TPH C10-C14 aliphatic	1730	9.99E-02	3.31E-04	3.30E-05	1.00E+00	4.53E-06	4.53E-07	4.53E-07	-	-	-	-	-
TPH C10-C14 aromatic	1730	2.53E+01	3.31E-04	8.37E-03	2.00E-01	4.53E-06	1.15E-04	5.73E-04	-	-	-	-	-
TPH C15-C28 aliphatic	1520	1.11E-04	3.31E-04	3.67E-08	7.00E+00	4.53E-06	5.03E-10	7.18E-11	-	-	-	-	-
TPH C15-C28 aromatic	1520	1.06E+00	3.31E-04	3.51E-04	1.05E-01	4.53E-06	4.80E-06	4.57E-05	-	-	-	-	-
TPH C29-C36 aliphatic	332	2.50E-06	3.31E-04	8.27E-10	7.00E+00	4.53E-06	1.13E-11	1.62E-12	-	-	-	-	-
TPH C29-C36 aromatic	332	6.60E-03	NV	-	1.05E-01	-	-	-	-	-	-	-	-
Xylenes (total)	6.7	1.06E+01	3.31E-04	2.22E-03	2.20E-01	4.53E-06	3.04E-05	1.38E-04	-	-	-	-	-
TOTAL								**9.03E-02**					**1.59E-08**

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Soil RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (Hazard Index)					Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity) (kg/mg)							RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Vapour Only Risk at Csat (if necessary)	Revised RBSL (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL				
			Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL (All Pathways)	Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL (All Pathways)						Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	unitless	unitless	unitless	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	mg/kg			mg/kg	mg/kg	%	%	%	%	%
Acenaphthene	270	3.94E+01	8.72E-04	1.85E-03	4.89E-07	1.30E-04	2.86E-03	3.23E-06	6.87E-06	1.81E-09	3.31E-06	1.01E-05	3.31E-06	1.34E-05	1.49E+04	1.51E-01	1.30E-04	1.98E+04	**1.98E+04**	31.95%	67.97%	0.02%	0.07%	100.00%
Acenaphthylene	1000	1.63E+02	3.23E-03	6.87E-03	1.81E-06	3.99E-04	1.05E-02	3.23E-06	6.87E-06	1.81E-09	2.46E-06	1.01E-05	2.46E-06	1.26E-05	1.59E+04	1.61E-01	3.99E-04	1.98E+04	**1.98E+04**	31.91%	67.88%	0.02%	0.20%	100.00%
Ammonia	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Anthracene	1200	1.42E+00	7.75E-04	1.65E-03	4.35E-07	2.52E-07	2.42E-03	6.46E-07	1.37E-06	3.62E-10	1.77E-07	2.02E-06	1.77E-07	2.20E-06	9.10E+04	1.84E-01	2.52E-07	9.90E+04	**9.90E+04**	31.97%	68.01%	0.02%	0.00%	100.00%
Benz(a)anthracene	910	3.33E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Benzene	61	6.59E+02	2.36E-02	-	2.42E-06	1.69E-02	4.05E-02	3.87E-04	-	3.96E-08	2.77E-04	3.88E-04	2.77E-04	6.64E-04	3.76E+02	2.50E-01	-	-	**3.76E+02**	58.32%	-	0.01%	41.67%	100.00%
Benzo(a)pyrene	650	1.90E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Benzo(b)fluoranthene	820	1.80E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Benzo(g,h,i)perylene	310	1.01E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Benzo(k)fluoranthene	320	9.39E-01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Dibenz(a,h)anthracene	73	9.51E+00	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Fluoranthene	2130	2.89E+01	1.03E-02	2.19E-02	5.79E-06	-	3.23E-02	4.84E-06	1.03E-05	2.72E-09	-	1.51E-05		1.51E-05	1.32E+04	2.00E-01	-	-	**1.32E+04**	31.97%	68.01%	0.02%	-	100.00%
Fluorene	1300	3.10E+01	6.30E-03	1.34E-02	3.53E-06	7.70E-05	1.98E-02	4.84E-06	1.03E-05	2.72E-09	2.48E-06	1.51E-05	2.48E-06	1.76E-05	1.13E+04	1.72E-01	7.70E-05	1.32E+04	**1.32E+04**	31.96%	67.98%	0.02%	0.04%	100.00%
Indeno(1,2,3-cd)pyrene	250	7.41E-01	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Naphthalene	8400	9.66E+01	8.14E-02	1.73E-01	1.07E-03	6.81E-02	3.24E-01	9.69E-06	2.06E-05	1.27E-07	7.05E-04	3.04E-05	7.05E-04	7.36E-04	2.72E+02	7.64E-02	6.81E-02	4.33E+03	**4.33E+03**	20.99%	44.66%	0.27%	34.07%	100.00%
Phenanthrene	3100	3.84E+01	1.00E-02	2.13E-02	5.62E-06	2.77E-05	3.13E-02	3.23E-06	6.87E-06	1.81E-09	7.20E-07	1.01E-05	7.20E-07	1.08E-05	1.85E+04	1.87E-01	2.77E-05	1.98E+04	**1.98E+04**	31.97%	68.00%	0.02%	0.01%	100.00%
Phenol	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Pyrene	1700	1.47E+01	1.10E-02	2.34E-02	6.16E-06	5.59E-06	3.43E-02	6.46E-06	1.37E-05	3.62E-09	3.81E-07	2.02E-05	3.81E-07	2.06E-05	9.72E+03	1.96E-01	5.59E-06	9.90E+03	**9.90E+03**	31.97%	68.01%	0.02%	0.00%	100.00%
Toluene	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
TPH C10-C14 aliphatic	54000	1.11E+02	1.05E-01	-	2.05E-05	9.44E-05	1.05E-01	1.94E-06	-	3.81E-10	8.49E-07	1.94E-06	8.49E-07	2.79E-06	4.49E+04	8.70E-02	9.44E-05	6.45E+04	**6.45E+04**	99.90%	-	0.02%	0.08%	100.00%
TPH C10-C14 aromatic	54000	1.54E+02	2.62E-01	-	1.03E-04	4.20E-04	2.62E-01	4.84E-06	-	1.90E-09	2.72E-06	4.85E-06	2.72E-06	7.57E-06	1.65E+04	8.05E-02	4.20E-04	2.57E+04	**2.57E+04**	99.62%	-	0.04%	0.34%	100.00%
TPH C15-C28 aliphatic	72000	7.02E+01	6.97E-03	1.14E-02	3.91E-06	4.10E-06	1.84E-02	9.69E-08	1.59E-07	5.44E-11	5.85E-08	2.55E-07	5.85E-08	3.14E-07	3.98E+05	1.02E-01	4.10E-06	4.89E+05	**4.89E+05**	37.92%	62.05%	0.02%	0.00%	100.00%
TPH C15-C28 aromatic	72000	8.04E+01	4.65E-01	7.61E-01	2.61E-04	2.20E-04	1.23E+00	6.46E-06	1.06E-05	3.62E-09	2.74E-06	1.70E-05	2.74E-06	1.98E-05	6.32E+03	1.08E-01	2.20E-04	7.33E+03	**7.33E+03**	37.86%	61.95%	0.02%	0.18%	100.00%
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	
Xylenes (total)	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-	

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Soil RBSL Derivation - Non-Threshold Lifetime Health Effects (Adult and Child)
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Chemical	Csoil	Csat	Risk at Input Soil Concentration (ILCR)					Risk/Soil Concentration (i.e., exposure and toxicity factor)							RBSL (assumes no sat limit)	Risk at RBSL (with sat)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL				
			Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL	Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL				Soil Ingestion	Dermal Contact	Dust Inhalation Outdoors	Vapours from Surface Soil Outdoors	TOTAL
	mg/kg	mg/kg	unitless	unitless	unitless	unitless	unitless	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	kg/mg	mg/kg		mg/kg	%	%	%	%	%
Acenaphthene	270	3.94E+01	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Acenaphthylene	1000	1.63E+02	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Anthracene	1200	1.42E+00	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Benz(a)anthracene	910	3.33E+00	1.08E-07	2.30E-07	4.30E-08	-	3.82E-07	1.19E-10	2.53E-10	4.73E-11	-	4.19E-10		4.19E-10			**-**					
Benzene	61	6.59E+02	5.91E-09	-	1.99E-12	1.39E-08	1.98E-08	9.69E-11	-	3.26E-14	2.28E-10	9.69E-11	2.28E-10	3.25E-10	3.08E+04	1.00E-05	**3.08E+04**	29.83%	-	0.01%	70.16%	100.00%
Benzo(a)pyrene	650	1.90E+00	7.74E-07	9.57E-05	3.07E-07	-	9.68E-05	1.19E-09	1.47E-07	4.73E-10	-	1.49E-07		1.49E-07	6.72E+01	1.00E-05	**6.72E+01**	0.80%	98.88%	0.32%	-	100.00%
Benzo(b)fluoranthene	820	1.80E+00	9.76E-08	2.08E-07	3.88E-08	-	3.44E-07	1.19E-10	2.53E-10	4.73E-11	-	4.19E-10		4.19E-10			**-**					
Benzo(g,h,i)perylene	310	1.01E+00	3.69E-09	7.85E-09	1.47E-09	-	1.30E-08	1.19E-11	2.53E-11	4.73E-12	-	4.19E-11		4.19E-11			**-**					
Benzo(k)fluoranthene	320	9.39E-01	3.81E-08	8.10E-08	1.51E-08	-	1.34E-07	1.19E-10	2.53E-10	4.73E-11	-	4.19E-10		4.19E-10			**-**					
Dibenz(a,h)anthracene	73	9.51E+00	8.69E-08	1.85E-07	3.45E-08	-	3.06E-07	1.19E-09	2.53E-09	4.73E-10	-	4.19E-09		4.19E-09			**-**					
Ethylbenzene	-	-	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Fluoranthene	2130	2.89E+01	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Fluorene	1300	3.10E+01	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	250	7.41E-01	2.98E-08	6.33E-08	1.18E-08	-	1.05E-07	1.19E-10	2.53E-10	4.73E-11	-	4.19E-10		4.19E-10			**-**					
Naphthalene	8400	9.66E+01	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Phenanthrene	3100	3.84E+01	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Pyrene	1700	1.47E+01	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
TPH C06-C09 aliphatic	-	-	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
TPH C10-C14 aliphatic	54000	1.11E+02	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
TPH C10-C14 aromatic	54000	1.54E+02	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
TPH C15-C28 aliphatic	72000	7.02E+01	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
TPH C15-C28 aromatic	72000	8.04E+01	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
TPH C29-C36 aliphatic	-	-	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
TPH C29-C36 aromatic	-	-	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-
Xylenes (total)	-	-	-	-	-	-	-	-	-	-	-			-	-	-	**-**	-	-	-	-	-

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

AECOM

Groundwater RBSL Derivation - Adult Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

			Risk at Input Groundwater Concentration (Hazard Index)				Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity)											Pathway Contributions to Total Estimated Risk at RBSL			
	Cgw	Solubility	GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	TOTAL (All Pathways)	GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL (All Pathways)	RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Vapour Only Risk at Sol (if necessary)	Revised RBSL (if necessary)	Adopted RBSL	GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	TOTAL
Chemical	mg/L	mg/L	unitless	unitless	unitless	unitless	L/mg	L/mg	L/mg	L/mg	L/mg	L/mg	mg/L			mg/L	mg/L	%	%	%	%
Acenaphthene	4.4	3.90E+00	8.41E-05	2.15E-04	1.43E-02	1.46E-02	2.16E-05	4.89E-05	3.26E-03	3.31E-03	2.16E-05	3.33E-03	6.01E+01	1.99E-01	8.41E-05	6.05E+01	**6.05E+01**	0.04%	1.48%	98.48%	100.00%
Acenaphthylene	43	1.61E+01	3.47E-04	2.10E-03	1.48E-01	1.51E-01	2.16E-05	4.89E-05	3.45E-03	3.50E-03	2.16E-05	3.52E-03	5.68E+01	1.99E-01	3.47E-04	5.71E+01	**5.71E+01**	0.17%	1.40%	98.43%	100.00%
Ammonia	350	4.82E+05	2.28E-02	-	-	2.28E-02	6.52E-05	-	-		6.52E-05	6.52E-05	1.53E+04	1.00E+00	-	-	**1.53E+04**	100.00%	-	-	100.00%
Anthracene	15	4.34E-02	1.87E-07	1.47E-04	1.61E-02	1.63E-02	4.31E-06	9.78E-06	1.08E-03	1.09E-03	4.31E-06	1.09E-03	1.84E+02	1.99E-01	1.87E-07	1.84E+02	**1.84E+02**	0.00%	0.90%	99.10%	100.00%
Benz(a)anthracene	13	9.40E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Benzene	41	1.79E+03	1.93E-02	2.41E-01	2.78E+00	3.04E+00	4.72E-04	5.87E-03	6.77E-02	7.36E-02	4.72E-04	7.40E-02	3.38E+00	2.50E-01	-	-	**3.38E+00**	0.64%	7.93%	91.43%	100.00%
Benzo(a)pyrene	9.3	1.62E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Benzo(b)fluoranthene	8.3	1.50E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Benzo(g,h,i)perylene	4.2	2.60E-04	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Benzo(k)fluoranthene	3.7	8.00E-04	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Dibenz(a,h)anthracene	0.82	2.49E-03	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Ethylbenzene	3.02	1.69E+02	1.05E-05	9.13E-05	3.48E-03	3.59E-03	3.48E-06	3.02E-05	1.15E-03	1.18E-03	3.48E-06	1.19E-03	2.11E+02	2.50E-01	5.89E-04	2.11E+02	**2.11E+02**	0.24%	2.55%	97.22%	100.00%
Fluoranthene	26	2.60E-01	-	1.91E-03	4.55E-01	4.57E-01	-	7.34E-05	1.75E-02	1.76E-02		1.76E-02	1.14E+01	2.00E-01	-	-	**1.14E+01**	-	0.42%	99.58%	100.00%
Fluorene	21	1.69E+00	5.47E-05	1.54E-03	1.31E-01	1.33E-01	3.24E-05	7.34E-05	6.25E-03	6.32E-03	3.24E-05	6.35E-03	3.15E+01	1.99E-01	5.47E-05	3.16E+01	**3.16E+01**	0.03%	1.16%	98.81%	100.00%
Indeno(1,2,3-cd)pyrene	3.1	1.90E-04	-	-	-	-	-	-	-			-	-	-	-	-	**-**	-	-	-	-
Naphthalene	283	3.10E+01	4.68E-02	4.15E-02	1.50E+00	1.59E+00	1.51E-03	1.47E-04	5.29E-03	5.44E-03	1.51E-03	6.95E-03	2.88E+01	2.00E-01	-	-	**2.88E+01**	21.72%	2.11%	76.16%	100.00%
Phenanthrene	74	1.15E+00	2.48E-05	3.62E-03	4.04E-01	4.07E-01	2.16E-05	4.89E-05	5.45E-03	5.50E-03	2.16E-05	5.52E-03	3.62E+01	1.99E-01	2.48E-05	3.63E+01	**3.63E+01**	0.01%	0.89%	99.10%	100.00%
Phenol	390	8.28E+04	-	3.82E-03	1.28E-02	1.66E-02	-	9.78E-06	3.29E-05	4.27E-05		4.27E-05	2.34E+04	1.00E+00	-	-	**2.34E+04**	-	22.94%	77.06%	100.00%
Pyrene	28	1.35E-01	5.82E-06	2.74E-03	4.26E-01	4.29E-01	4.31E-05	9.78E-05	1.52E-02	1.53E-02	4.31E-05	1.54E-02	1.30E+01	1.99E-01	5.82E-06	1.31E+01	**1.31E+01**	0.00%	0.64%	99.36%	100.00%
Toluene	18	5.26E+02	1.63E-05	2.37E-04	5.70E-03	5.96E-03	9.06E-07	1.32E-05	3.17E-04	3.30E-04	9.06E-07	3.31E-04	7.55E+02	2.50E-01	4.77E-04	7.56E+02	**7.56E+02**	0.19%	3.98%	95.83%	100.00%
TPH C06-C09 aliphatic	74	1.18E+01	2.91E-06	4.34E-05	6.59E-03	6.64E-03	2.46E-07	5.87E-07	8.91E-05	8.97E-05	2.46E-07	8.99E-05	1.39E+03	1.25E-01	2.91E-06	1.39E+03	**1.39E+03**	0.00%	0.65%	99.34%	100.00%
TPH C10-C14 aliphatic	1730	9.99E-02	4.53E-07	5.08E-02	5.07E+01	5.08E+01	4.53E-06	2.94E-05	2.93E-02	2.93E-02	4.53E-06	2.93E-02	4.26E+00	1.25E-01	4.53E-07	4.26E+00	**4.26E+00**	0.00%	0.10%	99.90%	100.00%
TPH C10-C14 aromatic	1730	2.53E+01	5.73E-04	1.27E-01	1.26E+01	1.27E+01	2.26E-05	7.34E-05	7.27E-03	7.34E-03	2.26E-05	7.37E-03	1.70E+01	1.25E-01	-	-	**1.70E+01**	0.31%	1.00%	98.70%	100.00%
TPH C15-C28 aliphatic	1520	1.11E-04	7.18E-11	2.23E-03	8.74E-01	8.76E-01	6.47E-07	1.47E-06	5.75E-04	5.76E-04	6.47E-07	5.77E-04	2.17E+02	1.25E-01	7.18E-11	2.17E+02	**2.17E+02**	0.00%	0.25%	99.75%	100.00%
TPH C15-C28 aromatic	1520	1.06E+00	4.57E-05	1.49E-01	4.10E+01	4.11E+01	4.31E-05	9.78E-05	2.70E-02	2.71E-02	4.31E-05	2.71E-02	4.61E+00	1.25E-01	4.57E-05	4.62E+00	**4.62E+00**	0.04%	0.36%	99.60%	100.00%
TPH C29-C36 aliphatic	332	2.50E-06	1.62E-12	4.87E-04	1.67E-01	1.68E-01	6.47E-07	1.47E-06	5.04E-04	5.06E-04	6.47E-07	5.07E-04	2.47E+02	1.25E-01	1.62E-12	2.47E+02	**2.47E+02**	0.00%	0.29%	99.71%	100.00%
TPH C29-C36 aromatic	332	6.60E-03	-	3.25E-02	1.65E+01	1.65E+01	-	9.78E-05	4.96E-02	4.97E-02		4.97E-02	2.51E+00	1.25E-01	-	-	**2.51E+00**	-	0.20%	99.80%	100.00%
Xylenes (total)	6.7	1.06E+01	1.38E-04	1.10E-04	4.01E-03	4.25E-03	2.06E-05	1.64E-05	5.98E-04	6.14E-04	2.06E-05	6.35E-04	3.94E+02	2.42E-01	2.18E-04	4.07E+02	**4.07E+02**	0.09%	2.67%	97.25%	100.00%

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Groundwater RBSL Derivation - Non-Threshold Health Effects
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Chemical	Cgw	Solubility	Risk at Input Groundwater Concentration (ILCR)				Risk/Soil Concentration (i.e., pathway specific factor for exposure and toxicity)						RBSL (assumes no sol limit)	Risk at RBSL (with sol)	Revised RBSL (if necessary)	Adopted RBSL	Pathway Contributions to Total Estimated Risk at RBSL			
			GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	TOTAL (All Pathways)	GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	Total Non-Vapour Pathways	Total Vapour Pathways	TOTAL (All Pathways)					GW to Trench Vapour	Incidental Ingestion of GW	Dermal Contact with GW	TOTAL
	mg/L	mg/L	unitless	unitless	unitless	unitless	L/mg	L/mg	L/mg	L/mg	L/mg	L/mg	mg/L		mg/L	mg/L	%	%	%	%
Acenaphthene	4.4	3.90E+00	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Acenaphthylene	43	1.61E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Ammonia	350	4.82E+05	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Anthracene	15	4.34E-02	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Benz(a)anthracene	13	9.40E-03	-	2.34E-08	1.00E-05	1.00E-05	-	1.80E-09	7.70E-07	7.72E-07		7.72E-07			1.29E+01	**1.29E+01**	-	0.23%	99.77%	100.00%
Benzene	41	1.79E+03	1.59E-08	6.02E-08	6.94E-07	7.70E-07	3.88E-10	1.47E-09	1.69E-08	1.84E-08	3.88E-10	1.88E-08	5.32E+02	1.00E-05	-	**5.32E+02**	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Benzo(a)pyrene	9.3	1.62E-03	-	1.68E-07	5.38E-03	5.38E-03	-	1.80E-08	5.79E-04	5.79E-04		5.79E-04	1.73E-02	1.00E-05	-	**1.73E-02**	-	#VALUE!	#VALUE!	#VALUE!
Benzo(b)fluoranthene	8.3	1.50E-03	-	1.50E-08	4.83E-06	4.85E-06	-	1.80E-09	5.82E-07	5.84E-07		5.84E-07					-	#DIV/0!	#DIV/0!	#DIV/0!
Benzo(g,h,i)perylene	4.2	2.60E-04	-	7.57E-10	6.57E-07	6.57E-07	-	1.80E-10	1.56E-07	1.56E-07		1.56E-07			6.39E+01	**6.39E+01**	-	0.12%	99.88%	100.00%
Benzo(k)fluoranthene	3.7	8.00E-04	-	6.67E-09	3.57E-06	3.57E-06	-	1.80E-09	9.64E-07	9.66E-07		9.66E-07			1.03E+01	**1.03E+01**	-	0.19%	99.81%	100.00%
Dibenz(a,h)anthracene	0.82	2.49E-03	-	1.48E-08	1.09E-05	1.09E-05	-	1.80E-08	1.33E-05	1.33E-05		1.33E-05			#VALUE!		-	#VALUE!	#VALUE!	#VALUE!
Ethylbenzene	3.02	1.69E+02	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Fluoranthene	26	2.60E-01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Fluorene	21	1.69E+00	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	3.1	1.90E-04	-	5.59E-09	5.36E-06	5.37E-06	-	1.80E-09	1.73E-06	1.73E-06		1.73E-06			5.77E+00	**5.77E+00**	-	0.10%	99.90%	100.00%
Naphthalene	283	3.10E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Phenanthrene	74	1.15E+00	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Phenol	390	8.28E+04	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Pyrene	28	1.35E-01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Toluene	18	5.26E+02	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C06-C09 aliphatic	74	1.18E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C10-C14 aliphatic	1730	9.99E-02	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C10-C14 aromatic	1730	2.53E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C15-C28 aliphatic	1520	1.11E-04	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C15-C28 aromatic	1520	1.06E+00	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C29-C36 aliphatic	332	2.50E-06	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
TPH C29-C36 aromatic	332	6.60E-03	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-
Xylenes (total)	6.7	1.06E+01	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Summary of Derived RBSLs
Barangaroo
Wharf 8, Hickson Road (Sussex Street), Barangaroo, NSW 2000
Scenario 2 - Intrusive Maintenance (Risk Based Calculations using Knalfa CSF for Groundwater and Soil Risks) Scenario

Back to User Input Sheet

Chemical	Soil RBSLs (mg/kg)						Groundwater RBSLs (mg/L)					
	Adult Threshold	Child Threshold	Non-Threshold (Lifetime)	Adopted RBSL (Lowest)	Saturation Limited?	Site Concentration	Adult Threshold	Child Threshold	Non-Threshold (Lifetime)	Adopted RBSL (Lowest)	Solubility Limited?	Site Concentration
Acenaphthene	1.98E+04	-	-	**1.98E+04**	-	2.70E+02	6.05E+01	-	-	**6.05E+01**	-	4.40E+00
Acenaphthylene	1.98E+04	-	-	**1.98E+04**	-	1.00E+03	5.71E+01	-	-	**5.71E+01**	-	4.30E+01
Anthracene	9.90E+04	-	-	**9.90E+04**	-	1.20E+03	1.84E+02	-	-	**1.84E+02**	-	1.50E+01
Benz(a)anthracene	-	-	-	**-**	-	-	-	-				
Benzene	3.76E+02	-	3.08E+04	**3.76E+02**	-	6.10E+01	3.38E+00	-	5.32E+02	**3.38E+00**	-	4.10E+01
Benzo(a)pyrene	-	-	6.72E+01	**6.72E+01**	-	6.50E+02	-	-	1.73E-02	**1.73E-02**	-	9.30E+00
Benzo(b)fluoranthene	-	-	-	**-**	-	-	-	-			-	-
Benzo(g,h,i)perylene	-	-	-	**-**	-	-	-	-			-	-
Benzo(k)fluoranthene	-	-	-	**-**	-	-	-	-			-	-
Dibenz(a,h)anthracene	-	-	-	**-**	-	-	-	-			-	-
Ethylbenzene	-	-	-	**-**	-	-	2.11E+02	-	-	**2.11E+02**	-	3.02E+00
Fluoranthene	1.32E+04	-	-	**1.32E+04**	-	2.13E+03	1.14E+01	-	-	**1.14E+01**	-	2.60E+01
Fluorene	1.32E+04	-	-	**1.32E+04**	-	1.30E+03	3.16E+01	-	-	**3.16E+01**	-	2.10E+01
Indeno(1,2,3-cd)pyrene								-			-	-
Naphthalene	4.33E+03	-	-	**4.33E+03**	-	8.40E+03	2.88E+01	-	-	**2.88E+01**	-	2.83E+02
Phenanthrene	1.98E+04	-	-	**1.98E+04**	-	3.10E+03	3.63E+01	-	-	**3.63E+01**	-	7.40E+01
Phenol	-	-	-	**-**	-	-	2.34E+04	-	-	**2.34E+04**	-	3.90E+02
Pyrene	9.90E+03	-	-	**9.90E+03**	-	1.70E+03	1.31E+01	-	-	**1.31E+01**	-	2.80E+01
Toluene	-	-	-	**-**	-	-	7.56E+02	-	-	**7.56E+02**	-	1.80E+01
TPH C06-C09 aliphatic	-	-	-	**-**	-	-	1.39E+03	-	-	**1.39E+03**	-	7.40E+01
TPH C10-C14 aliphatic	6.45E+04	-	-	**6.45E+04**	-	5.40E+04	4.26E+00	-	-	**4.26E+00**	-	1.73E+03
TPH C10-C14 aromatic	2.57E+04	-	-	**2.57E+04**	-	5.40E+04	1.70E+01	-	-	**1.70E+01**	-	1.73E+03
TPH C15-C28 aliphatic	4.89E+05	-	-	**4.89E+05**	-	7.20E+04	2.17E+02	-	-	**2.17E+02**	-	1.52E+03
TPH C15-C28 aromatic	7.33E+03	-	-	**7.33E+03**	-	7.20E+04	4.62E+00	-	-	**4.62E+00**	-	1.52E+03
TPH C29-C36 aliphatic	-	-	-	**-**	-	-	2.47E+02	-	-	**2.47E+02**	-	3.32E+02
TPH C29-C36 aromatic	-	-	-	**-**	-	-	2.51E+00	-	-	**2.51E+00**	-	3.32E+02
Xylenes (total)	-	-	-	**-**	-	-	4.07E+02	-	-	**4.07E+02**	-	6.70E+00

Bold denotes soil/ groundwater SSTC has been proposed (see text for details)

Pathways included in derivation of Soil RBSL:

- x Incidental Ingestion of Soil
- x Dermal Contact with Soil
- x Inhalation of Soil-Derived Dust in Outdoor Air
- x Inhalation of Surface Soil-Derived Vapours in Outdoor Air

SSTL for carcinogenic PAH's is included in SSTL for BaP

Pathways included in derivation of Groundwater RBSL:

- x Incidental Ingestion of Groundwater (Bathing or Excavation)
- x Dermal Contact with Groundwater (Bathing or Excavation)
- x Inhalation of Groundwater Vapours (Where GW Enters Trench)