Site Audit Report
Remedial Works Plan, PPP Site, SICEEP

Prepared for:
Lend Lease Project Management & Construction (Australia)

Prepared by:
ENVIRON Australia Pty Ltd

Date:
March 2013

Project Number:
AS121550

Audit Number:
GN474A

ENVIRON

13 March 2013 Our Ref: AS121550

Lend Lease Project Management & Construction (Australia) Pty Ltd
Attn: Ron Meyer
30 The Bond, 30 Hickson Rd
Millers Point NSW 2000

Dear Ron

Re: Site Audit Report - Remedial Works Plan, PPP Site, SICEEP

I have pleasure in submitting the Site Audit Report for the subject site. The Site Audit Statement, produced in accordance with the NSW Contaminated Land Management Act 1997 follows this letter. The audit was commissioned by Lend Lease Project Management & Construction (Australia) Pty Ltd to ultimately assess the suitability of the site for its intended use.

This Site Audit Report is not currently required by regulation or legislation and is therefore a non-statutory audit.

Thank you for giving me the opportunity to conduct this Audit. Please call me on 9954 8100 if you have any questions.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

ENVIRON Australia Pty Ltd, Level 3, 100 Pacific Highway, PO Box 560, North Sydney, NSW 2060, Australia
Tel: +61 2 9954 8100 Fax: +61 2 9954 8150

ACN 095 437 442
ABN 49 095 437 442

www.environcorp.com

NSW Site Auditor Scheme
SITE AUDIT STATEMENT

A site audit statement summarises the findings of a site audit. For full details of the site auditor's findings, evaluations and conclusions, refer to the associated site audit report.

This form was approved under the* Contaminated Land Management Act 1997 *on 31st October 2012. For more information about completing this form, go to Part IV.

PART I: Site audit identification

Site audit statement no. GN 474 A

This site audit is a ~~**statutory audit**~~**/non-statutory audit*** within the meaning of the *Contaminated Land Management Act 1997*.

Site auditor details (as accredited under the *Contaminated Land Management Act 1997*)

Name: Graeme Nyland Company: ENVIRON Australia Pty Ltd

Address: Level 3, 100 Pacific Highway (PO Box 560)

North Sydney NSW Postcode: 2060

Phone: 02 9954 8100 Fax: 02 9954 8150

Site details

Address: Public Private Partnership Area, Darling Harbour, NSW (see attachment at end of Part I of this statement).

Postcode: 2000

Property description *(attach a list if several properties are included in the site audit)*

Lot	Deposited Plan	Address	Area
Part 1010	1147364	1 Darling Drive, Sydney	Sydney Convention and Exhibition Centre area
Part Lot 2	1048307	31 Harbour Street, Sydney (air space over and area around overpass)	Air space over and area around Western Distributer overpass
Part 900	1132344	-	Tumbalong Park area
901	1132344	1B Harbour Street, Sydney	Small portion of Tumbalong Park area
Part 200	1165804	5000 Pier Street, Haymarket	Residue Pier Street underbridge
Part 1	612907	41 Lackey Street, Haymarket	Southern edge of Pier Street area
Part 602	1009796	-	Darling Drive area
Part 33	870306	-	Darling Drive area

Strike out as appropriate

Local Government Area:	City of Sydney
Area of site (e.g. hectares):	17.2 Ha
Current zoning:	The site is affected by the Darling Harbour Development Plan No. 1 which is deemed a State Environment Planning Policy under the EP&A Act

To the best of my knowledge, the site ~~**is/**~~**is not*** the subject of a declaration, order, agreement or notice under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.

Declaration/Order/Agreement/Proposal/Notice* no(s): N/A

Strike out as appropriate

Site audit commissioned by

Name: Ron Meyer

Company: Lend Lease Project Management & Construction (Australia) Pty Ltd (Lend Lease)

Address: The Bond, 30 Hickson Rd, Millers Point NSW Australia

Postcode: 2000

Phone: 9277 2069 Fax: 9383 8139

Name and phone number of contact person (if different from above)

N/A

Purpose of site audit

~~☐ A. To determine land use suitability *(please specify intended use[s])*~~

~~...~~

~~**OR**~~

☑ B(i) To determine the nature and extent of contamination, and~~/or~~

☑ B(ii) To determine the appropriateness of an ~~investigation/remedial action~~/management plan*, and/~~or~~

☑ B(iii) To determine if the land can be made suitable for a particular use or uses by implementation of a specified ~~remedial action plan/~~management plan* (please specify intended use[s]):

Commercial/industrial and open space

Information sources for site audit

Consultancy(ies) which conducted the site investigation(s) and/or remediation

- Coffey Geotechnics Pty Ltd (Coffey)
- Coffey Environments Australia Pty Ltd (Coffey)
- AECOM Australia Pty Ltd (AECOM)

Title(s) of report(s) reviewed:

- 'Contamination Investigation, Sydney International Convention and Entertainment Centre,' 23 August 2011, Coffey
- 'Geotechnical Investigation, Proposed Sydney International Conference Exhibition and Entertainment Precinct (SICEEP), Darling Harbour,' 25 May 2012, Coffey.
- 'Stage 2 – Detailed Site Investigation, Sydney International Conference Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney,' 1 June 2012, Coffey.
- 'Stage 1 – Preliminary Environmental Investigation, Sydney International Conference Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney,' 8 June 2012, Coffey.
- 'Supplementary Site Investigation, Sydney International Conference Exhibition and Entertainment Precinct, Darling Harbour,' 17 August 2012, Coffey.

Strike out as appropriate

- ‘SICEEP SAQP Summary’, Revision 01, 22 October 2012, AECOM.
- ‘Draft Human health and Ecological Risk Assessment, Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP)’, Revision A, 25 January 2013, AECOM.
- ‘Supplementary Site Investigation: Factual Report, Sydney International Conference Exhibition and Entertainment Precinct, Darling Harbour,’ 30 January 2013, Coffey.
- ‘Draft Human health and Ecological Risk Assessment, Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP) – PPP Sector ’, 5 February 2013 Revision B, AECOM.
- ‘Draft Remedial Works Plan, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Revision C, 25 February 2013, AECOM.
- ‘Draft Sampling Analysis and Quality Plan’, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Revision C, 25 February 2013, AECOM.
- ‘Draft Remedial Works Plan, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, 1 March 2013, AECOM.
- ‘Draft Human Health and Ecological Risk Assessment, Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP) – PPP Sector ’, 4 March 2013, AECOM.
- ‘Remedial Works Plan, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Final. 11 March 2013, AECOM.
- ‘Sampling Analysis and Quality Plan’, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Final, 11 March 2013, AECOM (included as Appendix B to the RWP).
- ‘Human Health and Ecological Risk Assessment, Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP) – PPP Sector ’, Final, 11 March 2013, AECOM.

Other information reviewed (including previous site audit reports and statements relating to the site)

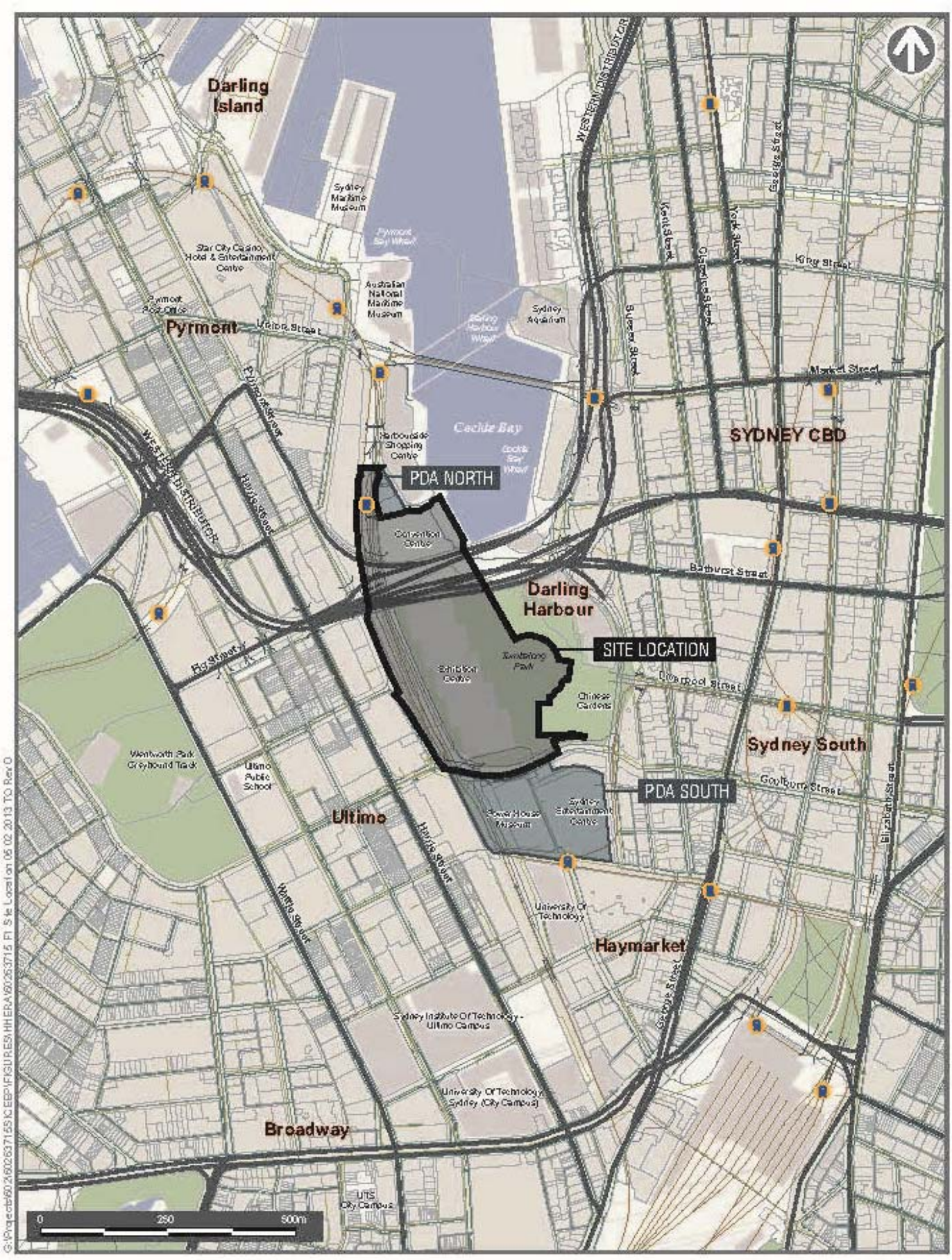
N/A

Site audit report

Title:… Site Audit Report – Remedial Works Plan, PPP Site, SICEEP

Report no. GN 474 A (ENVIRON Ref: AS121550) Date: March 2013

Strike out as appropriate



AECOM

SITE LOCATION

Human Health and Ecological Risk Assessment
Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct
Darling Harbour, New South Wales

FIGURE 1

PART II: Auditor's findings

Please complete either Section A or Section B, **not** both. *(Strike out the irrelevant section.)*

Use Section A where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land use(s).

Use Section B where the audit is to determine the nature and extent of contamination and/or the appropriateness of an investigation or remedial action or management plan and/or whether the site can be made suitable for a specified land use or uses subject to the successful implementation of a remedial action or management plan.

~~Section A~~

❑ **I certify that, in my opinion, the site is SUITABLE for the following use(s)** *(tick all appropriate uses and strike out those not applicable)*:

- ❑ Residential, including substantial vegetable garden and poultry
- ❑ Residential, including substantial vegetable garden, excluding poultry
- ❑ Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry
- ❑ Day care centre, preschool, primary school
- ❑ Residential with minimal opportunity for soil access, including units
- ❑ Secondary school
- ❑ Park, recreational open space, playing field
- ❑ Commercial/industrial
- ❑ Other *(please specify)* ……

subject to compliance with the following environmental management plan *(insert title, date and author of plan)* **in light of contamination remaining on the site: …**

OR

❑ **I certify that, in my opinion, the site is NOT SUITABLE for any use due to the risk of harm from contamination.**

Overall comments…

Section B

Purpose of the plan[1] which is the subject of the audit, with respect to the site audit is:

- Provide a framework to manage the known contamination in fill and the uncertainty in distribution of contamination in fill and groundwater to ensure that the site is made suitable for the proposed use.

I certify that, in my opinion:

☑ **the nature and extent of the contamination HAS/~~HAS NOT~~* been appropriately determined**

AND/~~OR~~

☑ **the ~~investigation/remedial action plan/~~management plan* IS/~~IS NOT~~* appropriate for the purpose stated above**

AND/~~OR~~

☑ **the site CAN BE MADE SUITABLE for the following uses (tick all appropriate uses and strike out those not applicable):**

- ☐ ~~Residential, including substantial vegetable garden and poultry~~
- ☐ ~~Residential, including substantial vegetable garden, excluding poultry~~
- ☐ ~~Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry~~
- ☐ ~~Day care centre, preschool, primary school~~
- ☐ ~~Residential with minimal opportunity for soil access, including units~~
- ☐ ~~Secondary school~~
- ☑ Park, recreational open space, playing field
- ☑ Commercial/industrial
- ☐ ~~Other *(please specify)* ……~~

if the site is remediated/managed* in accordance with the following remedial action plan/management plan* *(insert title, date and author of plan)*

- 'Remedial Works Plan, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW', Final, 11 March 2013, AECOM Australia Pty Ltd, including the 'Sampling Analysis and Quality Plan' included as Appendix B of the Remedial Works Plan.

subject to compliance with the following condition(s):

- Preparation of a Section A Site Audit Statement at the completion of the management and any remedial measures certifying that the site is suitable for the proposed use.

[1] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

Overall comments

Key elements have been incorporated in the remedial works plan that are integral to the ultimate objective of certifying the suitability for the site for the proposed commercial/industrial and open space land uses (Section A Site Audit Statement).

The key elements are:

- Appropriate identification of contaminant conditions that vary in nature or extent to the contamination that has currently been characterised.
- Appropriate response to the above including remediation or management if/where necessary
- Appropriate assessment of site won soils that are to be reused at the surface or in service trenches.
- Validation of in situ soils where they remain near the surface in open space and accessible areas
- Further assessment of groundwater conditions to provide a more robust data base for assessing potential risks to offsite ecological receptors

The outcome of these key elements will need to be provided in a validation report to an EPA accredited auditor for audit prior to preparation of a Section A Site Audit Statement.

PART III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority under the *Contaminated Land Management Act 1997* (Accreditation No. 9808).

I certify that:

- I have completed the site audit free of any conflicts of interest as defined in the *Contaminated Land Management Act 1997,* and
- with due regard to relevant laws and guidelines, I have examined and am familiar with the reports and information referred to in Part I of this site audit, and
- on the basis of inquiries I have made of those individuals immediately responsible for making those reports and obtaining the information referred to in this statement, those reports and that information are, to the best of my knowledge, true, accurate and complete, and
- this statement is, to the best of my knowledge, true, accurate and complete.

I am aware that there are penalties under the *Contaminated Land Management Act 1997* for wilfully making false or misleading statements.

Signed...  Date... 13/3/2013

PART IV: Explanatory notes

To be complete, a site audit statement form must be issued with all four parts.

How to complete this form

Part I identifies the auditor, the site, the purpose of the audit and the information used by the auditor in making the site audit findings.

Part II contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remedial action or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use(s) of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A or Section B of Part II, **not** both.

In **Section A** the auditor may conclude that the land is *suitable* for a specified use(s) OR *not suitable* for any beneficial use due to the risk of harm from contamination.

By certifying that the site is *suitable*, an auditor declares that, at the time of completion of the site audit, no further remediation or investigation of the site was needed to render the site fit for the specified use(s). Any **condition** imposed should be limited to implementation of an environmental management plan to help ensure the site remains safe for the specified use(s). The plan should be legally enforceable: for example a requirement of a notice under the *Contaminated Land Management Act 1997* (CLM Act) or a development consent condition issued by a planning authority. There should also be appropriate public notification of the plan, e.g. on a certificate issued under s.149 of the *Environmental Planning and Assessment Act 1979*.

Auditors may also include **comments** which are key observations in light of the audit which are not directly related to the suitability of the site for the use(s). These observations may cover aspects relating to the broader environmental context to aid decision-making in relation to the site.

In **Section B** the auditor draws conclusions on the nature and extent of contamination, and/or suitability of plans relating to the investigation, remediation or management of the land, and/or whether land can be made suitable for a particular land use or uses upon implementation of a remedial action or management plan.

By certifying that a site *can be made suitable* for a use or uses if remediated or managed in accordance with a specified plan, the auditor declares that, at the time the audit was completed, there was sufficient information satisfying guidelines made or approved under the CLM Act to determine that implementation of the plan was feasible and would enable the specified use(s) of the site in the future.

For a site that *can be made suitable*, any **conditions** specified by the auditor in Section B should be limited to minor modifications or additions to the specified plan. However, if the auditor considers that further audits of the site (e.g. to validate remediation) are required, the auditor must note this as a condition in the site audit statement.

Auditors may also include **comments** which are observations in light of the audit which provide a more complete understanding of the environmental context to aid decision-making in relation to the site.

In **Part III** the auditor certifies his/her standing as an accredited auditor under the CLM Act and makes other relevant declarations.

Where to send completed forms

In addition to furnishing a copy of the audit statement to the person(s) who commissioned the site audit, statutory site audit statements must be sent to:

EPA (NSW)
Contaminated Sites Section
PO Box A290, SYDNEY SOUTH NSW 1232
nswauditors@epa.nsw.gov.au

AND

the **local council** for the land which is the subject of the audit.

Contents

List of Tables and Figures

List of Appendices

List of Abbreviations

ACM	Asbestos Containing Material
AECOM	AECOM Australia Pty Ltd
AHD	Australian Height Datum
ALS	Australian Laboratory Services
ANZECC	Australian and New Zealand Environment and Conservation Council
ARC	Asbestos Removal Contractor
ASET	Australian Safer Environment and Technology Pty Ltd. (Laboratory)
ASLP	Australian Standard Leaching Procedure
AASS	Actual Acid Sulphate Soils
ASS	Acid Sulphate Soils
BACM	Bonded Asbestos Cement Sheet
BaP	Benzo(a)pyrene
BGL	below ground level
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes (Monocyclic Aromatic Hydrocarbons)
CCMR	Construction Contamination Management Report
CLM Act	NSW Contaminated Land Management Act 1997
CN	Cyanide (total or free)
COC	Chain of Custody
Council	City of Sydney Council
CT	Certificate of Title
DA	Development Application
DAF	Dilution Attenuation Factor
DEC	Department of Environment and Conservation (former)
DECCW	Department of Environment, Climate Change and Water (former)
DP	Deposited Plan
DQI	Data Quality Indicator
DQO	Data Quality Objective
EC	Electrical Conductivity
EMP	Environmental Management Plan
Envirolab	Envirolab Services Pty Ltd
EP&A Act	Environmental Planning and Assessment ACT 1979
EPA	Environment Protection Authority (NSW)
ESA	Environmental Site Assessment report
GME	Groundwater Monitoring Event
HHERA	Human Health and Ecological Risk Assessment
HIL	Health Investigation Level
HSL	Health Screening Level
ha	Hectare
km	Kilometres
LOR	Limit of Reporting
m	Metres
MAH	Monocyclic Aromatic Hydrocarbons
Mercury	Inorganic mercury unless noted otherwise
Metals	As: Arsenic, Cd: Cadmium, Cr: Chromium, Cu: Copper, Ni: Nickel, Pb: Lead, Zn: Zinc, Hg: Mercury
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
mbgl	Metres below ground level
µg/L	Micrograms per Litre
NATA	National Association of Testing Authorities
NC	Not Calculated
ND	Not Detected
ng/L	Nanograms per Litre
NEHF	National Environmental Health Forum
NEPM	National Environment Protection Measure

NHMRC	National Health and Medical Research Council
n	Number of Samples
NSW	New South Wales
OCPs	Organochlorine Pesticides
OEH	Office of Environment and Heritage
OH&S	Occupational Health & Safety
OCPs	Organochlorine Pesticides
OPPs	Organophosphorus Pesticides
PASS	Potential0020Acid Sulphate Soils
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
pH	a measure of acidity, hydrogen ion activity
PDA	Project Delivery Agreement
PID	Photoionisation Detector
ppm	Parts Per Million
PPP	Public Private Partnership
PQL	Practical Quantitation Limit
PSH	Phase Separated Hydrocarbon
QA/QC	Quality Assurance/Quality Control
RAP	Remediation Action Plan
RPD	Relative Per Cent Difference
RWP	Remedial Works Plan
RfC	Reference Concentrations
SAQP	Sampling Analysis and Quality Plan
SAR	Site Audit Report
SAS	Site Audit Statement
SCEC	Sydney Convention and Exhibition Centre
SICEEP	Sydney International Conference Exhibition and Entertainment Precinct
SILs	Soil Investigation Levels
SVOCs	Semi Volatile Organic Compounds
SWL	Standing Water Level
TCLP	Toxicity Characteristic Leaching Procedure
TPHs	Total Petroleum Hydrocarbons
TV	Trigger Value
UCL	Upper Confidence Limit
UST	Underground Storage Tank
USEPA	United States Environment Protection Agency
VENM	Virgin Excavated Natural Material
VMP	Voluntary Management Proposal
VHCs	Volatile Halogenated Hydrocarbons
VOCs	Volatile Organic Compounds
-	On tables is "not calculated", "no criteria" or "not applicable"

1 Introduction

1.1 Background

A site contamination audit has been conducted in relation to part of the site known as the proposed Sydney International Conference Exhibition and Entertainment Precinct (SICEEP) at Darling Harbour, Sydney NSW. The site locality is shown on Attachment 1, Appendix A.

The SICEEP site is approximately 19.62 ha and has been divided into two development areas as follows:

- Public Private Partnership (PPP) Sector: includes current Sydney Convention Centre, Sydney Exhibition Centre and public areas including Tumbalong Park (approximately 17.2 ha).
- Project Delivery Agreement (PDA) Sector: This area is divided into PDA South (Entertainment Centre, car park rail corridor and Darling Drive) and PDA North (hotel precinct).

This audit covers the PPP Sector only, "the site" for the purpose of this audit. The PPP site layout is shown on Attachment 2, Appendix A.

The audit was conducted to ultimately provide an independent review by an EPA Accredited Auditor of whether the land is suitable for any specified use or range of uses. However, this initial stage of the audit was conducted to review the suitability and appropriateness of a plan of management as defined in Section 4 (1) (b) (v) of the NSW Contaminated Land Management Act 1997 (the CLM Act).

Details of the audit are:

Requested by: Ron Meyer on behalf of Lend Lease Project Management & Construction (Australia) Pty Ltd (Lend Lease)

Request/Commencement Date: 16 October 2012

Auditor: Graeme Nyland

Accreditation No.: 9808

The scope of the audit included:

- Review of the following reports:
  - 'Contamination Investigation, Sydney International Convention and Entertainment Centre,' 23 August 2011, Coffey Environments Australia Pty Ltd (Coffey)
  - 'Geotechnical Investigation, Proposed Sydney International Conference Exhibition and Entertainment Precinct (SICEEP), Darling Harbour,' 25 May 2012, Coffey.
  - 'Stage 2 – Detailed Site Investigation, Sydney International Conference Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney,' 1 June 2012, Coffey.
  - 'Stage 1 – Preliminary Environmental Investigation, Sydney International Conference Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney,' 8 June 2012, Coffey.

- ‘Supplementary Site Investigation, Sydney International Conference Exhibition and Entertainment Precinct, Darling Harbour,’ 17 August 2012, Coffey.
- ‘SICEEP SAQP Summary’, Revision 01, 22 October 2012, AECOM Australia Pty Ltd (AECOM).
- ‘Draft Human health and Ecological Risk Assessment, Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP)’, Revision A, 25 January 2013, AECOM.
- ‘Supplementary Site Investigation: Factual Report, Sydney International Conference Exhibition and Entertainment Precinct, Darling Harbour,’ 30 January 2013, Coffey.
- ‘Draft Human health and Ecological Risk Assessment, Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP) – PPP Sector ’, 5 February 2013 Revision B, AECOM.
- ‘Draft Remedial Works Plan, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Revision C, 25 February 2013, AECOM.
- ‘Sampling Analysis and Quality Plan’, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Revision C, 25 February 2013, AECOM.
- ‘Draft Remedial Works Plan, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, 1 March 2013, AECOM.
- ‘Draft Human Health and Ecological Risk Assessment, Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP) – PPP Sector ’, 4 March 2013, AECOM.
- ‘Remedial Works Plan, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Final. 11 March 2013, AECOM (“the RWP”).
- ‘Sampling Analysis and Quality Plan’, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Final, 11 March 2013, AECOM (“the SAQP”) (included as Appendix B to the RWP).
- ‘Human Health and Ecological Risk Assessment, Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP) – PPP Sector ’, Final. 11 March 2013, AECOM (“the HHERA”).

- A site visit was conducted by the Auditor on 12 March 2013.
- Discussions with Lend Lease and with AECOM. AECOM has prepared the HHERA and the RWP based on data collected by Coffey. No discussions have been held with Coffey.

1.2 The Audit Team

The audit team is summarised in Table 1.1.

Table 1.1: Audit Team

Role	Company	Details
Site Auditor	Environ	Graeme Nyland
Audit Assistant	Environ	Xanthe Holford
Expert Support (Risk Assessment)	Environ	Emma Struik
Expert Support (Risk Assessment)	Environmental Risk Sciences Pty Ltd	Jackie Wright, Therese Manning

2 Site Details

2.1 Location

The site locality is shown on Attachment 1, Appendix A.

The site details are as follows:

Street address: Darling Harbour, NSW 2000

Identifier: See Table 2.1

Table 2.1: Site Identification

Lot	Deposited Plan	Address	Area
Part 1010	1147364	1 Darling Drive, Sydney	Sydney Convention and Exhibition Centre area
Part Lot 2	1048307	31 Harbour Street, Sydney (air space over and area around overpass)	Air space over and area around Western Distributer overpass
Part 900	1132344	-	Tumbalong Park area
901	1132344	1B Harbour Street, Sydney	Small portion of Tumbalong Park area
Part 200	1165804	5000 Pier Street, Haymarket	Residue Pier Street underbridge
Part 1	612907	41 Lackey Street, Haymarket	Southern edge of Pier Street area
Part 602	1009796	-	Darling Drive area
Part 33	870306	-	Darling Drive area

Local Government: City of Sydney

Owner: NSW Government

Site Area: 17.2 ha approximately

The PPP site is bounded by Darling Drive to the west; Pier Street followed by the PDA South site (including Sydney Entertainment Centre) to the south; Cockle Bay, Chinese Garden of Friendship and Darling Quarter followed by Harbour Street to the east; and the PDA North site and the Harbourside Shopping Centre to the north.

The site boundaries are generally not well defined on the ground.

2.2 Zoning

The site is affected by the Darling Harbour Development Plan No. 1 which is deemed a State Environmental Planning Policy under the Environmental Planning and Assessment Act 1979 (EP&A Act).

2.3 Adjacent Uses

The site is located within the Darling Harbour entertainment area and is surrounded by commercial, retail, residential and open space uses. The PDA South and PDA North sites are located adjacent to the site in the south (on the other side of Pier Street) and north respectively.

Cockle Bay adjoins the north east side of the site in the northern portion of the site.

2.4 Site Condition

The site contains the Sydney Convention Centre in the north and Sydney Exhibition Centre in the south (in combination referred to as Sydney Convention and Exhibition Centre - SCEC), separated by the elevated Western Distributor. The eastern side of the site is public open space including Tumbalong Park.

Coffey notes that where the public open space is paved it is via a combination of concrete, asphalt and brick paving. Onsite vegetation consist of managed landscaping including mature trees within designated tree pits around various perimeters of the buildings and through the open space areas. Tumbalong Park is located in the central eastern part of the site and comprises grassed public open space and scattered garden and flower beds. At the time of the site visit there were bare patches in the grass cover.

Coffey notes that the site is essentially flat. The auditor notes there are local level changes associated with construction of landscaping and building features.

Details of the current infrastructure, such as the presence of basements were generally not provided in the reviewed reports. The Remedial Works Plan (RWP) (AECOM 2013) indicates that a partial basement (undercroft) car park was constructed beneath the Sydney Exhibition Centre. During the site visit by the Auditor it was noted that the car park was generally at ground level with some areas built up from the surrounding ground level and some areas lower than the surrounding ground level.

During the site visit by the Auditor it was noted that structures were present beneath some parts of the Sydney Exhibition Centre (e.g. plant rooms) including on the eastern side where the ground floor of the building was elevated above the surrounding grade. Access was not available to these structures and it was not clear whether they also extended below surrounding grade (i.e. partial basements).

2.5 Proposed Development

The site is being developed as the Sydney International Conference Exhibition and Entertainment Precinct (SICEEP). The development will include redevelopment of the SCEC buildings as follows:

- Demolition of existing improvements on the site, including the existing Sydney Convention Centre (part) and the Sydney Exhibition Centre (however, the slabs and below ground infrastructure will remain).

- Construction of new buildings and refurbishment of selected existing buildings. The proposed development works will involve construction of slab on grade commercial buildings which will be built on top of the existing concrete slabs. Basement bulk excavation works will not be required.
- Some relatively shallow trenches will be excavated for the installation of utilities.
- The development may also include:
  - Ground level or undercroft parking within the SCEC facilities.
  - Reconfiguration of access points, loading areas and the local road network
  - Bridges and elevated structures linking the SICEEP to neighbouring areas and facilities
  - Multi storey hotel and commercial buildings
  - Public domain improvements (e.g. reinvigorating and expanding Tumbalong Park; pedestrian connections; integrated art, play zones, water play and recreation areas; retail kiosks; etc.)
  - Extensive hard and soft landscaping of public areas within the SICEEP
  - Associated tree removal and replanting.

For the purposes of this audit, the 'commercial/industrial' and 'recreational open space' land use scenarios will be assumed.

Land uses under the proposed development are shown on Attachment 2, Appendix A.

2.6 Proposed Earthworks

Future redevelopment earthworks will consist of:

- Bored piers extending to the depth of rock for the installation/construction of foundation/piles and lift piles.
- Relatively shallow excavations for the installation of utilities (i.e. 1-2 m deep), strip footings and pile caps. Where possible, the existing services will be reused (i.e. stormwater culverts and sewer mains). Although some new service trenches will be required .
- Minor cut and fill of soils at the proposed "Public Realm" landscape area that is currently occupied by Tumbalong Park.
- Redevelopment works will generate approximately 26,000 m^3 of soil that that can potentially be reused on-site or will require offsite disposal.
- Redevelopment works may require the importation of fill materials for possible re-levelling works at Tumbalong Park.
- Construction is to be at grade (utilising exiting slabs) with no further basement excavations (excluding the minor cut and fill activities).

3 Site History

Coffey provided a site history based on historical parish maps, aerial photographs, planning certificates, review of the Contaminated Land Register, search of the NSW WorkCover Licenses to Keep Dangerous Goods Database, and site walk over. The site history is summarised in Table 3.1.

Table 3.1: Site History

Date	Activity
Late 19th and early 20th centuries	Progressive reclamation
Pre 1942 - 1980s	Railway and port related infrastructure including railway sidings, sheds and associated buildings and wharves
1986 - present day	Development of Darling Harbour including current public uses

The RWP (AECOM 2013) indicates that the PPP site was predominantly covered by (railway) goods sheds which were demolished to construct the current Convention Centre, Exhibition Centre and Tumbalong Park. No supporting documentation was provided in the RWP. Historical aerial photographs provided in the Coffey (8 June 2012) Stage 1 report show large sheds.

As part of the development a partial basement car park was constructed beneath the Exhibition Centre. AECOM then say "it is reasonable to assume that that much of the historic fill in this area was likely removed at this time. In summary the presence of the goods shed and the likely removal of bulk fill has resulted in less impact at the PPP site…". No evidence was provided to support this. The Auditor notes substantial fill is apparent in bore logs and it is understood that the basement is an "undercroft", so it is not clear how much fill was actually "bulk" excavated. It is also noted that the basement footprint doesn't cover the whole site.

The former Ultimo Power Station was located adjacent to the western boundary of the site and operated from 1900 to 1961.

In the Auditor's opinion, the site history provides an adequate indication of past activities for the purpose of the studies completed. Uncertainties include:

- Knowledge regarding filling history is limited but is likely to have occurred over a period of time prior to and during the establishment of the goods yard between the 1880s and 1950s.
- Knowledge regarding the potential use of fill materials sourced former the former Ultimo Power Station.
- Knowledge regarding the existence and/or location of potential above ground or underground fuel storage across the site is limited. Coffey (1 June 2012) stated "Information regarding the possible existence of underground fuel or chemical storage tanks was not available for the SCEC part of the study site…the presence on the site of this common potential contamination source remains uncertain and must not be

disregarded.“ Also, (Coffey 8 June 2012) stated “there was potential for small quantity storage of diesel for use in emergency generators across the site. However, access to all areas of the site was not possible during the walk over and this was unable to be confirmed”.

- Knowledge of the location and nature of specific railway workshop activities was limited and generally not provided in the reports reviewed with the exception of the RWP (AECOM 2013) that indicates the PPP site was largely goods sheds.
- Construction details for existing buildings was limited and generally not provided in the reports reviewed (such as presence of basement facilities) with the exception of the RWP (AECOM 2013) which indicates that a partial basement car park was constructed beneath the Exhibition Centre.

The uncertainties in relation to the site history were considered by the Auditor when drawing conclusions in relation to evidence of contamination at the site and the proposed management approach.

4 Contaminants Of Concern

The Coffey reports listed the contaminants of concern and potentially contaminating activities across both the PPP and PDA sites. These have been reviewed by the Auditor and summarised in Table 4.1.

Table 4.1: Contaminants of Concern

Area	Activity	Potential Contaminants (identified by Auditor based on Coffey reports)
Whole site	Railway and associated ancillary activities	Metals, asbestos, fuels, lubrication oils (TPH, BTEX, PAHs), herbicides, pesticides, other organic contaminants (e.g. VOCs, VHCs, SVOCs)
Whole site	Filling from unknown sources (may include material from the former Ultimo Power Station)	Metals, asbestos, fuels, lubrication oils (TPH, BTEX, PAHs), combustion products such as clinker and ash (TPH, PAHs, metals), acid sulphate soils, other organic contaminants (e.g. VOCs, VHCs, SVOCs)
Fenced compound beneath Pier street overpass	Storage of maintenance equipment, vehicles and small plant associated with control and administration of the Darling Harbour precinct	Metals, fuels, lubrication oils (TPH, BTEX, PAHs).
Localised parts of the site (unspecified)	Current uses. Some potential for small quantity storage of diesel for us in emergency generators (unconfirmed)	Metals, fuels, lubrication oils (TPH, BTEX, PAHs).

The contaminants of concern and the analyte list used by Coffey are consistent with the potential contaminants listed in Table 4.1. The Auditor considers that the analyte list used by Coffey adequately reflects the site history and condition and generally considers the uncertainties identified in Section 3.

5 Stratigraphy and Hydrogeology

Following a review of the reports provided, a summary of the site stratigraphy and hydrogeology across both the PPP and PDA sites was compiled as summarised in the following sections.

5.1 Stratigraphy

Coffey (May 2012) presented geotechnical cross sections of the subsurface conditions. The sub-surface profile of the site is summarised in Table 5.1.

Table 5.1: Sub-surface profile

Material/Origin	Depth to top of Unit (m)	Thickness of Unit (m)	Elevation at Top of Unit (mAHD)
Fill The fill generally comprised a heterogeneous mix of sand, sandy gravel, clay and gravelly sand, gravelly clay and/or gravelly clayey sand. Orange brick fragments or orange or cream sandstone fragments were commonly noted on logs through the fill. The gravels comprise grey to dark grey rock with some igneous fragments. Cobbles and occasional boulder sized fragments were observed. Other less common anthropogenic inclusions observed within the fill comprised discrete ash layers or ashy fill, concrete, brick, glass, porcelain/ceramic, and metal fragments. Gravel logged as “ballast” underlying concrete was observed beneath the and Sydney Exhibition Centre building. Surface cover of concrete and asphalt materials at most locations.	0	0.4 to 14.5	2.3 to 5.4
Alluvium/Estuarine Clayey sands and clays with occasional shell layers and organic matters.	0.4 to 14.5	1.5 to 14.3 (where proven)	0 to -10.6
Residual Soil Clayey sand or sandy clay derived from weathering of underlying sandstone.	1.4 to 14.7	0.4 to 5.3	1.4 to -117
Hawkesbury Sandstone	0.3 to 23.5	Not Proven	2.7 to -13.2

The reported thickness of fill materials across the site ranges from 0.5m to 14.5 m across the centre of the site (and was generally greater than 2 m at the locations tested). The fill materials appear to thin towards the west and south. The thickest fill recorded (14.5 m) was at NBH14 in the central eastern portion of the larger SICEEP site (PPP and PDA sites). The Auditor notes that the fill in some of the closest boreholes adjacent to NBH14 in the central

eastern portion of the site (e.g. NBH/MW13, NB12, BH108, BH108A) was not penetrated (up to approximately 6 m).

The Auditor notes it is likely that filling has occurred in stages or during progressive reclamation. This may have resulted in “generations” or types of fill in different areas/depths. However, no distinctions in relation to fill materials have been identified by the consultant. The Auditor notes that there were variations between logging events in drilling and sampling techniques and changes in field personnel that should be considered when comparing logging data.

The Coffey (May 2012) Geotechnical Investigation also noted the presence of a north-west to south-east orientated igneous intrusion known regionally as the “Great Sydney Dyke” running through the site. The dyke consisted of extremely weathered dolerite with stiff clay properties.

Overall, the Auditor is of the opinion that the stratigraphy is adequately characterised for the purpose of this audit.

5.2 Hydrogeology

Groundwater at the site is expected to flow to the north towards Cockle Bay. Groundwater levels would be expected to be tidal and reflect the level in the vicinity of Cockle Bay.

Groundwater levels were measured by Coffey (August 2011) in three wells (BH1, BH12 and BH13) at depths between 1.98 and 4.5 m with tidal fluctuations of approximately 1 m between separate sampling events in specific wells. Comparable depths were recorded during the subsequent monitoring events (sampling in May 2012, August 2012, January 2013). Similarly, groundwater inflow was observed by Coffey (in May 2012) between depths of 2 m and 5 m during drilling depending on the ground elevation and tidal level over the course of the works.

Coffey (August 2011) stated that the observed water levels indicated flow to the north which was consistent with the expected flow direction.

5.3 Acid Sulphate Soils

Coffey (August 2011) states that review of the acid sulphate soil risk maps presented on the Austral Resource Information website indicate a low probability of the presence of acid sulphate soils beneath the site. The maps however indicate there is a high probability of ASS in the sediments of Darling Harbour and Sydney Harbour. There is evidence that the site and surrounds have been reclaimed using harbour sediment possibly along with other sources of fill material. As such, it is possible that fill material at the site could contain ASS.

6 Evaluation of Quality Assurance and Quality Control

6.1 Data sources

The Auditor has assessed the overall quality of the data by review of the information presented in the referenced reports. The data sources are summarised in Table 6.1

Table 6.1: Summary of Investigations

Investigation and Reporting	Field Investigations	Analytical data obtained
Coffey (August 2011) Contamination Investigation	No investigations within the PPP site (all PDA).	Nil
Coffey (May 2012) Geotechnical Investigation	Geotechnical investigations 22 boreholes (NBH1 to NBH7, NBH9 to NBH22, NBH28) One borehole (NBH8) offsite (east) Five boreholes converted to groundwater monitoring wells (NBH5, NBH11 (dry), NBH13, NBH16, NBH20) One offsite borehole converted to a groundwater monitoring well offsite (NBH8)	No laboratory data relevant to contamination. Groundwater level data Geotechnical borehole logs and cross sections compiled
Coffey (1 June 2012) Stage 2 – Detailed Site Investigation	Utlised the 22 geotechnical investigation locations of Coffey (May 2012) (excluding NBH9 and NBH14)	Two to five samples per location analysed Approximately 61 soil samples (TPH, BTEX, metals, PAHs): • Approximately 27 samples (asbestos) (fill only) • Three soil samples (fill) and one soil sample (alluvium) (PCBs, VOCs, SVOCs, OCPs and/or OPPs) • Six soil samples (from alluvium) were field screened (by the laboratory) for ASS • TCLP for waste characterisation on six soil samples (based on laboratory results) plus one from offsite. Five groundwater samples (NBH5, NBH11 (dry, no sample), NBH13, NBH16, NBH20 and NBH8 (offsite)) (metals, TPH, BTEX and PAH). EC, pH (laboratory)

Table 6.1: Summary of Investigations

Investigation and Reporting	Field Investigations	Analytical data obtained
Coffey (8 June 2012) Stage 1 – Preliminary Environmental Investigation	Site walkover and desktop review across PPP and PDA sites.	Nil (desktop only)
Coffey (August 2012) Supplementary Site Investigation	Four auger drilled boreholes (CBH1 to CBH4); plus one bore on boundary of PPP and PDA sites CBH6 Objective to further characterise the extent of impact within an areas of concern (Area C). An additional area (Area A) located within the PDA site (south) adjacent PPP site. Northern edge of the 'hotspot" may encroach within the footprint of Pier Street which is located within the PPP site. One of the bores was converted to a groundwater monitoring well (CBH/MW6) Plus sampling from previous wells (CBH/MW6, NBH5, NBH11 (dry), NBH13, NBH16, NBH20) and NBH8 (offsite)).	Area C encompassed locations NBH10 and NBH9 from previous investigations and CBH1, CBH2, CBH2A, CBH2B, CBH3 and CBH4 from these supplementary investigations: • Approximately 14 primary soil samples (TPH, BTEX, and PAHs). • Approximately three primary soil samples (asbestos). • Approximately six primary soil samples (SVOCs). • Approximately four primary fill samples (screened for ASS - pH field test and field pH peroxide test). • Six groundwater samples (TPH, BTEX, PAHs (al samples), VOCs and SVOCs (selected samples).
Coffey (30 January 2013) Supplementary Factual Report	19 boreholes BH101, BH102, BH104, BH105, BH106, BH107, BH108, BH108A, BH109, BH110, BH110A, BH111, BH112, BH112A, BH113, BH114, BH115, BH116, BH117 Eight of the boreholes were converted to groundwater monitoring wells (BH102/MW102, BH104/MW104, BH105/MW105, BH106/MW106, BH107/MW107, BH109/MW109, BH110A/MW110A BH117/MW117) Plus sampling from seven 7 existing wells (NBH/MW20, CBHMW6, NBH/MW16, NBH/MW11, NBH/MW13, NBH/MW5, NBH/MW8) Installation of data loggers in four monitoring wells	Up to eight samples per location (every 0.5 to 1m): • Approximately 75 soil (BTEX, TPH, PAH) • Approximately 42 soil (metals) • Approximately 25 soil (asbestos) • Approximately 6 soil (VOCs and SVOCs) 15 groundwater samples (BTEX, TPH, PAH, metals) (filtered) and PAHs (unfiltered) Five TCLP (metals 8), one TCLP (lead only), one TCLP (nickel and lead only) Two TCLP (PAHs) 13 ASLP (metals 8), one ASLP (lead only) seven ASLP (PAHs), four ASLP (TPH)

6.2 Data Quality Review

The Auditor's assessment of the investigations conducted to January 2013 are assessed Tables 6.2 and 6.3.

Table 6.2: QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
Data Quality Objectives (DQO)	**Coffey (August 2011, 1 June 2012 & August 2012)** Specific DQOs were defined in accordance with the seven step process outlined in DEC (2006). The Auditor is of the opinion that these were generally consistent with industry standards and were generally appropriate for the investigations conducted. However, the Auditor notes that the DQOs did not address the problem of collecting samples that were representative of the heterogeneous fill and variable conditions across the site. **Coffey (30 January 2013) - Supplementary Factual Report** DQOs were not specified by Coffey. However, Coffey were implementing a sampling analysis and quality plan referred to as the "Summary SAQP" prepared by AECOM (22 October 2012). The Summary SAQP does not provide specific DQOs. However on the basis that the summary SAQP clearly stated the project objectives and AECOM designed effective sampling strategies to achieve them, overall the Auditor considers that the omission of specific DQOs does not affect the outcome of the audit.
Sampling pattern, locations and density	**Coffey (1 June 2012) Stage 2 – Detailed Site Investigation** **Soil:** Locations were restricted by site buildings and other access issues and appear to be located within accessible areas based on a systematic (or not targeted) pattern. Majority placed in open space areas; minimal number placed beneath the existing buildings which occupy the majority of the site. Site area is approximately 17.2 hectares. Soil samples were collected from 22 boreholes. Minimum number recommended by EPA (1995) Sampling Design Guidelines is over 160 locations for a site of this size. Samples were generally tested for the main contaminants of concern as discussed in Section 4. **Groundwater:** Five groundwater samples analysed for the main contaminants of concern as discussed in Section 4. NBH/MW16 and NBH/MW20 - towards the southern (up gradient) boundary. NBH/MW11 and NBH/MW5 - on the western (cross gradient) boundary. NBH/MW13 - on the eastern (cross gradient) boundary of the site. NBH/MW8 (offsite - north of NBH/MW13 and approximately 40m from the eastern site boundary). **Coffey (August 2012) Supplementary Site Investigation** **Soil:** Four boreholes placed to further delineate impact identified by Coffey (1 June 2012) at location NBH10 (Area C). Placed at a radius of approximately 20m from NBH10. Consideration also appeared to be given to other investigation locations in the vicinity, when placing the boreholes. Elevated concentrations were detected in the most north-west (CBH2B) location suggesting impact has not been fully delineated by the current boreholes. **Coffey (30 January 2013) Supplementary Factual Report** **Soil:** Placed to improve coverage across site and fill "gaps" including sampling

Table 6.2: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
	beneath buildings. Investigation locations were typically spaced from approximately 50m up to 160m apart. Additional 11 boreholes increased total sample density to 33 locations over approximately 17.2 ha. This is still much less than the minimum recommended by EPA (1995) Sampling Design Guidelines (over 160 locations). **Groundwater:** Eight wells placed to improve coverage across site and fill "gaps". **Overall Auditor Comment** **Soil:** Considering the data as a whole, the number and position of soil investigation locations are below the number required to assess the soils beneath the site in accordance with minimum requirements of EPA (1995). This issue is considered by the Auditor throughout this site audit report and when drawing conclusions and making decisions based on the available data. **Groundwater:** No wells are immediately down gradient of the Area C "hotspot". Groundwater wells are not positioned or installed to penetrate the deeper thickness of fill encountered at the site in the central eastern portion of the site. The number and distribution of groundwater wells provides acceptable coverage across the site to provide a general overview of water quality. The density of wells was very low along the north-east (down-gradient) boundary of the site.
Sample depths	**Coffey (August 2011) Contamination Investigation & Coffey (1 June 2012) Stage 2 – Detailed Site Investigation** Range of depths. The majority of samples (approximately 2/3^{rds}) were analysed from fill materials. Approximately 1/3rd were analysed from the underlying alluvial, residual and/or estuarine soils. Selected to target depths where visual or olfactory indications of contamination were observed (e.g. odour, anthropogenic inclusions and elevated PID readings) (if any). **Coffey (August 2012) Supplementary Site Investigation** As above, however samples were collected from fill only and the Auditor notes consideration appeared to have generally been given to the analysing samples from, and above and below, the approximate depths of impact identified in the previous investigations. **Coffey (30 January 2013) Supplementary Factual Report** Range of depths generally through full thickness of fill profile (where penetrated). Approximately 0.5-1m intervals. Occasional samples analysed form underlying residual or alluvial soils. Fill generally penetrated (max depth 4.4m). Three boreholes terminated in fill at 3.6m, 6m and 6m respectively. No samples of fill below approximately 4m. Samples targeted zones of anthropogenic inclusions, different horizons within fill and natural soils, and elevated PID readings (where present). **Overall Auditor Comment** Considering the data as whole, the sample depths were appropriate and adequate to characterise the primary material types present at the investigation locations and the depths tested. Samples were generally not analysed below a depth of approximately 5m. fill was

Table 6.2: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
	present up to 14.5m in the eastern central portion of the site. Thus fill materials at depth have not been characterised. The fill and development history is not well known. Former ground surface at the time of operations of the rail yards may be a zone of potential contamination. The potential depth of the zone (in relation to the current ground surface does is not discussed or addressed. Some unidentified contamination may present at this horizon. These issues are considered by the Auditor throughout this site audit report and when drawing conclusions and making decisions based on the available data.
Well construction	**Coffey (1 June 2012) Stage 2 – Detailed Site Investigation** Final depths between 3.2m and 13.07m. 50mm PVC casing with machine slotted screens. Review of logs by the Auditor indicates the wells were screened to intercept the standing water level. However, the location of water ingress during drilling was not noted on the logs. At least 0.5m (and generally 1m or more) of screen was available above the recorded standing water level to accommodate tidal fluctuations in the water table. The elements used to depict the well construction details on the logs are not fully defined in the key provided on the logs and appears inconsistent. Thus details of the placement depths of bentonite and/or backfill other than sand (such as cuttings) is not clear. The reports states "graded filter sand was placed in the borehole around the screened interval and bentonite was used to seal the annulus of the monitoring well. Fitted with lockable well caps and flush fitting covers." It is considered likely based on information provided in the other reports reviewed during this audit and the Auditor's past experience with Coffey the that the wells were constructed to a standard adequate for purpose. **Coffey (30 January 2013) Supplementary Factual Report** Final depths between 1.1m (but generally at least 3m) to 6m. Water ingress generally not noted logs. SWL generally at least 0.6m to 1m below top of screened interval. Generally at least 0.5m of sand above top of screen followed by 0.5m bentonite followed by cuttings and concrete. 50mm HDPE casing. **Overall Auditor Comment** The Auditor is of the opinion the wells appear to have been constructed to a standard adequate for purpose and would be considered adequate to intercept PSH (if any).
Sample collection method	**Coffey (1 June 2012) Stage 2 – Detailed Site Investigation** **Soil:** Collected from solid flight augers. Logs indicate "environmental samples" and "SPT" samples collected. Details of the soil sampling methodology were not provided. **Groundwater:** Developed of each well reportedly occurred on 3 May 2012. Details of methodology were not provided. Groundwater quality parameters DO, Eh, pH, EC and temperature were reportedly recorded during development. Records of this were not provided. Groundwater was reportedly purged from each monitoring well using a disposable bailer and approximately of three well

Table 6.2: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
	volumes were purged or the well was bailed dry. However, details of the volume and quality of the purge water were not provided. Groundwater samples collected by disposable bailer. Samples collected for metals were filtered in the field using a 0.45um filter. Groundwater quality parameters were reportedly not recorded during sampling due to equipment malfunction. **Coffey (August 2012) Supplementary Site Investigation** **Soil:** As per Coffey (1 June 2012). Samples collected off auger flights. **Groundwater:** As per Coffey (1 June 2012). However, groundwater quality parameters (DO, Eh, EX, pH and temperature) were recorded. A summary of these results were provided in the report. Individual measurements and field sheets were not provided. **Coffey (30 January 2013) Supplementary Factual Report** **Soil:** Soil samples were collected from the split tube sampler or off the flights of the auger bit. Other sampling equipment was not specified. Samples placed quickly in in to laboratory supplied jars with minimal headspace to minimize volatile (if any) loss. **Groundwater:** The new Coffey wells and the existing wells were reportedly "developed" by removal of 3 well volumes. Purging was undertaken with a low flow peristaltic pump approximately 1 week after development. Groundwater monitored for pH, temperature, dissolved oxygen, electrical conductivity and redox potential. Samples collected using the low flow pump. Water level recorded with interface probe. **Overall Auditor Comment** **Soil:** Boreholes in the earlier investigations were advanced by solid stem auger drilling. This poses inherent difficulties in relation to accurately logging the nature and depths of the various lithological strata including variations in fill materials and observations of contamination indictors. Samples were collected off the auger flights and from the SPT. Thus, potential for loss of volatiles. However, volatiles were not identified at the site and they were not considered a significant COPC. Boreholes from the most recent round of data collection (Coffey 30 January 2013) were advanced using the SPT sampler until refusal followed by auger drilling. This represents just under half the data collected and provided more accurate logging. Any further anomalies noted above in the review are not considered significant enough to have a material outcome of the quality of the data for the purpose of this audit. **Groundwater**: Differences between sampling methods between rounds (where applicable, as some wells have only one round of sampling and others have two) may result in some variations. However, based on the data reviewed these are not likely to be significant with respect to outcomes at the site. Minimal well development appears to have occurred. This is likely to have resulted in sediment being entrained in the wells during drilling. This may impact on the quality of the groundwater and may overestimate the concentration of

Table 6.2: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
	organic contaminants that could be mobile in the aquifer due to contaminants attached to sediment/soil particles. Any further anomalies noted above in the review are not considered significant enough to have a material outcome of the quality of the data for the purpose of this audit.
Decontamination procedures	**Coffey (August 2011, 1 June 2012 & August 2012)** **Soil:** The various reports indicate all non-dedicated sampling equipment was cleaned with detergent and tap water and then rinsed with tap water prior to sampling and between sampling events to prevent cross contamination. The Auditor notes decontamination of augers between locations was not explicitly reported. **Groundwater**: The various reports indicate dedicated sampling equipment was used for each well. New gloves were reportedly used for each new sample. **Coffey (30 January 2013) Supplementary Factual Report** **Soil:** Non-disposable sampling equipment (not specified in the report but presumable included including the spilt tube sampler) was decontaminated by scrubbing with Decon 90 solution and rinsed with deionised water between samples. **Groundwater**: Interface probe decontaminated with Decon 90 solution and rinsed with deionised water between wells. Other equipment disposable. **Overall Auditor Comment** Overall, the Auditor is of the opinion that the decontamination procedures were adequate.
Sample handling and containers	**Coffey (August 2011, 1 June 2012, August 2012, 30 January 2013)** The various reports indicate all samples were placed into prepared and preserved sampling bottles provided by the laboratory and chilled during storage and subsequent transport to the laboratories. Sample receipt notification was not provided in Coffey (August 2011, 1 June 2012 & August 2012) but was provided in Coffey (30 January 2013). Where available SRN indicated samples arrived in appropriate condition at the laboratory. **Overall Auditor Comment** Overall, the Auditor is of the opinion that sample handling and containers were appropriate.
Chain of Custody (COC)	**Coffey (August 2011) Contamination Investigation** Chain of custody forms were not provided in the report. **Coffey (1 June 2012) Stage 2 – Detailed Site Investigation** Chain of custody forms signed an returned by the laboratory were provided in the report. **Coffey (August 2012) Supplementary Site Investigation** Chain of custody forms signed an returned by the laboratory were provided in the

Table 6.2: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
	report. **Coffey (30 January 2013) Supplementary Factual Report** Chain of custody forms were not provided in the report. These were subsequently provided separately by Coffey. **Overall Auditor Comment** Acceptable. The August 2011 report relates to the PDA site and has been used only for background information for this site audit. Thus the absence of COCs does not impact on the quality of the data for the PPP site.
Detailed description of field screening protocols	**Coffey (August 2011, 1 June 2012 & August 2012)** Field screening for volatiles with a PID for "environmental samples" only. A subsample was collected for screening. Details of how the screening was conducted were not provided. **Coffey (30 January 2013) Supplementary Factual Report** Sample was placed inside a sealed plastic bag and screened using a PID with a 10.6eV lamp. **Overall Auditor Comment** Appropriate, considering volatile contaminants were not detected at the site.
Calibration of field equipment	**Coffey (August 2011, 1 June 2012, August 2012, 30 January 2013)** PID was reported to have been calibrated prior to use. Calibration records were not provided. PID readings are generally provided on the borehole logs. Field sheets for groundwater sampling were not provided Calibration of water quality meters was not discussed. **Overall Auditor Comment** Appropriate, considering volatile contaminants were not detected at the site. Further anomalies noted above are not considered significant enough to have a material outcome of the quality of the data for the purpose of this audit.
Sampling logs	**Coffey (August 2011, 1 June 2012, August 2012 & 30 January 2013)** Soil logs are provided within the various reports, indicating sample depth, PID readings and lithology. August 2011 (PDA site), August 2012 and 30 January 2013 logs report visual and olfactory indications of contamination where present (e.g. odour and anthropogenic inclusions). The Auditor notes a separate sample register was not provided. The Auditor notes groundwater field sampling records were not provided. **Overall Auditor Comment** Variation/anomaly is noted between observations of anthropogenic inclusions made on borehole logs between sampling rounds. Likely due to different drilling methods (logging off augers versus logging from SPT samples) and different personnel logging soils (logs from Coffey 1 June 2012 logged by geotechnical engineer, other logged by environmental scientist). Extent of anthropogenic inclusions may be underestimated in the earlier rounds of sampling.

Table 6.2: QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	Also, all investigation locations are boreholes which are less conducive to allowing anthropogenic inclusions (including potential asbestos containing materials) than other methods such as test pitting.

Table 6.3: QA/QC – Field and Laboratory Quality Assurance and Quality Control

<table>
<tr><th>Field and Laboratory QA/QC</th><th>Auditor Comments</th></tr>
<tr><td>Field quality control samples</td><td>
<table>
<tr><th>Matrix</th><th>TS</th><th>TB</th><th>RB</th><th>Inter</th><th>Intra</th><th>Total</th></tr>
<tr><td colspan="7">Coffey (1 June 2012)</td></tr>
<tr><td>Soil</td><td>4</td><td>4</td><td>2</td><td>6</td><td>7</td><td>60</td></tr>
<tr><td>GW</td><td>1</td><td>0</td><td>1</td><td></td><td>1</td><td>7</td></tr>
<tr><td colspan="7">Coffey (August 2012)</td></tr>
<tr><td>Soil</td><td>1</td><td>1</td><td>1</td><td>2</td><td>6</td><td>50</td></tr>
<tr><td>GW</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>9</td></tr>
<tr><td colspan="7">Coffey (30 January 2013)</td></tr>
<tr><td>Soil</td><td>3</td><td>3</td><td>3</td><td>2</td><td>6</td><td>75</td></tr>
<tr><td>GW</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>14</td></tr>
</table>
Overall Auditor Comment
Overall, the field quality control samples were considered appropriate.
</td></tr>
<tr><td>Field quality control results</td><td>
Coffey (August 2011, 1 June 2012, August 2012 & 30 January 2013)
RPD results exceeding the control limit of 50% were commonly reported across the sampling events for metals, TPH and PAHs. Outliers ranged up to 157%. The variations for metals and PAHs were generally higher than TPH. Coffey attributed the RPDs to “heterogeneous nature of the fill material from which the RPD exceedances were noted, and uneven distribution of contaminants within the soil matrix, even across a distance of centimeters.”
RPD results for groundwater ranged from 0-67% and were generally 0% (where results were below the LOR for organics) and less than 30% where metals were detected at low levels.
Zinc was detected in the two rinsate samples (33ug/L and 43ug/L) in Coffey (1 June 2012). Rinsate water was reportedly provided by the primary laboratory (SGS Australia). All soil samples reported zinc below the assessment criteria. Significant cross contamination does not appear to have occurred. All other blank data was below the LOR. Spike recovery data ranged 80-113% and were within acceptable ranges.
There were some omissions/typographical errors in the reporting/tabulating of rinsate and trip blank data in Coffey (August 2012).
Overall Auditor Comment
Overall, considered appropriate. Results indicate significant cross contamination does not appear to have occurred; and significant volatile loss during transport is unlikely. RPD results suggest heterogeneity of the soil matrix. Further anomalies noted above are not considered significant enough to have a material
</td></tr>
</table>

Table 6.3: QA/QC – Field and Laboratory Quality Assurance and Quality Control	
Field and Laboratory QA/QC	**Auditor Comments**
	outcome of the quality of the data for the purpose of this audit.
NATA registered laboratory and NATA endorsed methods	**Coffey (August 2011) Contamination Investigation** Primary laboratory: SGS, Alexandria NSW (Asbestos analysed by Approved Identifier) Secondary laboratory: Nil **Coffey (1 June 2012) Stage 2 – Detailed Site Investigation** Primary laboratory: SGS, Alexandria NSW (Asbestos analysed by Approved Identifier) Secondary laboratory: Envirolab, Chatswood NSW **Coffey (August 2012) Supplementary Site Investigation** Primary laboratory: MGTLabmark, Lane Cove NSW (Asbestos: ASET NATA Accreditation: 14484) Secondary laboratory: Envirolab, Chatswood NSW **Coffey (30 January 2013) Supplementary Factual Report** Primary laboratory: MGTLabmark, Lane Cove NSW (Asbestos: ASET NATA Accreditation: 14484) Secondary laboratory: Envirolab, Chatswood NSW **Overall Auditor Overall Auditor Comment** Laboratory certificates were NATA stamped.
Analytical methods	**Coffey (August 2011, 1 June 2012, August 2012, 30 January 2013)** Analytical methods were included in the laboratory test certificates. While, references to the USEPA methods for extraction and analysis were given for the certificates for TPH, VOCs and SVOCs the exact methods used have not been detailed. **Overall Auditor Comment** Appropriate
Holding times	**Coffey (August 2011, 1 June 2012, August 2012, 30 January 2013)** Review of the COCs and laboratory certificates by the Auditor indicate that the holding times had generally been met. However, some exceptions were noted by both the Auditor and the consultant. Overall, these were not considered to be significant by the consultant or the Auditor. **Overall Auditor Comment** Appropriate
Laboratory Limit of Reporting (LORs)	**Coffey (August 2011, 1 June 2012 & August 2012)** LORs were all less than the threshold criteria for the contaminants of concern for soil. LORs for the groundwater assessment were generally sufficiently low. The LOR of 1 µg/L for cadmium was slightly higher than the screening criterion of 0.7 µg/L. In some cases the LOR was raised by the laboratory to a level

Table 6.3: QA/QC – Field and Laboratory Quality Assurance and Quality Control	
Field and Laboratory QA/QC	**Auditor Comments**
	greater than the criterion. LORs for some PAHs were above the low reliability ANZECC 2000 screening criteria. **Coffey (30 January 2013) Supplementary Factual Report** No threshold criteria provided as factual report. LORs were generally comparable to those discussed above for the previous reports. The LOR for the ASLP PAH data was an order of magnitude higher than the corresponding TCLP data (1 June 2012 & 30 January 2013) and was higher than the auditor screening levels. **Overall Auditor Comment** LORs for the groundwater assessment were generally sufficiently low. Exceptions were generally not considered to have a significant impact on the quality of the data for the purpose of the assessment (except where discussed and considered later in this site audit report).
Laboratory quality control samples	**Coffey (August 2011, 1 June 2012, August 2012 & 30 January 2013)** Laboratory quality control samples including surrogate spikes, duplicates, laboratory control samples, method blanks, matrix spikes were undertaken by the laboratory at generally appropriate frequencies in general accordance with: • Laboratory Control Samples (at least 1 per process batch) • Matrix Spikes (one matrix for each soil type) • Surrogate Spikes (for chromatographic analysis of organics) • Blanks (at least 1 per process batch) • Duplicates (at least 1 per process batch or 1 per 10, whichever is smaller) **Overall Auditor Comment** Appropriate
Laboratory quality control results	**Coffey (August 2011, 1 June 2012, August 2012 & 30 January 2013)** **SGS, Alexandria NSW** Method blank results were below the LOR. Surrogate spike recoveries were within control limits. Laboratory control sample recoveries where within control limits with the exception of a recovery in one sample of: Duplicate RPDs were within control limits with the exception of one sample 104% naphthalene, 55% fluorene; one sample 63% copper (SE107335); one sample 35% zinc; one sample 68% chromium, 51% copper, 39% lead; one sample 39% chromium (SE107819); one sample 145% lead, 121% zinc; (SE107862). The RPDs for surrogate spike recoveries in one duplicate water samples were 46% and 41% (SE108118) Matrix spike recoveries were within control limits with the exception of a recovery in one sample: 420% for TPH C15-C28 (SE107335); one sample 50% for nickel and 131% lead (SE107556); one sample 62% for lead, one sample 268% for TPH C15-C28 (SE107686); one sample -70% zinc and 52% lead (SE107819); 41% zinc (SE100739); 20% zinc (SE100882). **MGTLabmark, Lane Cove NSW** Method blank results were below the LOR with the exception of one soil sample for nickel (0.012mg/l). Surrogate spike recoveries were within control limits.

Table 6.3: QA/QC – Field and Laboratory Quality Assurance and Quality Control	
Field and Laboratory QA/QC	**Auditor Comments**
	Laboratory control sample recoveries where within control limits with the exception of a recovery in one sample 68% copper; 0% pentachlorophenol. Duplicate RPDs were within control limits with the exception of 72% lead; 59% cadmium; 68% cadmium; 78% arsenic; 59% mercury; 70% mercury; 41% chromium; 86% mercury; 42% nickel; 39% arsenic; 200% arsenic; 39% chromium; 170% arsenic; 33% nickel; 45% chromium; 110% mercury; 45% chromium; 110% mercury; 36% nickel; 37% dibenzofuran (0.5 and 0.7mg/kg respectively); 31% flourene; 44% lindane (1.4 and 1.9mg/kg); 200% cadmium; 34% copper; 58% mercury; 78% nickel; 110% lead; 280% mercury; 38-55% various PAHs; in individual samples respectively. Matrix spike recoveries were within control limits. **Envirolab, Chatswood NSW** Method blank results were below the LOR. Laboratory control sample recoveries where within control limits. Surrogate spike recoveries were within control limits. Duplicate RPDs were within control limits. Matrix spike recoveries were within control limits.
Data Quality Indicators (DQI) and Data Evaluation (completeness, comparability, representativeness, precision, accuracy)	**Coffey (August 2011) Contamination Investigation** DQIs were identified by Coffey for RPDs for field duplicates, trip blanks, rinsate blanks. However, DQIs were not set for trip spikes. DQIs were identified by Coffey for laboratory blanks, spike recoveries. DQIs were not identified for other laboratory QA/QC samples. Coffey did not undertake a formal QA/QC data evaluation against the five category areas. They did, however, conclude undertake a review of data against the DQIs and concluded *"The data is acceptable for the purpose of this assessment"*. Any anomalies noted above are not considered significant enough to have a material outcome of the quality of the data for the purpose of this audit. **Coffey (1 June 2012) Stage 2 – Detailed Site Investigation** As per Coffey (August 2011). However, Coffey concluded "the data quality objectives have been adequately addressed and the data is representative of subsurface conditions at sampling locations across the site on a conservative basis". **Coffey (August 2012) Supplementary Site Investigation** As per Coffey (August 2011). However, Coffey concluded "the data quality objectives have been adequately addressed and the data is reasonably representative of subsurface conditions at sampling locations within the nominated AECs". **Coffey (30 January 2013) Supplementary Factual Report** As per Coffey (August 2011). However, Coffey concluded "the data .. .is representative of subsurface conditions at the sampling locations and are acceptable for the purposes of this investigation."

In considering the data as a whole the Auditor concludes that:

- Sampling density across the site is very low compared to minimum requirements of EPA (1995) for hotspot detection. Reduced sampling densities are acceptable in some cases. This issue is considered by the auditor throughout this site audit report and when drawing conclusions and making decisions based on the available data.
- Presence of visual/olfactory indicators of contamination including anthropogenic inclusions may be underestimated on the available borehole logs based on the following:
  - Borehole logs between sampling events are not directly comparable due to variations in drilling methods and sampling personnel. Variation/anomaly is noted between observations of anthropogenic inclusions. Extent of anthropogenic inclusions is likely to be underestimated in the earlier rounds of sampling.
  - All investigation locations are boreholes which are less conducive to allowing anthropogenic inclusions (including potential asbestos containing materials) than other methods such as test pitting.
- A high degree of heterogeneity was present in fill materials and uneven distribution of contaminants within the soil matrix (even across a distance of centimeters) as evidenced by field observations and both field and laboratory duplicates. This should be considered when assessing data.
- The fill and development history is not well known. Former ground surface at the time of operations of the rail yards may be a zone of potential contamination. The potential depth of the zone (in relation to the current ground surface does is not discussed or addressed.
- An areas of deeper fill (up to 14.5 m) in the central eastern portion has not been characterised below approximately 5 m. The lateral extent is not well delineated. Groundwater wells don't penetrate this fill.
- The number and position of groundwater wells is appropriate to provide general overview of water quality beneath and leaving the site. They may not be adequate to asses localised variations (if any) including along the down-gradient north-eastern boundary.
- The primary laboratories provided sufficient information to conclude that data is of sufficient precision subject to inherent heterogeneity in the soil matrix.
- The field and laboratory quality control samples provided sufficient information to conclude that data is of sufficient accuracy subject to inherent heterogeneity in the soil matrix.

This issues discussed above have been considered by the Auditor when drawing conclusions and opinions during the site audit. Overall, the data is considered sufficiently precise, accurate, reproducible, comparable and complete to provide an adequate basis for decision making within the context of the objectives of this stage of the site audit.

7 Environmental Quality Criteria

A conservative set of environmental quality screening criteria were developed by the Auditor for use in performing an initial review of the soil and groundwater analytical data for key contaminants. The screening criteria were used to gauge the general degree of contamination impact and distribution.

7.1 Auditor Screening Criteria - Soil

Table 7.1 presents a summary of the soil screening criteria used for the main contaminants of concern detected at the site. Equivalent screening criteria have been used for other potential contaminants. Although these criteria would generally be above background, they provide an overall indication of the degree of contaminant impact. They would be protective of most site uses, but not necessarily of leaching of contaminants to groundwater. However, it is generally acknowledged that the 'provisional phytotoxicity-based investigation levels' would likely be reasonably protective of groundwater.

Table 7.1: Summary of Auditor's Screening Criteria for Key Soil Contaminants

Analyte	Screening Criteria (mg/kg)	Source
Arsenic	20	Soil Investigation Levels for Urban Redevelopment Sites in NSW in DEC (2006) 'Guidelines for the NSW Site Auditor Scheme, 2nd Edition'. Lower of: • SIL Column 1 – 'residential with gardens and accessible soil' (HIL A) • SIL Column 5 – 'provisional phytotoxicity-based investigation levels' (PPIL) (except Cr (VI) HIL A). Consideration has also been given to SILs relevant to the future land use as follows: • SIL Column 4 – 'commercial/industrial' (HIL F) • SIL Column 3 – 'recreational open space' (HIL E).
Cadmium	3	
Total Chromium	100	
Copper	100	
Lead	300	
Nickel	60	
Zinc	200	
Mercury (inorganic)	1	
Total PAH	20	SIL Column 1 – 'residential with gardens and accessible soil'
Benzo(a)pyrene	1	SIL Column 1 – 'residential with gardens and accessible soil'
TPH C10-C36	1000	EPA (1994) 'Guidelines for Assessing Service Station Sites'
Other Organics	LOR	Laboratory limit of reporting

Further details of the sources adopted are provided in Appendix B.

There are no national or EPA approved guidelines for asbestos in soil relating to human health. DEC (2006) state that auditors must exercise their professional judgement when assessing whether a site is suitable for a specific use. The OEH (formerly DEC) states that the position of the Health Department is that there should be no asbestos in surface soil.

7.2 Auditor Screening Criteria - Groundwater

The receptor is Cockle Bay. The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for marine waters. Trigger values (TVs) provided are concentrations that, if exceeded, indicate a potential environmental problem and 'trigger' further investigation. The marine 95% level of protection have been adopted for the current review. Some have been modified based on bioaccumulation or acute-toxicity or potential toxicity to particular species.

A low reliability ANZECC (2000) TVs has been adopted for arsenic of 2.3 µg/L, conservatively assuming that arsenic detected in the groundwater is As(III), rather than As(V) (TV: 4.5 µg/L). Chromium has been assumed chromium (III) (27.4 µg/L) rather than chromium (VI) (rather than 4.4 µg/L)

Other low reliability ANZECC (2000) TVs have been adopted for benzene, toluene, ethylbenzene and the xylene isomers (collectively these are referred to as "BTEX"). Also, anthracene (0.01 µg/L), benzo(a)pyerene (0.1 µg/L), fluoranthene (1 µg/L), phenanthrene (0.6 µg/L) at 99% protection levels.

ANZECC (2000) 99% protection level has been adopted for cadmium (0.7 µg/L), nickel (7 µg/L) and mercury (0.1 µg/L) due to the potential for bio-accumulation or acute toxicity to particular species and 99% protection level has also been adopted for nickel due to the potential toxicity to particular species.

There are no reliable Australian criteria for TPH in groundwater. The current NSW EPA position is that there should be no free phase product in groundwater, and that the aromatic components of dissolved-phase TPH in groundwater should be assessed using the ANZECC (2000) TVs where available. These guidelines include criteria for some BTEX compounds and for some polycyclic aromatic hydrocarbons.

7.3 Acid Sulphate Soils

The results of acid sulphate soil analysis were assessed against the values presented in Appendix 1 of the Acid Sulphate Soil Manual (ASMACC, 1998).

8 Evaluation of Soil Analytical Results

8.1 Introduction

Soil conditions have been investigated by approximately 30 systematic (not targeted) boreholes as outlined in Section 6.1. Soil and groundwater investigation locations are shown on Attachment 3, Appendix A.

The following sections discuss the field and laboratory results.

Note: The numbers presented in the tables in the following sections have been complied and transcribed manually from data tabulated by the consultant. Care has been taken to make this data accurate. However, the nature of the task is such that some errors in the numbers presented may be inevitable. Any such errors are not considered by the Auditor to be significant in the overall context of the data reviewed and conclusions drawn regarding the site during the audit.

8.2 Field Observations

The Auditor notes significant visual or olfactory indications of potential contamination were generally not observed within the lithology based on information recorded on the logs. Slight to strong hydrocarbon odour and elevated PID readings were noted in a relative few samples (3), ash (3) and slag (1) (offsite) was observed at one location as follows:

- “Slight odour” was logged at approximately 1.5-2 m and blue metal gravel and slag were logged between approximately 2.6 m and 7.3 m at NBH8 (offsite) within fill materials (sandy gravelly clays) . Elevated PID readings of up to 31.5 ppm (corresponding to the odour) were recorded. Elevated PAHs and TPH above LOR were present at this location.
- “Slight hydrocarbon odour” was logged at approximately 2.5 m at CBH2B (Area C) within clayey sand fill materials (PID reading of 4 ppm). PID readings of up to 20.1 ppm at 4.5 m were recorded within the fill. The fill extended to a depth of at 5.4 m (the maximum depth of the borehole). Elevated PAHs and TPH were present at this location.
- Material logged by Coffey as “ballast” was present at a number of locations beneath the Sydney Exhibition Centre building directly beneath the concrete hard stand to a depth of generally less than approximately 0.5 m. It is not clear from the information reviewed whether this is a “ballast” material relating to former rail uses or a construction (sub grade) material. Given the location and depth of occurrence, the Auditor suspects the latter may be more likely.
- A layer of gravelly ash was observed at BH104/MW104 (1.2-1.7 m) (locally elevated PID reading of 93 ppm in this layer); “material looks ashy” between 0.7-1.4 m in BH116; and “ash intermixed within sandstone layer – approx. 1 cm lens” logged at approximately 1.6 m in BH107/MW107. The presence of ash did not appear to correlate with significantly elevated analytical results.

Fill was heterogeneous. Anthropogenic inclusions (mainly brick, but at some locations included glass, ceramics, wire, “electrical piece”) were observed at approximately 40% of the borehole locations and were distributed across the site. A higher rate of inclusion were noted during the latest round of investigations (Coffey 30 January 2013) where inclusion

were noted at just under 75% of locations. Variations between personnel conducting the logging as well as sampling techniques (e.g. off the auger flight versus SPT samples) may account for this discrepancy. The Auditor considers that the earlier studies may underestimate the degree of anthropogenic inclusions (more logging off auger flights and logging undertaken by geotechnical engineers rather than environmental scientists).

PID readings varied across the site and typically ranged from less than approximately 2 ppm up to approximately 20 ppm. Isolated elevated readings of greater than 30 ppm and up to 186 ppm (NBH18) were also recorded, typically in fill materials (e.g. NBH4, NBH14, NBH17, NBH18, NBH21 and NBH22). No odour or visual signs of contamination were logged through the profile at these locations.

Elevated PID readings (approximately 70-130 ppm) through the depth of the borehole at locations BH111 and BH112A. No significant staining or odour noted. Some slight organic matter/staining in the underlying alluvium at depth.

The elevated PID readings generally did not correlate to detections of TPH or PAHs. However, low levels of PAHs were generally detected through fill materials including (but not limited to) locations with elevated PID readings.

“Organic odour” was also noted within alluvium at some locations (though not specific on the logs by Coffey the Auditor considers this is likely representative of natural odours in the alluvial sediments) towards the southern portion of the site. The odour did not generally correlate to detections of TPH or PAHs.

With the exception of the “slight hydrocarbon odour” in one of the seven boreholes in Area C and the “slight odour” in NBH8 offsite, there did not appear to be a clear correlation between elevated concentrations of PAHs and TPH and significant visual or olfactory indications of contamination. PAHs and TPH were detected widely across the site in samples where there were no apparent visual/olfactory indications of contamination.

8.3 Soil Analytical Results

Soil samples were analysed for a variety of contaminants including petroleum hydrocarbons, PAHs, asbestos, heavy metals, pesticides, volatile and semi-volatile organic compounds, and PCBs. The results have been assessed against the environmental quality criteria. Soil investigation locations are shown as Attachment 3, Appendix A.

Coffey (1 June 2012) Stage 2 – Detailed Site Investigation

Table 8.1: Evaluation of Soil Analytical Results for Fill Materials – Summary Table (mg/kg)

Analyte	N	Detections	Maximum	n > Auditor Screening Criteria	n > SIL Column 3 (DEC 2006)	n > SIL Column 4 (DEC 2006)
Asbestos	27	Nil	Not Detected	Nil	-	-
Arsenic	46	27	20	Nil	Nil	Nil
Cadmium	46	21	3.9	1	Nil	Nil
Total Chromium	46	46	64	Nil	Nil	Nil
Copper	46	46	320	1	Nil	Nil
Lead	46	45	550	1	Nil	Nil
Nickel	46	45	100	4	Nil	Nil

Table 8.1: Evaluation of Soil Analytical Results for Fill Materials – Summary Table (mg/kg)

Analyte	N	Detections	Maximum	n > Auditor Screening Criteria	n > SIL Column 3 (DEC 2006)	n > SIL Column 4 (DEC 2006)
Zinc	46	46	890	1	Nil	Nil
Mercury (inorganic)	46	26	0.83	Nil	Nil	Nil
TPH (C_6-C_9)	46	Nil	<LOR	Nil	-	-
TPH (C_{10}-C_{36})	46	12	900	Nil	-	-
BTEX	46	Nil	<LOR	Nil	-	-
Total PAHs	46	23	93	3	2	Nil
Benzo(a)Pyrene	46	21	6.5	6	3	1
PCBs	3	Nil	<LOR	Nil	-	-
OCP/OPPs	3	Nil	<LOR	Nil	-	-
OCPs	3	Nil	<LOR	Nil	-	-
VOC/SVOC	3	Nil	<LOR	Nil	-	-

n number of samples, - No criteria available/used

Based on the above the Auditor notes:

- Asbestos was not detected in any of the samples tested.
- Some metals (especially copper, lead, zinc) were elevated in relation to typical uncontaminated background but metals generally were not significantly elevated with respect to the auditor screening levels.
- Heavy end petroleum hydrocarbons (TPH C10-C36) were detected in approximately one quarter of the samples tested. However, the levels were generally low compared to the auditor screening levels.
- Volatile petroleum hydrocarbons (TPH C6-C9 and BTEX) were not detected.
- PAHs were detected in approximately half the samples. However, these were at generally low levels compared to the auditor screening levels and the health based SILs for open space and commercial/industrial land use.
- Where detected, benzo(a)pyrene was above the auditor screening levels in approximately 30% of the samples.
- Other organic contaminants were not widely tested for and were not detected in the few samples analysed.

Table 8.2: Evaluation of Soil Analytical Results for Estuarine, Alluvial and/or Residual Soils – Summary Table (mg/kg)

Analyte	N	Detections	Maximum	n > Auditor Screening Criteria	n > SIL Column 3 (DEC 2006)	n > SIL Column 4 (DEC 2006)
Asbestos	Nil	Nil	Not detected	Nil	-	-
Arsenic	15	11	12	Nil	Nil	Nil
Cadmium	15	4	0.5	Nil	Nil	Nil
Total Chromium	15	15	27	Nil	Nil	Nil
Copper	15	14	35	Nil	Nil	Nil

Table 8.2: Evaluation of Soil Analytical Results for Estuarine, Alluvial and/or Residual Soils – Summary Table (mg/kg)

Analyte	N	Detections	Maximum	n > Auditor Screening Criteria	n > SIL Column 3 (DEC 2006)	n > SIL Column 4 (DEC 2006)
Lead	15	14	150	Nil	Nil	Nil
Nickel	15	15	20	Nil	Nil	Nil
Zinc	15	15	130	Nil	Nil	Nil
Mercury (inorganic)	15	4	0.31	Nil	Nil	Nil
TPH (C_6-C_9)	15	Nil	<LOR	Nil	-	-
TPH (C_{10}-C_{36})	15	1	224	Nil	-	-
BTEX	15	Nil	<LOR	Nil	-	-
Total PAHs	15	2	28	1	Nil	Nil
Benzo(a)Pyrene	15	2	2.3	1	1	Nil
PCB	1	Nil	<LOR	Nil	-	-
OCPs/OPPs	1	Nil	<LOR	Nil	-	-
VOCs/SVOCs	1	Nil	<LOR	Nil	-	-

n number of samples, - No criteria available/used

Based on the above the Auditor notes:

- Concentrations of PAHs were generally not detected above the LOR in “natural” materials underlying fill with the following exceptions:
- A concentration of PAHs was also detected above the auditor screening criteria in one sample of “natural” material. The sample was logged as sandstone at NBH19/1.3-1.4 m and was located at the at the interface of the overlying fill materials. This concentration was an order of magnitude higher than the concentration recorded in the overlying fill material. The borehole was terminated at 1.4 m and the sample may have been incorrectly logged as sandstone rather than fill materials.
- A concentration of PAHs was detected above the LOR but below the auditor screening criteria in another sample of “natural” material. The sample was logged as clayey sand alluvium at NBH18/4.3-4.5 m and was located approximately 1 m below the interface of the overlying fill materials at the approximate location of groundwater ingress. This concentration was slightly higher (but similar to) the concentrations recorded in the overlying fill material. The PAH detections correlated to elevated PID readings through the soil profile (70 ppm at the depth of the sample and up to 186 ppm in the overlying fill). The results may indicate leaching of contamination from the overlying fill. However, in the absence of indications of leaching in other samples of natural materials it is more likely that the PAHs are a result of cross-contamination or materials being incorrectly logged as “natural” rather than fill materials.
- Based on the above, the natural soils underlying the fill materials generally do not appear to exhibit elevated concentrations of contaminants.
- The natural soils do not appear to have been contaminated prior to or after filling.

Table 8.3: Evaluation of Acid Sulphate Soil Screening Results – Summary Table				
Sample	**Stratum**	**Field pH**	**pH_{FOX}**	**Field Peroxide pH Test**
BH17-3.0-3.45	Fill/Alluvium	8.3	4.0	Very vigorous, gas evolution and heat generation
BH18-3.0-3.45	Fill/Alluvium	6.5	5.1	Slight reaction
BH21-3.0-3.45	Alluvium	6.6	2.0	High reaction
BH28-3.0-3.45	Alluvium	7.1	2.1	Very vigorous, gas evolution and heat generation
BH30-4.5-4.9	Alluvium	8.1	4.5	Very vigorous, gas evolution and heat generation

Based on the above the Auditor notes:

- Potential acid sulphate soils are present in alluvium.

Coffey (August 2012) Supplementary Site Investigation (Area C)

Area C is a "hotspot" of TPH and PAH contamination identified by Coffey beneath the northern portion of the Sydney Exhibition Centre at NBH10 at a depth of 0.4-0.5 m (Coffey 1 June 2012). Soil samples were collected from targeted locations around the hotspot and analysed for primary contaminants of concern based on the results from NBH10 (TPH C_{10}-C_{36} and PAHs). Samples were also screened for asbestos, (C_6-C_9), BTEX and SVOCs. The results have been assessed against the environmental quality criteria.

Table 8.4: Evaluation of Soil Analytical Results for Fill Materials – Summary Table (mg/kg)						
Analyte	**N**	**Detections**	**Maximum**	**n > Auditor Screening Criteria**	**n > SIL Column 3 (DEC 2006)**	**n > SIL Column 4 (DEC 2006)**
Asbestos	3	Nil	Not detected	Nil	-	-
TPH (C_6-C_9)	14	Nil	<LOR	Nil	-	-
TPH (C_{10}-C_{36})	14	3	4000	1	-	-
BTEX	14	Nil	<LOR	Nil	-	-
Total PAHs	14	9	330	4	3	1
Benzo(a)Pyrene	14	8	4.8	7	3	Nil
SVOCs	6	Nil	<LOR	Nil	-	-

n number of samples, - No criteria available/used

Based on the above the Auditor notes:

- The above data were collected by the consultant for "hotspot characterisation".
- The data indicates the hotspot is characterised by elevated petroleum hydrocarbons (TPH C_{10}-C_{36}) and PAHs in fill materials and coincides to a "slightly HC odour" noted on the logs for one only of the seven boreholes within the "hotspot". Anomalously, the logged odour does not correspond to the maximum recorded TPH concentration.
- At their highest, the concentrations of PAH and TPH are at levels approximately three to four times greater than respective health based SIL for commercial/industrial land.

- The Auditor notes the delineation boreholes were placed at four locations (CBH1, CBH3, CBH4 and CBH2B) at a radius of approximately 20 m from NBH10. Boreholes were also advanced at locations CBH2 and CBH2A adjacent to CBH2B and were terminated at 0.32 and 0.8 m respectively above what was noted on the log to be a sewer pipe.
- Concentrations above AECOM's health based assessment criteria for commercial/industrial land use (HIL F) were detected in the most north-west location (CBH2B at a depth of 3.5-3.6m) suggesting impact has not been fully delineated in this direction by the current boreholes. Samples from CBH2B above and below this depth were of lower concentrations (below HILF, but close to auditor screening levels in some samples). Results for samples from the other boreholes were below HIL F but were often above or close to auditor screening levels. The auditor screening levels for benzo(a)pyrene was exceeded in approximately half the samples tested.
- Slight hydrocarbon odour was noted in CBH2B at approximately 2.5 m. However, the sample from this depth had concentrations an order of magnitude lower than the underlying 3.5-3.6 m. Slight "organic matter odour" was noted at 3 m in CBH3. No other significant visual/olfactory indications of contamination were noted on the borehole logs.
- The hotspot was initially detected in NBH10 at a depth of 0.4-0.5 m. The samples from this depth in CBH1 and CBH4 were comparable in magnitude to the NBH10 data (but were below HIL F). Samples from this depth were not tested in CBH2B and CBH3.
- Samples at depths comparable to 3.5-3.6 m (i.e. the depth of the high CBH2B data) were not analysed in any borehole (NBH10, CBH1, CBH3 and CBH4).
- Based on the above, the Auditor notes that the hotspot does not appear to be correlated to any significant visual/olfactory indications of contamination.
- Impact has been identified over an area of approximately 1200 m^2. However, the extent of the hotspot has not been well delineated in any direction, particularly within the depth zone 3.5-3.6 m and to a lesser extent 0.4-0.5 m. There seems to be "less" contamination between these two zones (with results generally less than HIL F and less than or close to auditor screening levels). Thus, the mechanism of contamination is not clear and may be due to heterogeneous fill.

Table 8.5: Evaluation of Acid Sulphate Soil Screening Results – Summary Table

Sample	Stratum	Field pH	pH_{FOX}	Field Peroxide pH Test
CBH1-ASS2-3.0m	Fill	7.5	7.1	Low
CBH1-ASS3-4m	Fill	7	5.9	Low
CBH3-ASS2-3.5m	Fill	7.7	4.3	Low
CBH4-ASS2-3.5m	Fill	7.2	7.2	Low

Based on the above the Auditor notes:

- Potential or actual acid sulphate soils were not indicated in the fill tested.

Coffey (31 January 2013) Supplementary Factual Report

Soil samples were collected to supplement the existing data and increase the sample density across the site including beneath buildings. Samples analysed for similar variety of contaminants as per Coffey (1 June 2012) Stage 2 – Detailed Site Investigation.

Table 8.6: Evaluation of Soil Analytical Results for Fill Materials – Summary Table (mg/kg)

Analyte	N	Detections	Maximum	n > Auditor Screening Criteria	n > SIL Column 3 (DEC 2006)	n > SIL Column 4 (DEC 2006)
Asbestos	25	Nil	ND	Nil	-	-
Arsenic	41	33	13	Nil	Nil	Nil
Cadmium	41	14	1.9	Nil	Nil	Nil
Total Chromium	41	30	110	1	Nil	Nil
Copper	41	36	200	8	Nil	Nil
Lead	41	36	500	2 (plus 3 over 200 mg/kg, 1 over 160 mg/kg)	Nil	Nil
Nickel	41	31	180	6	Nil	Nil
Zinc	41	37	630	8	Nil	Nil
Mercury (inorganic)	41	21	0.83	Nil	Nil	Nil
TPH (C_6-C_9)	63	Nil	<10	Nil	-	-
TPH (C_{10}-C_{36})	63	7	2900	3	-	-
BTEX	63	Nil	Nil	Nil	-	-
Total PAHs	63	21	22	2	Nil	Nil
Benzo(a)Pyrene	63	16	2.6	7	2	Nil
MAHs	4	Nil	<LOR	Nil	-	-
VOC/SVOC/MAHs	2	Nil	<LOR	Nil	-	-

Based on the above the Auditor notes:

- Asbestos was not detected in any of the samples tested, consistent with the earlier results.
- Consistent with earlier results, metals were not significantly elevated with respect to the auditor screening levels.
- Heavy end petroleum hydrocarbons (TPH C_{10}-C_{36}) were detected in approximately 10% of the samples tested and were above the auditor screening levels in approximately 5% of the samples tested.
- Volatile petroleum hydrocarbons (TPH C_6-C_9 and BTEX) were not detected.
- PAHs were detected in approximately a third of the samples. However, these were at generally low levels compared to the auditor screening levels and the health based SILs for open space and commercial/industrial land use.
- Where detected, benzo(a)pyrene was above the auditor screening levels in approximately 40% of samples.
- Other organic contaminants were not widely tested for but were not detected in the few samples analysed.

- A comparison with the "first round" of soil data collected (Coffey 1 June 2012) indicates results were generally comparable in nature and magnitude with the following variations noted:
    - TPHs were less frequently detected in the samples tested this round of soil data collection (approximately 10% of samples tested) compared to the "first round" (approximately 25% of the samples analysed).
    - The average concentration of the data set of detections of TPHs (i.e. excludes non detects) this round was higher (approximately 1150 mg/kg) compared to the "first round" round (approximately 250 mg/kg).
    - PAHs were detected at approximately the same rate between the two sample rounds (30 to 40%).
    - The average concentration of the data set of detections of total PAHs (i.e. excludes non detects) in the "first round" was slightly higher compared to this round (approximately 16 mg/kg compared to approximately 8 mg/kg).
    - The average concentrations of benzo(a)pyrene were comparable between the two rounds (approximately 1 mg/kg each round).

Table 8.7: Evaluation of Soil Analytical Results for Natural Materials – Summary Table (mg/kg)

Analyte	N	Detections	Maximum	n > Auditor Screening Criteria	n > SIL Column 3 (DEC 2006)	n > SIL Column 4 (DEC 2006)
Arsenic	1	1	4.7	Nil	Nil	Nil
Cadmium	1	Nil	<0.4	Nil	Nil	Nil
Total Chromium	1	1	13	1	Nil	Nil
Copper	1	1	15	Nil	Nil	Nil
Lead	1	1	78	Nil	Nil	Nil
Nickel	1	Nil	<5	Nil	Nil	Nil
Zinc	1	1	10	Nil	Nil	Nil
Mercury (inorganic)	1	1	0.1	Nil	Nil	Nil
TPH (C_6-C_9)	10	Nil	<LOR	Nil	-	-
TPH (C_{10}-C_{36})	10	Nil	<LOR	Nil	-	-
BTEX	10	Nil	<LOR	Nil	-	-
Total PAHs	10	Nil	<LOR	Nil	Nil	Nil
Benzo(a)Pyrene	10	Nil	<LOR	Nil	Nil	Nil

Based on the above the Auditor notes:

- The natural soils underlying the fill materials generally do not appear to exhibit elevated concentrations of contaminants.
- The natural soils do not appear to have been contaminated prior to or after filling.

Overall Auditor Comments

In summary, based on the results in the Tables 8.1 to 8.7 and considering the data as a whole the Auditor notes:

- Natural soil beneath the fill do not appear to have been impacted by contamination prior to or after filling.
- Concentrations of PAHs detected above the LOR and both above and below the auditor screening criteria were widespread through fill materials (concentrations above the LOR were detected in approximately 30-40% the total samples analysed and concentrations above the auditor screening criteria were detected in approximately 15% of the total samples analysed). Detections were recorded up to depth of approximately 5 m. Fill materials generally ranged in depth from approximately 1 m up to 14.5 m (with the deeper fill generally located in the central and eastern portion of the site). Analytical data for fill below approximately 5 m was generally not available.
- The highest concentrations of total PAH and benzo(a)pyrene were recorded within the central northern portion of the site (Area C), as follows:
  - A concentration of benzo(a)pyrene (6.5 mg/kg) was detected at one (NBH10) location at a depth of 0.4-0.5 m (fill materials). PAHs above the LOR (and below the Coffey assessment criteria) were detected at this location up to a depth of 3 m (in fill). Elevated concentrations of TPH (C_{10}-C_{36}) above the LOR (maximum concentration of 900 mg/kg at 0.4-0.5 m and decreasing with depth) and below the assessment criterion were also detected to a depth of 3 m at this location. No data was available below 3 m.
  - Subsequently during "hotspot" delineation sampling, concentrations of Total PAHs (330 mg/kg) and TPH (C_{10}-C_{36}) (4,000 mg/kg) were detected at location CBH2B (3.5-3.6 m) adjacent to NBH10 in fill materials exhibiting slight hydrocarbon odour. PAHs were detected above the LOR through the fill profile to the maximum extent of analytical investigations (2.1 m). Also, it is noted that a sample from 0.4-0.5 m (coinciding with the depth of impact in the adjacent NBH10) was not analysed at CBH2B.
  - Impact has been identified over an area of approximately 1200 m^2. However, the extent of the hotspot has not been well delineated in any direction, particularly within the depth zone 3.5-3.6 m and to a lesser extent 0.4-0.5 m. There seems to be "less" contamination between these two zones (with results generally less than HIL F and less than or close to auditor screening levels). Thus, the mechanism of contamination is not clear and may be due to heterogeneous fill.
- TPH was detected above the LOR (below screening criteria) in approximately 20% of the samples of fill analysed (and one sample of natural materials). These detections generally correlated with corresponding detections of PAHs.
- Concentrations of TPH (C_{10}-C_{36}) were generally below the auditor screening criteria with the exception of the following:
  - At the Area C "Hotspot" up to 4000 mg/kg
  - Beneath the Sydney Exhibition Centre building. A concentration of 2300 mg/kg detected at BH117 0.25-0.35 m and 1100 mg/kg detected at BH17 0.9-1 m. TPH was not detected in the 2 m sample. TPH (C_{10}-C_{36}) was also detected at similar depths in adjacent sample (BH115). The extent and continuity of the "hotspot" is not

well defined due to limited number of boreholes, but did not appear to correspond to particularly elevated PAH results.

  - At BH104/0.12-0.22 m adjacent the northern boundary towards Cockle Bay. The concentration was 2900 mg/kg. TPH was not detected in the 0.7 m samples, and did not appear to correlate to PAH results. The extent of the "hotspot" is not well defined due to limited number of boreholes

- Significant visual or olfactory indications of contamination were generally not noted on the logs. Slight to strong hydrocarbon odour and elevated PID readings were noted in a few samples of fill.
- With the exception of the "slight hydrocarbon odour" in one of the seven boreholes in Area C and the "slight odour" in NBH8 offsite, there did not appear to be a clear correlation between elevated concentrations of PAHs and TPH and significant visual or olfactory indications of contamination. PAHs and TPH were detected widely across the site in samples where there were no visual/olfactory indications of contamination.
- Concentrations of metals generally did not appear significantly elevated and were generally below (with a few minor exceptions) the conservative auditor screening criteria in all samples analysed from of fill, alluvial, residual or estuarine soils.
- Concentrations of TPH C_6-C_9, BTEX, VOCs, SVOCS, OCPS, OPPs, OPPs were not detected above the LOR in any sample analysed from of fill, alluvial, residual or estuarine soils.
- Asbestos was not detected in any of the samples analysed. No visual observations of potential ACMs were noted on the logs.
- Screening for ASSs indicated that the alluvial soils have a high likelihood of the presence of acid sulphate.

In summary, fill materials have widespread impact by low levels of PAHs and petroleum hydrocarbons with no clear correlation with visual/olfactory indications. The fill materials are heterogeneous and areas appear to exist that exhibit higher concentrations of PAHs and/or petroleum hydrocarbons compared the "average" concentrations detected. These include the area referred to as "Area C" and areas where petroleum hydrocarbons are present (BH117/BH115, BH116 and BH104). The extent of these "hotspots" has not been delineated. There is potential for further "pockets" and variation form the current data set to be present between sample locations.

In the Auditor's opinion, the soil analytical results are consistent with the site history (particularly the history of progressive filling with fill of unknown quality) and field observations.

Overall, giving due consideration to the above the Auditor is of the opinion that the current data set provides a reasonable characterisation/representation of the soil conditions at the site. However, it is acknowledged that some variation between investigation locations would be expected.

"Hotspots" on the Boundary

The PPP site is located adjacent to the PDA South site with the boundary between the two development sites located in the vicinity of the southern side of Pier Street. Two "hotspots"

referred to as “Area and A” and “Area B” have been identified by Coffey within the boundary of the PDA site. These hotspots are located in the northern portion of the PDA site and are thus adjacent to the PPP site.

Maximum concentrations of 1400 mg/kg Total PAHs; 74 mg/kg benzo(a)pyrene and 4620 mg/kg C10-C36 were detected in Area A. Maximum concentrations of 300 mg/kg Total PAHs; 20 mg/kg benzo(a)pyrene and 4220 mg/kg C10-C36 were detected in Area B. Coffey completed some delineation of Area A and Area B. Impacted samples were detected at depths of 0.5-0.4 m, approximately 1 m, and 1.5-2 m). Samples were analysed up to approximately 3.5 m where fill was present at or beyond this depth, but less data is generally available at or below this depth. The hotpots have not been well delineated.

Contamination was not detected in the boreholes in the southern portion of the PPP site. However, these boreholes are up to approximately 50 m from the contamination detected in Area A and Area B and a similar distance from the southern boundary of the PPP site. As the hotspots have not been well delineated it is possible that the “hotspots” may encroach in to the southern portion of the PPP site in areas that have not been sampled and analysed.

9 Evaluation of Groundwater Analytical Results

Groundwater samples were collected and analysed on three occasions (samples collected in in May 2012, and August 2012 and January 2013) from the wells installed within the PPP site (and one offsite well) as outlined in Section 6.1 and below. Due to the order and dates of well installation and the sampling programs, some wells were samples three times, some twice and some once. In particular, the most recent onsite wells (eight wells), installed by Coffey (January 2013) have been sampled only once.

Groundwater sampling locations are shown on Attachment 3, Appendix A.

The following sections discuss the field and laboratory results.

Coffey (1 June 2012) Stage 2 – Detailed Site Investigation

No indications of contamination were noted during well development. Water purged from each monitoring well was observed to be brown to dark brown with a high turbidity. No chemical odour or hydrocarbon sheen was observed for groundwater in any of the wells.

Results of field screening of water quality parameters (where available) indicate brackish to saline water with slightly reducing to slightly oxidising conditions. pH ranged from 6.8 to 7.5 pH units.

Table 9.1: Evaluation of Groundwater Analytical Results – Summary Table (µg/L)

Analyte	Sampling in May 2012			
	n	Detections	Maximum	n >ANZECC Fresh (2000)
Arsenic	5	Nil	<2	Nil
Cadmium	5	Nil	<1	1[a]
Total Chromium	5	Nil	<10	Nil
Copper	5	4	0.5	Nil
Lead	5	Nil	<0.1	Nil
Nickel	5	Nil	<0.10	Nil
Zinc	5	4	43	3
Mercury (inorganic)	5	Nil	<0.1	Nil
TPH (C_6-C_9)	5	Nil	<400	-
TPH (C_{10}-C_{36})	5	Nil	<200	-
BTEX	5	Nil	<5	Nil
Benzo(a)pyrene	5	Nil	<0.1	Nil
Naphthalene	5	1	0.1	Nil
Anthracene	5	Nil	<0.1	5[a]
Fluoranthene	5	1	0.2	Nil
Phenanthrene	5	1	0.3	Nil

n number of samples

- No criteria available/used

a) Detection limit greater than criteria

Based on the above the Auditor notes:

- Results for metals were generally low. Metals were generally not detected or where detected (e.g. copper) were well below the screening criteria. Cadmium was not detected. However, the LOR of 1 µg/L was slightly greater than the screening criterion

of 0.7 µg/L. However, cadmium was not a significant contaminant detected in soils. Thus this is not considered to be a significant issue. Zinc (43 µg/L) was detected above the screening criterion of 15 µg/L but was of comparable magnitude.

- TPH was not detected above the (relatively high) LOR.
- Low levels of PAHs were detected above the LOR both above and below the screening criteria. In some cases the LOR was higher than the screening criterion.

Coffey (August 2012) Supplementary Site Investigation

Coffey (August 2012) report that during gauging a visible sheen was noted in NBH/MW20 although no distinct odour was observed. An "organic odour" was noted in NBH/MW16. The type of organic odour was not specified. However, the Auditor considers this is likely representative of natural odours.

No other indications of contamination were noted during well development.

Results of field screening of water quality parameters (where available) indicate brackish to saline water with slightly reducing to slightly oxidising conditions. pH ranged from 4.9 to 8pH units.

Table 9.2: Evaluation of Groundwater Analytical Results – Summary Table (µg/L)

Analyte	Sampling in August 2012			
	n	Detections	Maximum	n >ANZECC Fresh (2000)
TPH (C_6-C_9)	6	Nil	<20	-
TPH (C_{10}-C_{36})	6	Nil	<100	-
BTEX	6	Nil	<1	Nil
Benzo(a)pyrene	6	Nil	<1	Nil
Naphthalene	6	Nil	<1	Nil
Anthracene	6	Nil	<1	6[a]
Fluoranthene	6	Nil	<1	Nil
Phenanthrene	6	Nil	<1	6[a]
Total PAHs	6	Nil	<LOR	-
VOCs	2	Nil	<LOR	Nil
SVOC	2	Nil	<LOR	Nil

n number of samples

- No criteria available/used

a) Detection limit greater than criteria

Based on the above the Auditor notes:

- No data was collected for metals.
- TPH was not detected above the (relatively high) LOR.
- PAHs were not detected above the LOR. However, the LOR was above the screening criteria for some PAHs
- TPH or PAHs were not detected in MW20 (where a visible sheen was noted).

Coffey (30 January 2013) Supplementary Factual Report

It is noted that the eight wells installed by Coffey (MW102, MW104, MW105, MW106, MW107, MW109, MW110A, MW117) were sampled on one occasional only.

Coffey reported that no visual signs of contamination were observed. No olfactory signs of contamination were observed in any wells with the exception of MW20 where a slight hydrogen sulphide odour was observed during the initial well purge. This odour subsided and was no longer detectable during sample collection.

Table 9.3: Evaluation of Groundwater Analytical Results – Summary Table (µg/L)

Analyte	Sampling in January 2013			
	n	Detections	Maximum	n >ANZECC Fresh (2000)
Arsenic	13	9	8	6
Cadmium	13	10	0.4	Nil
Total Chromium	13	Nil	<1	Nil
Copper	13	8	4	8
Lead	13	2	1	Nil
Nickel	13	8	13	1
Zinc	13	9	42	3
Mercury (inorganic)	13	Nil	<0.1	Nil
TPH (C_6-C_9)	13	Nil	<20	-
TPH (C_{10}-C_{36})	13	Nil	100-175 (MW07)	-
BTEX	13	Nil	<1	Nil
Benzo(a)pyrene	12	3	<1 (next highest 0.03[a])	1 (including <1)[b]
Naphthalene	12	2	<1 (next highest 0.27[a])	Nil
Anthracene	12	6	<1 (next highest 0.06[a])	6[b]
Fluoranthene	12	4	2 (at MW104)	1
Phenanthrene	12	3	<1 (next highest 0.28)	1 (including <1)[b]
Total PAHs	12	6	6 (at MW104)	-

n number of samples

\- No criteria available/used

a) Detection limit raised to 1 from 0.01 at MW104

b) Detection limit greater than criteria

Field duplicate samples were filtered and analysed for PAHs with the exception of MW104, MW117 due to insufficient sample volume. All filtered results for PAHs were below the LOR.

- Results for metals were generally low. There were some exceedances of the screening criteria for arsenic, copper, nickel and zinc. However, the concentrations were of comparable magnitude to the screening criteria.
- TPH (C_{10}-C_{36}) was detected above the LOR at one location (MW07) (approximately 100 m to the north of the “Area C” hotspot). The TPH in groundwater did not correlate to a detection of TPH at this location. However TPHs were detected in soils to the north and south, including Area C). Results may indicate some “unidentified” TPH impact in soils.
- Low levels of PAHs were detected (in unfiltered samples) above the LOR both above and below the screening criteria. In some cases the LOR was higher than the screening criteria.

- PAHs were not detected in filtered samples. However, the sample with the highest concentration of PAHs in the unfiltered sample (MW04) could not be analysed due to insufficient volume.
- TPH or PAHs were not detected in MW20 (where hydrogen sulphide odour was noted and where a visible sheen was noted in the previous sample event - August 2012).

Overall Auditor Comments

Considering the results as a whole, the Auditor notes:

- Metals in groundwater are detected at low levels, generally of comparable magnitude to the screening levels
- PAHs in groundwater are present at low levels. However, the concentrations are comparable to the screening criteria which are also low. The LOR was often higher than the screening level. PAHs were detected in groundwater (in unfiltered samples) in the north eastern portion (BH105/MW105 and BH104/MW04) where ashy fill and TPH impact were identified in soils (although a sample of the ash returned results for PAHs and TPH below the LOR). Also, PAHs have been detected in groundwater (in unfiltered samples) in central southern portion of site in the area of “deep fill” (NBH/MW13)
- PAHs were not detected after filtering the samples. However, data was not available for the well where the highest level (albeit still low) of PAHs were detected (MW04).
- TPHs in groundwater are present at one location (MW107, approximately 125m from Cockle Bay) and does not correlates to elevated TPH in soil at this location. However TPHs were detected in soils to the north and south, including Area C). Results may indicate some “unidentified” TPH impact in soils.

10 Contamination Migration Potential

10.1 Soils

Site soils are covered in hardstand or landscaping. Migration of soil offsite is considered unlikely subject to appropriate controls during any disturbance such as during construction.

10.2 Leachate analytical results

Coffey conducted Toxicity Characteristic Leaching Procedure Test (TCLP) and Australian Standard Leaching Procedure (ASLP) to further assess the potential for fill materials to leach to groundwater.

Coffey (1 June 2012) Stage 2 – Detailed Site Investigation

Table 10.1: Evaluation of TCLP Results – Summary Table (µg/L)

Analyte	Sampling in May 2012			
	n	Detections	Maximum	n >ANZECC Fresh (2000)
Arsenic	7	Nil	<50	7[a]
Cadmium	7	1	15	7[a]
Total Chromium	7	Nil	<5	Nil
Copper	7	6	1700	7[a]
Lead	7	3	650	7[a]
Nickel	7	7	75	7
Zinc	7	7	4000	7
Benzo(a)pyrene	7	Nil	<0.1	Nil
Naphthalene	7	Nil	<0.1	Nil
Anthracene	7	2	0.5	7[a]
Fluoranthene	7	2	0.7	Nil
Phenanthrene	7	3	3.3	3
Total PAHs	7	3	6	-

n number of samples

\- No criteria available/used

a) Detection limit greater than criteria

Coffey (30 January 2013) Supplementary Factual Report

Table 10.2: Evaluation of TCLP Results – Summary Table (µg/L)

Analyte	n	Detections	Maximum	n >ANZECC Fresh (2000)
Arsenic	5	1	8	5[a]
Cadmium	5	Nil	<0.5	Nil
Total Chromium	5	Nil	<5	Nil
Copper	5	1	7	5[a]
Lead	7	2	170	7
Nickel	6	Nil	<5	Nil
Zinc	5	1	7	Nil
Mercury (inorganic)	5	Nil	<0.1	Nil
Benzo(a)pyrene	2	Nil	<1	2[a]
Naphthalene	2	Nil	<1	2[a]
Anthracene	2	Nil	<1	2[a]
Fluoranthene	2	Nil	<1	Nil
Phenanthrene	2	Nil	<1	2[a]

Table 10.2: Evaluation of TCLP Results – Summary Table (µg/L)				
Analyte	**n**	**Detections**	**Maximum**	**n >ANZECC Fresh (2000)**
Total PAHs	2	Nil	<2	2[a]

n number of samples

- No criteria available/used

a) Detection limit greater than criteria

Table 10.3: Evaluation of ASLP Results – Summary Table (µg/L)				
Analyte	**n**	**Detections**	**Maximum**	**n >ANZECC Fresh (2000)**
Arsenic	13	2	8	13[a]
Cadmium	13	Nil	<0.5	Nil
Total Chromium	13	1	14	Nil
Copper	13	2	7	13[a]
Lead	14	1	60	13[a]
Nickel	13	Nil	<5	Nil
Zinc	13	3	16	1
Mercury (inorganic)	13	Nil	<0.1	Nil
TPH (C_{10}-C_{14})	4	2	300	-
Benzo(a)pyrene	7	Nil	<1	7[a]
Naphthalene	7	Nil	<1	7[a]
Anthracene	7	Nil	<1	7[a]
Fluoranthene	7	Nil	<1	Nil
Phenanthrene	7	Nil	<1	7[a]
Total PAHs	7	Nil	<2	7[a]

n number of samples

- No criteria available/

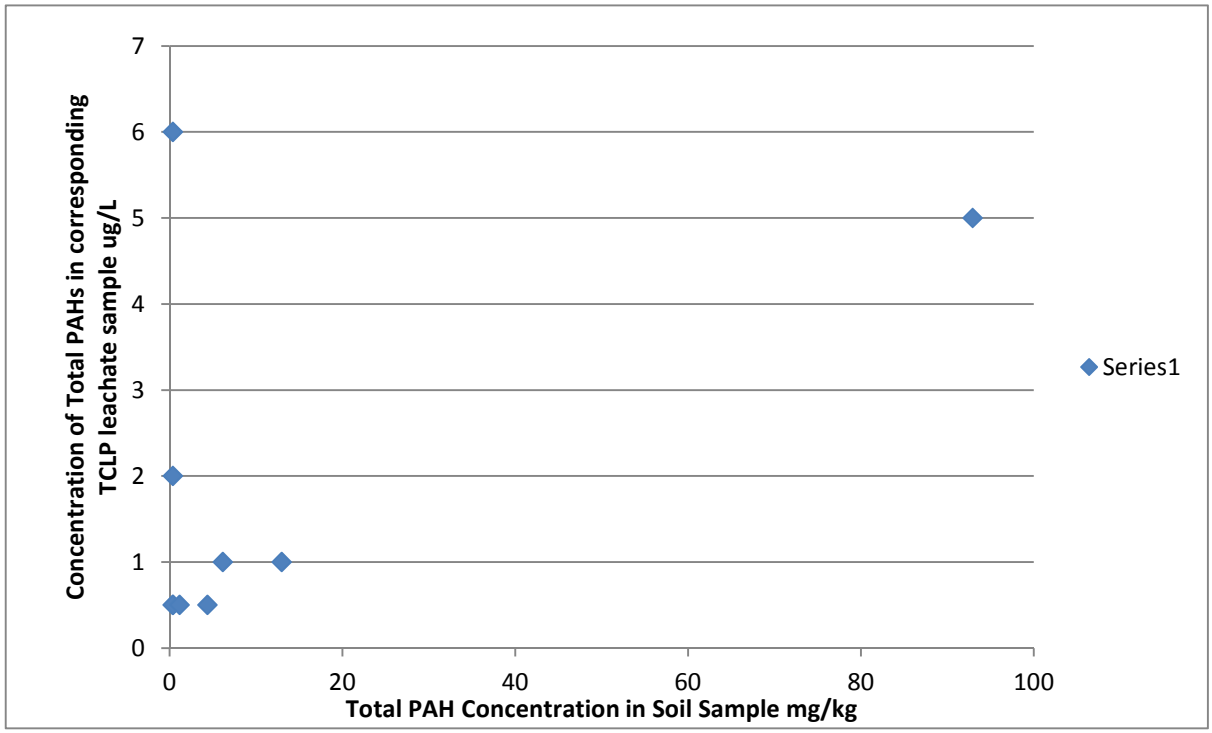
a) Detection limit greater than criteria

Based on the above, the Auditor notes

- Arsenic, copper, nickel and zinc were detected above screening criteria in groundwater samples. Copper, nickel and zinc were detected in soils above the auditor screening criteria in a few samples. TCLP and ASLP results suggest arsenic, copper and zinc do leach from the soils at low levels. Thus, fill materials may be contributing to the low concentrations of metals in groundwater.
- Other metals were found to leach from soil samples (such as lead) and were also present in soils above screening criteria but were not detected in groundwater samples above screening criteria.
- PAHs leached at low levels from some samples. Samples selected for TCLP testing had total PAH concentrations ranging from less than the LOR to 93 mg/kg with an average concentration of approximately 10 mg/kg. This appears to be reasonably representative of the available data set as a whole. However, it is noted that the data set contains a maximum concentration of 330 mg/kg along with a few samples with concentrations ranging from approximately 20 mg/kg to 80 mg/kg which were not tested.

- It is noted that leachable PAHs were detected in some samples where PAHs were not detected in the soil samples. For example PAHs were not detected in NBH1/ 0.5-0.6 m. However, a leachable concentration of 6 µg/L was detected in the TCLP sample. There did not appear to be sufficient data to assess a clear correlation between total concentrations in the soil sample and leachable concentrations. Leachate results versus the corresponding concentration in soil samples for Total PAHs is shown on Graph 1.

Graph 1: Leachate results versus corresponding concentration in soil samples



- TCLP testing is designed to represent acidic landfill conditions and thus may be a conservative indication of the leaching potential under site conditions.
- PAHs were not detected in the ASLP samples. However, the ASLP testing was done on fewer samples and the distribution of samples was generally less representative than the testing for TCLP. Of the samples tested the highest total PAH concentration in soils was 6.2 mg/kg with an average concentration of approximately 7 mg/kg. Also, the LORs for the ASLP testing was an order of magnitude higher than the LOR for the TCLP testing and were generally above the groundwater screening criteria. Therefore, the ASLP data has certain limitations. However, overall soil leachate data suggested that PAHs have a limited ability to leach from soil into groundwater. The leaching potential of metals also appears to be minimal.

10.3 Groundwater

Concentrations of PAHs, TPH and metals in groundwater have been detected above screening levels.

PAHs

PAHs were detected in the wells adjacent to Cockle Bay in the north eastern portion of the site (MW105 and MW104) at concentrations of 1.1 µg/L and 6 µg/L respectively. PAHs were also detected at low levels in wells along the western (MW106) and eastern boundary (MW110A, MW109 and MW13). The levels in groundwater were generally relatively low and comparable in magnitude to the conservative screening levels.

The reports reviewed suggest minimal development of groundwater wells was completed by Coffey prior to sampling (removal of three well volumes by bailer). Thus it is likely that soil particles are present within the water column as a results of drilling activities. These particles may be contributing to the PAH results and may not be representative of contamination that is mobile within the aquifer. This is supported by samples filtered before analyses for PAHs returning results below the LOR. However, other factors such as absorption/entrainment of dissolved PAHs and colloidal materials (that may be mobile in the aquifer) on the filter paper cannot be excluded and may result in false negative results for filtered samples. Thus the filtered data must be treated with caution.

PAHs were detected in the limited TCLP leachate data suggesting the PAHs in the soil samples were leachable under the acidic TCLP test conditions (which are designed to simulate aggressive landfill conditions would likely overestimate leachate potential under site conditions). PAHs were not detected by the less aggressive ASLP testing. However, the LORs were above the screening criteria and an order of magnitude higher than the TCLP data. Thus the TCLP and ASLP data cannot be meaningfully compared.

TPH

A concentration of TPH of 100-175 µg/L was detected at one location towards the centre of the site (MW107) slightly above the LOR and was located over 100m from Cockle Bay. TPH was not detected above LOR in the wells adjacent to Cockle Bay (MW105 and MW104). Based on the available data, it does not appear likely that TPH has a significant risk of migrating offsite.

Metals

Metals were detected in wells adjacent to site boundaries. Therefore, there appears to be some potential for migration of metals in groundwater at low levels offsite.

Data Gaps

Based on the available data including data , there does not appear to have been significant migration of contaminants offsite at the locations tested including MW104 and MW105 adjacent Cockle Bay). However, the sampling density is low and there is an absence of groundwater monitoring wells along the north eastern boundary (adjacent other parts of the Darling Harbour entertainment area). Also, some wells have been sampled only once. The remedial works plan (Section 12) includes measures to compensate for these data gaps.

11 Assessment of Risk

A human health and ecological risk assessment (HHERA) was completed by AECOM in March 2013 to assess potential human health and ecological risks to on and off site receptors following the proposed redevelopment of the site for combined commercial / recreation open space use.

Review of the HHERA by the Auditor (and his expert support team) has predominantly focused upon issues of regulatory compliance and technical defensibility.

11.1 Human Health Risk Assessment Review

11.1.1 Hazard Assessment

Soil

Due to the heterogeneous nature of the fill at the site and the limited data, AECOM considered soil data from across the whole PPP site at all depths, in both paved (including beneath buildings) and unpaved areas, when assessing risks to the identified human receptors.

The chemicals of concern in soil were selected based on the maximum concentrations in fill detected above the Tier 1 screening criteria. The Tier 1 screening criteria were selected based on the proposed recreational and commercial land uses and included:

- NEPC (1999) HIL E – levels for recreational use of land including parks, open space and playing fields
- NEPC (1999) HIL F – levels for commercial / industrial use of land
- CRC Care (2011) HSLs for individual BTEX compounds and naphthalene only
- USEPA (2012) Regional Screening Levels for:
  - Commercial / industrial soil (adjusted for a 1 x 10^{-5} risk where applicable)
  - Recreational soil calculated using the RSL calculator.

Table 11.1 presents the chemicals of concern selected by AECOM for each of the identified exposure scenarios and the concentrations used in their risk calculations.

Table 11.1: AECOM Selected Contaminants of Concern

Contaminants of Concern	Selected Concentration (mg/kg)	AECOM Justification and Auditor Comment
Recreational Users and Intrusive Workers		
TPH C_{10}-C_{14}	410	As the total PAH concentration failed the Tier 1 screening criteria, the maximum detected individual PAH concentrations were included by AECOM in their assessment of direct
TPH C_{15}-C_{28}	2500	
TPH C_{29}-C_{36}	1600	
Naphthalene	3.6	

Table 11.1: AECOM Selected Contaminants of Concern		
Contaminants of Concern	**Selected Concentration (mg/kg)**	**AECOM Justification and Auditor Comment**
Acenaphthene	0.6	contact risks. The Auditor considers this to be reasonable. AECOM did not consider naphthalene in their assessment of inhalation risks as the concentration was below the Tier 1screening criteria for vapour inhalation. The Auditor considers this to be reasonable.
Acenaphthylene	1.3	
Anthracene	3.4	
Benz(a)anthracene	39	
Benzo(a)pyrene	6.5	
Benzo(b)fluoranthene	9.3	
Benzo(b&k)fluoranthene	62	
Benzo(g,h,i)perylene	3.9	
Dibenz(a,h)anthracene	1.0	
Indeno(1,2,3-c,d)pyrene	3.5	
Fluoranthene	94	
Fluorene	1.8	
Indoor Commercial Worker		
TPH C_{10}-C_{14}	410	PAHs were not selected as contaminants of concern for the commercial worker as AECOM assumed that commercial workers do not have significant direct contact with soil as they are considered to spend the majority of time indoors and the commercial area is generally paved. The Auditor considers this to be reasonable for this site.

Overall Auditor Comment

In general, the contaminants of concern and concentrations selected by AECOM for the assessment of risks to recreational users, intrusive workers and indoor commercial workers are considered reasonable.

Groundwater

The maximum reported concentrations reported for the filtered groundwater samples were screened using the NHMRC, NRMMC (2011) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy (DWG). AECOM reported that no chemicals of concern were identified above the drinking water guidelines and therefore human health risks associated with exposure to groundwater were not considered further.

The Auditor notes that concentrations of PAHs exceeding the DWG were detected in the unfiltered samples. For example a concentration of 0.2 µg/L of benzo(a)pyrene was detected in MW13 in January 2013 which exceeded the DWG of 0.1 µg/L. Higher concentrations may also be present in MW104 where the LOR was raised by the laboratory and a concentration of 6 µg/L Total PAHs was detected.

Comparison of filtered and unfiltered data for PAHs is discussed in Section 10.

The Auditor considers that the levels detected are unlikely to be at concentrations high enough to pose a risk to construction or maintenance workers.

11.1.2 Exposure Assessment

The exposure assessment involves the determination of the receptor populations who may be exposed to the chemicals of concern during normal recreational, indoor commercial or maintenance activities on the site and the pathways by which they are exposed.

Exposure Populations

On the basis of the data review detailed in Table 11.1 above, AECOM identified the following receptor populations:

- On-site outdoor recreational open space users
- Intrusive maintenance workers
- Indoor commercial workers.

Exposure Pathways

AECOM identified the relevant potential exposure pathways to be as follows:

- Indoor and outdoor inhalation of volatile contaminants of concern from impacted soil
- Indoor and outdoor inhalation of soil derived dust
- Direct contact with contaminated fill (via dermal and incidental ingestion).

Exposure Scenarios

Given the exposure populations and pathways identified, the exposure scenarios assessed by AECOM are presented in Table 11.2:

Table 11.2: Exposure Scenarios Considered by AECOM	
Receptor	**AECOM Exposure Scenarios**
Recreational User (Child and Adult)	Dermal contact with contaminated soil
	Incidental ingestion of contaminated soil
	Inhalation of soil-derived dust outdoors
	Inhalation of soil-derived vapours outdoors
Indoor Commercial Worker	Inhalation of soil derived vapours indoors
Intrusive Maintenance Worker	Dermal contact with contaminated soil
	Incidental ingestion of contaminated soil
	Inhalation of soil-derived dust outdoors
	Inhalation of soil-derived vapours outdoors

.

The Auditor considers the exposure scenarios considered by AECOM are reasonable. The Auditor notes that the site is covered with buildings, pavements or grass, the potential for the dust inhalation pathway to be significant is considered negligible.

Exposure Assumptions

The main exposure assumptions adopted by AECOM are presented in Table 11.3.

Table 11.3: Significant Exposure Parameters Used by AECOM				
Parameter	**Outdoor recreational user**	**Indoor Commercial Worker**	**Intrusive Maintenance worker**	**Auditor Comments**
Body Weight (kg)	78 (adult) 15 (child)	78	78	Acceptable and consistent with enHealth (2012).
Exposure Duration (yrs)	35 (adult) 6 (child)	30	30	Acceptable. Recreational adult is based on residential occupancy periods (enHealth 2012). Intrusive worker is based on AECOM judgement considering NEPC (1999) value for commercial worker. This is likely conservative for an intrusive worker.
Exposure Frequency Outdoors	52	240	20	Acceptable. Value for recreational user and intrusive worker are based on AECOM's

Table 11.3: Significant Exposure Parameters Used by AECOM				
Parameter	**Outdoor recreational user**	**Indoor Commercial Worker**	**Intrusive Maintenance worker**	**Auditor Comments**
(days/yr)				judgement with the rationale that the outdoor recreational exposure is based on seasonal variations, where, in winter months, recreational users are unlikely to undertake activities such as picnics, or wear clothing such as short sleeves, shorts and no shoes.
Time of exposure (hr/day)	2 outdoors	8 indoors	10 outdoors	Value for commercial worker, recreational adult and child is acceptable and consistent with enHealth (2012) assuming a 2-3 year old child. Value for intrusive worker is based on AECOM's judgement and is considered reasonable.
Averaging time (years) carcinogens	70(adult and child)	70	70	Acceptable and consistent with the enHealth (2012).
Averaging time (years) non-carcinogens	35 (adult) 6 (child)	30	30	Acceptable and consistent with exposure duration.
Exposed skin area (cm^2)	10500 (adult) 4300 (child)	NA as no direct contact exposure	6800	Value for recreational adult are 95% UCL from enHealth (2012) for forehead, hands, arms, lower legs and feet. The value for a recreational adult is inconsistent with the value used for the intrusive workers also from enHealth (2012) but is the average value for forearms, hands, lower legs and feet which is considered more reasonable. For a child the value is the enHealth (2012) 95% UCL for head, hands, arms, lower legs and feet which is reasonable.
Soil to skin adherence factor (mg/cm^2)	0.5	NA as no direct contact exposure	0.5	Acceptable and consistent with enHealth (2012)
Daily soil ingestion rate	60 (adult)	NA as no direct contact	60	Acceptable and consistent with maximum values in enHealth

Table 11.3: Significant Exposure Parameters Used by AECOM				
Parameter	**Outdoor recreational user**	**Indoor Commercial Worker**	**Intrusive Maintenance worker**	**Auditor Comments**
(mg/day)	100 (child)	exposure		(2012).

Overall Auditor Comment

Overall, the exposure parameters adopted by AECOM are considered reasonable for use in the assessment of risks from residual contaminated soil at the PPP site.

11.1.3 Toxicity Assessment

The toxicity data for the chemicals of concern adopted by AECOM and the Auditor's comments are listed in Table 11.4.

Table 11.4: Toxicity criteria used by AECOM				
Chemical of Concern	**Cancer Slope Factor (CSF) $(mg/kg/day)^{-1}$ (AECOM)**	**RfD (mg/kg/day)**	**Inhalation Toxicity Value (mg/m^3) ** (AECOM)**	**Auditor Comments**
TPH C_{10}-C_{14} (aromatic)	NA	0.04	0.2	Acceptable and consistent with TPHCWG (1997)
TPH C_{10}-C_{14} (aliphatic)	NA	0.1	1.0	Acceptable and consistent with TPHCWG (1997)
TPH C_{16}-C_{35} (aromatic)	NA	2.0	NA	Acceptable and consistent with TPHCWG (1997)
TPH C_{16}-C_{35} (aliphatic)	NA	0.03	NA	Acceptable and consistent with TPHCWG (1997)
Benzo(a)pyrene*	0.43	NC	NA	Value from NHMRC 2011. Considered reasonable.
Benzo(a)anthracene*	0.043	NC	NA	Based on BaP CSF and TEF of 0.1 Considered reasonable.
Benzo(b)fluoranthene*	0.043	NC	NA	Based on BaP CSF TEF of 0.1 Considered reasonable.
Benzo(k)fluroanthene*	0.043	NC	NA	Based on BaP CSF TEF of 0.1 Considered reasonable.
Benzo(g,h,i)perylene*	0.0043	NC	NA	Based on BaP CSF TEF of 0.01 Considered reasonable.
Chrysene*	0.0043	NC	NA	Based on BaP CSF TEF of

Table 11.4: Toxicity criteria used by AECOM				
Chemical of Concern	**Cancer Slope Factor (CSF) $(mg/kg/day)^{-1}$ (AECOM)**	**RfD (mg/kg/day)**	**Inhalation Toxicity Value (mg/m^3) ** (AECOM)**	**Auditor Comments**
				0.01 Considered reasonable.
Dibenz(a,h,i)anthracene*	0.43	NC	NA	Based on BaP CSF TEF of 1 Considered reasonable.
Indeno(1,2,3-cd)pyrene*	0.043	NC	NA	Based on BaP CSF TEF of 0.1 Considered reasonable.
Acenaphthene	NA	0.06	NA	USEPA, 1994 IRIS Considered reasonable.
Acenaphthylene	NA	0.06	NA	Based on acenaphthene as surrogate Considered reasonable.
Anthracene	NA	0.3	NA	US EPA, 1993 IRIS Considered reasonable.
Fluoranthene	NA	0.04	NA	US EPA, 1993, IRIS Considered reasonable.
Fluorene	NA	0.04	NA	US EPA, 1990, IRIS Considered reasonable.
Naphthalene	NA	0.02	NA	Only considered in direct contact risks by AECOM therefore inhalation toxicity not considered. Oral toxicity data from US EPA IRIS Considered reasonable.
Phenanthrene	NA	0.04	NA	RIVM, 2000 Considered reasonable.
Pyrene	NA	0.03	NA	US EPA, 1993 Considered reasonable.

NA- Not Applicable
NC – Not considered as assessed as genotoxic carcinogen

* Considered genotoxic carcinogen by CCME (2010) and enHealth (2012)
** Note the Auditor has only reviewed inhalation toxicity criteria for chemicals considered volatile as dust inhalation is not considered significant

The Auditor notes that AECOM considered intakes from background exposure to PAHs in soil, drinking water food and air to be insignificant in comparison to the adopted dose-response criteria and therefore the PAH reference doses were not adjusted for background exposure. TPH direct contact reference doses were also not adjusted for background exposure by AECOM however inhalation toxicity values for TPH were adjusted by 10% to account for background inhalation exposures.

Overall Auditor Comment

Overall, the Auditor considers the toxicity data adopted by AECOM listed in Table 11.3 are acceptable for the assessment completed. .

11.1.4 Acceptable Levels of Risk

The Auditor considers that the acceptable levels of risk adopted by AECOM of:

- For non-threshold (carcinogenic) chemicals of concern, the incremental lifetime cancer risk estimates for each receptor have been compared to an acceptable carcinogenic risk level of 1 in 100,000 (1×10^{-5}).
- For threshold (non-carcinogens), potentially unacceptable chemical intake/exposure is indicated if the exposure level exceeds the TDI or TC (i.e. if the HQ is greater than 1).

are reasonable.

11.1.5 Method of Risk Estimation

AECOM assessed potential vapour intrusion risks using the Johnson and Ettinger (1991) equations presented in ASTM (2010) and USEPA (2004).

In general, the equations used and risks calculations presented were acceptable.

Model Assumptions

Table 11.5 presents a summary of the key model assumptions made by AECOM for the vapour modelling from soil and the Auditor's opinion regarding these assumptions.

The Auditor notes that it is generally not considered appropriate to model vapour risks from soil sources due to the uncertainties with theoretical partitioning / equilibrium relationships in the models. Further, as the maximum volatile TPH concentration identified in soil (TPH C_{10}-C_{14} at 410 mg/kg) is less than the NSW EPA (1994) Service Station Guidelines for sensitive sites, the Auditor does not consider modelling of inhalation risks using the available data for residual volatile TPH in soil is necessary. A review of the modelling inputs has however been completed.

Table 11.5: Vapour Intrusion Modelling Assumptions

Assumption	Receptors (Recreational User, Commercial Worker and Intrusive Worker)	Auditor Comment
Assumed thickness of soil contamination (cm)	100 Outdoor Receptors 15 Indoor Receptors	Not justified, default of 100. Reasonable for limited vapour assessment.

Table 11.5: Vapour Intrusion Modelling Assumptions		
Assumption	**Receptors (Recreational User, Commercial Worker and Intrusive Worker)**	**Auditor Comment**
Fraction Organic Carbon	0.002	Not justified but acceptable given the value of 0.002 is more conservative than default of 0.01 and reasonable.
Total Soil Porosity %	0.38	Not justified but reasonable.
Water Filled porosity %	0.12	Not justified but reasonable.
Commercial Building Floor Area (m^2)	400	Reasonable and consistent with CRC Care (2011) assumptions for commercial building.
Commercial Building Foundation Thickness (cm)	15	Acceptable and consistent with Building Code of Australia.
Commercial Building Air Exchange Rate (exchanges / hour)	2	AECOM state is minimum air exchange rate of commercial buildings based on Australian Building Code. Auditor notes that CRC Care adopts a value of 0.83 exchange/hour in derivation of the HSLs for a commercial building. Value adopted by AECOM is considered reasonable.
Rate of Advection (L/min)	5	Acceptable. USEPA (1994) default.
Width of source area parallel to wind (cm)	1500	Acceptable. ASTM
Ambient air mixing zone height (cm)	200	Acceptable. ASTM
Wind Speed in Outdoor Mixing Zone (cm/s)	380 – Recreational User 38 Intrusive worker NA Commercial Worker	Based on annual average 9 am and 3 pm Sydney Observatory Hill weather station for recreational user and 10% of this value in trench. Acceptable

Note: Assessment is limited by the inputs identified in this table

11.1.6 Human Health Risk Characterisation and Conclusions

A HHERA was completed by AECOM (2013) to assess the potential health risks associated with residual soil contamination and the proposed future commercial and recreational site use. Based on the assessment completed, AECOM (2013) found that:

- "...the estimated potential health risks to future on-site recreational users, commercial workers, and intrusive maintenance workers were considered to be low and acceptable."

Although the Auditor does not necessarily endorse all the individual assumptions made by AECOM, based on independent review of the information and data available, the Auditor agrees with the conclusion made by AECOM that the residual soil contamination at the site is unlikely to pose a risk to future recreational or commercial or intrusive workers at the site.

11.2 Ecological Risk Assessment Review

The potential for ecological risks to terrestrial flora of Tumbalong Park and marine aquatic receptors in Cockle Bay was assessed qualitatively by comparing reported soil and groundwater concentrations against generic Tier 1 screening criteria (NEPC 1999 EIL) that are protective of ecological receptors.

The uptake of PAHs and hydrocarbons from soil was considered to be a relatively minor pathway of exposure and therefore the ecological risk assessment only considered the potential for metal uptake into flora of Tumbalong Park. The Tier 1 screening identified concentrations in soil of copper, mercury, nickel and zinc above the criteria.

However, as the 95% UCL concentrations for these metals were below the Tier 1 screening criteria, AECOM considered that there is minimal potential for ecological impact to flora within Tumbalong Park. This conclusion was supported by the presence of healthy and established flora recently observed in Tumbalong Park. The Auditor notes that it is generally not acceptable to use the 95% UCL when assessing ecological risks. However, the exceedances were few and minor and the Auditor is of the opinion that they are unlikely to pose an ecological risk in the context of the proposed development.

Although the reported concentrations of some metals (copper and zinc) and PAHs (fluoranthene and pyrene in unfiltered samples) in groundwater exceeded the Tier 1 ecological screening criteria (ANZECC 2000, marine waters 95% protection level where high or moderate reliability data available; RIVM 2001, Ecotoxicological Serious Risk Concentraions and CCME (2007) Aquatic Life), AECOM considered there would be minimal ecological impact to aquatic receptors within Cockle Bay based on the following:

- The dilution potential for contaminants as groundwater migrates through the aquifer and enters Cockle Bay. USEPA (1996) indicates that the reduction on concentrations from soil leachate to groundwater and finally to the receptor can be expressed as a dilution attenuation factor (DAF). The USEPA (1996) suggests a default DAF of five for groundwater moving to a surface water body. Using a DAF of five, groundwater concentrations would be below the Tier 1 water quality criteria except for pyrene.

However, given the PAH exceedances were relatively small and there were no concentrations of PAHs within the filtered samples (i.e. the bioavailable fraction) above the laboratory LORs, the PAH detections were considered likely to be related to suspended

particles in the samples which are unlikely to move easily through the soil profile. Some limitations on the use of filtered data are discussed in Section 10.2.

Therefore, the pyrene concentration is considered unlikely to represent an unacceptable risk to Cockle Bay.

- Comparison of reported surface water zinc and copper concentrations in Darling Harbour are within groundwater concentrations reported in the PPP site (taking into consideration the dilution potential as groundwater migrates to Cockle Bay).
- Soil leachate data suggested that PAHs have a limited ability to leach from soil into groundwater (as indicated by no PAH concentrations being reported above the laboratory LORs in the ASLP leachate tests). This indicates that the PAHs present in the groundwater are not very available to move or to impact organisms. The leaching potential of metals also appears to be minimal with only three, out of 12, samples in the leachate tests showing concentrations marginally above the laboratory LORs (for arsenic, chromium, copper and zinc) noting also that for the metals, the leachate test results were below the water quality guidelines or would be if a fivefold DAF was applied. However, some limitations on the use of ASLP and TCLP data are discussed in Section 10.2.
- Cockle Bay is an active non-pristine waterway and any potential contamination migrating from the PPP site (where the fill has been in place for greater than 20 years) is likely to be minor.

It was therefore considered by AECOM that the potential ecological risks from site-derived groundwater impacts to Cockle Bay were low and acceptable.

Based on review of the available data, the Auditor considers that AECOM's conclusions with respect to potential ecological risks are reasonable. AECOM did not provide a justification for the use RIVM (2001) and CCME (2007) Tier 1 criteria. However, there were no detections in unfiltered samples that exceeded the generally more conservative (i.e. lower) auditor screening levels (largely based on low reliability ANZEEC 2000) once the fivefold DAF was applied. In some cases the LOR was not low enough to make this comparison. However, this is unlikely to have a significant impact on the outcome in the context of the site and further data will be collected under the RWP.

It is noted that some wells have only been sampled once; and the potential for currently unidentified contaminant sources is to be addressed under the RWP.

11.3 References

ASTM (2010) Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites

ATSDR online toxicity profiles, Agency for Toxic Substances and Diseases Registry US Department of Health and Human Services, Atlanta Georgia

BCA (2010) Building Codes of Australia, Volume 1 and Volume 2, 2010 Edition. Australian Building Codes Board, Australian Government

CCME, 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Part of Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME).

CRC Care (2011), Health Screening Levels for petroleum hydrocarbons in soil and groundwater, E. Friebel and P. Nadebaum, Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC Care) Technical Report Series, no. 10

CRC Care (2009), Field Assessment of Vapours, G.B. Davis, J. Wright and B.M.Patternson, Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC Care) Technical Report Series, no. 13

enHealth (2012) Environmental Health Risk Assessment Guidelines for assessing human health risks from environmental hazards, Department of Health and Ageing and enHealth Council

enHealth (2003), Australian Exposure Factors Handbook – Consultation Draft, Department of Health and Ageing and enHealth Council

ITRC (2007),Vapour Intrusion Pathway: A Practical Guideline, Interstate Technology & Regulatory Council Vapour Intrusion Team, Washington, DC 20001

Johnson, P.C., & Ettinger, R.A. (1991) Heuristic Model for Predicting the Intrusion Rates of Contaminated Vapours into Buildings. Environ.Sci.Technol., 25, 1445-1452

NEPC (1999), National Environment Protection (Assessment of Site Contamination) Measure, National Environmental Protection Council Canberra

RIVM, 2001. Technical evaluation of the Intervention Values for Soil/sediment and Groundwater. Human and ecotoxicological risk assessment and derivation of risk limits for soil, aquatic sediment and groundwater. RIVM Report 711701 023. National Institute of Public Health and the Environment. February 2001.

Standards Australia (2002), The use of ventilation and airconditioning in buildings Part 2: Ventilation design for indoor air contaminant control, AS 1668.2-2002

TPHCWG (1997), Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons, Total Petroleum Hydrocarbon Criteria Working Group, Toxicology Technical Action Group

USEPA (1996), Soil Screening Guidance: Users Guide. Office of Solid Waste and Emergency Response, United States Environmental Protection Agency, Washington, D.C.

USEPA (2002), Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, US Environmental Protection Agency, Office of Emergency and Remedial Response

USEPA (2004) User's Guide for Evaluating Subsurface Vapour Intrusion into Buildings, US Environmental Protection Agency, Office of Emergency and Remedial Response

US EPA (2009) Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), United States Environmental Protection Agency, Office of Emergency and Remedial Response

US EPA Integrated Risk Information System (IRIS). Electronic database maintained by the United States Environment protection Agency National Centre for Environmental Assessment, Office of Research and Development

12 Assessment of Remedial Works Plan

12.1 Background

The investigations to date have identified fill materials that have been impacted by TPH and PAHs. Low levels of TPH and PAHs have been detected in groundwater samples. The identified contamination does not appear to pose a risk to human health under a commercial/industrial land use scenario including maintenance workers (see Section 11).

Risks at the site are to be addressed by the Remedial Works Plan. These include:

- The known soil contamination discussed in Section 8.
- The potential for variable contamination conditions to those detected may exist between sample locations within the heterogeneous fill and considering the low sample density across the site. The variable contamination could fall into the following categories:
    1. Unidentified contamination that is similar in nature and magnitude to the known PAH and TPH contamination
    2. Unidentified TPH and PAH contamination at higher concentrations than identified
    3. Other unidentified types of contamination such as volatile contamination that may pose a vapour intrusion risk and exposure pathway to human receptors; asbestos contamination from past land uses (rail uses and the adjacent former Ultimo Power Station); or contamination at significantly higher concentrations than identified
    4. Potential for unidentified infrastructure such as USTs.
- Potential risks to human receptors in recreational open space.
- Potential risks to offsite ecological receptors - some wells have only been sampled once, and there is potential for currently unidentified contaminant sources.

In summary, there is known contamination in fill and there is potential variation and uncertainty in distribution of contamination in fill and groundwater. The nature and extent of the contamination has been adequately characterised for the purpose of developing within the RWP a management framework to address the above issues.

12.2 Remedial Works Plan

AECOM has prepared a Remedial Works Plan (RWP) and associated Sampling Analysis and Quality Plan (SAQP) as follows:

- ‘Draft Remedial Works Plan, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Revision C, 25 February 2013, AECOM Australia Pty Ltd (“the RWP”)
- ‘Sampling Analysis and Quality Plan’, Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct, Darling Harbour, NSW’, Revision C, 25 February 2013, AECOM Australia Pty Ltd (“the SAQP”) (included as Appendix B to the RWP).

The RWP will inform the construction environment management plan (CEMP) to be prepared by the development contractor.

With respect to the purpose of providing a management framework to address the issues identified in section 12.1, the key management procedures of the RWP are identified and reviewed in Table 12.1.

Table 12.1: Key Management Procedures

Key Procedure/Element of RWP	Details	Auditor Comment
1) Description of materials that would be expected to be representative of the fill encountered to date.	Based on the materials described in the Coffey borehole logs and in particular that are likely to be excavated at the PPP within the upper 2 m, the RWP indicates that it is expected that the excavated fill materials will comprise the following: • Predominantly sand/sandy gravels. The gravels comprise grey to dark grey rock with some igneous fragments • The presence of some grey, orange brown and cream sandstone fragments • Will be generally odour free and contain relatively low VOCs, as measured using a PID • Will be free of significant discoloration or staining.	This is considered an adequate summary of the logged conditions. Limitations in these descriptions have been noted as logged off auger flights. Also, the known elevated concentrations of PAHs did not correlate to well to visual/olfactory indications. However, overall this is likely to be a reasonable basis for assessing soils that are representative of the known conditions (which acknowledges the presence of some locally high results for PAHs. Acceptable
2) Description of potential variation in contaminant characteristics or identification of unanticipated contaminants and materials.	The RWP indicates that potential variations may be indicated by the following: • Soil that appears to be contaminated based on visual and olfactory (odour) observations • Soil that contains significant (defined as 50 ppm) VOC concentrations (as measured during the field screening of bagged soils samples using a PID • Groundwater that appears to be contaminated based on visual and olfactory (odour) observations (including potential hydrocarbon sheens on the water surface) • Material containing ash or furnace slag • Drums or underground storage tanks with unknown contents (i.e. either contained or potentially leaked into the surrounding soils).	As per 2) above Acceptable

Table 12.1: Key Management Procedures		
Key Procedure/Element of RWP	**Details**	**Auditor Comment**
3) Systematic inspection and screening of walls and base of all trenches.	Systematic inspection of walls and base of all trenches by environmental consultant giving consideration to known conditions from existing logs and data. Description of the materials on the based and wall of the trenches will be logged and recorded. Three soils bag samples collected every 10 m (2 x walls, 1 x base) every 10 m (lineal) using a PID. Photographs will be taken. Samples to be screened using a PID. Details reported in a Construction Contamination Management Report (CCMR).	This will provide additional data to further assess whether site soils have been adequately characterised by the available/current data set for the purpose of assessing suitability for the proposed land use. If "significant changes to the nature and type of contaminants" are identified then further assessment would be required. Further works (in relation to soil and/or groundwater) may be required if contamination differing in nature and extent to the known contamination is identified.
4) Collection and chemical testing of soil samples from service trench excavations where there are "significant changes to the nature and type of contaminants" compared to previous investigations based on visual and olfactory indications and PID readings.	The site auditor will be consulted. Sample rate: Samples from walls and base (2 x walls, 1 x base) per 10 m (lineal). Photographs will be taken. Analytical suite: TPH, PAHs. Additional analytes including metals, TPH C_6-C_9 and BTEX to be added where there are visual/olfactory of PID indications of "different" contamination.	As per 3) above. Asbestos should be added to analytical suite if indicated by observations. Adequate
5) Collection and chemical testing of soil samples from stockpiled spoil to assess for suitability for reuse onsite.	Materials generated from pilings will be stockpiled adjacent to the piling location. Materials generated from trenches will be progressively placed in stockpiles. Sample rate for stockpiled material to be placed below slabs : 1 per 100m^3. Sample rate for stockpiled material to be reused at the surface (open space areas or trenches outside building footprints): 1 per 50m^3. Where possible service trenches will be backfilled with VENM. Analytical suite: metals, TPH, BTEX, PAHs. This is to be expanded where there are visual/olfactory indications of "different" contamination.	As per 3) above. Additionally, will provide validation data for to demonstrate reused site-won materials are suitable for the proposed land use. Asbestos should be added to analytical suite if indicated base on observations. Adequate

Table 12.1: Key Management Procedures		
Key Procedure/Element of RWP	**Details**	**Auditor Comment**
	No sample to be greater than 250% of the criteria and standard deviation to be within 50% of criteria.	
6) Collection and chemical testing of soil samples from stockpiled spoil for waste classification for offsite disposal	Sample rate 1 per 500m^3. Analytical suite metals, TPH, BTEX, PAHs, asbestos. TCLP for metals and PAHs. Classification in accordance with DECCW (2009) Waste Classification Guidelines Part 1: Classifying Waste or Part 4 in the case of PASS and AASS. If treatment of excavated material is required to facilitate offsite disposal, an Immobilisation Approval prepared in accordance with DECCW (2009) Waste Classification Guidelines, Part 2: Immobilisation of Waste will be sought from the NSW EPA prior to offsite disposal.	It is the responsibility of the consultant and the receiving landfill facility to confirm that waste has been adequately classified.
7) Management of bonded asbestos containing materials	Use of a licensed Asbestos Removal Contractor (ARC) to remove the ACM. Air monitoring during removal. Sample rate: 1 sample per 10 m (lineal) where asbestos has been removed. Visual inspection and clearance certificate from ARC. If BACM is below 2 m then testing will not be undertaken.	Adequate
8) Assessment of imported material (to be VENM or ENM).	Homogenous quarried material: • Certificate warranting that the material is VENM or demonstrating the physical and chemical quality of the fill, including supporting test data • Visual confirmation that the material is free from contamination as it is imported. Landscaping material (not VENM such as mulch): • Site inspection of the source site • One sample per 100m^3 will be collected and analysed or a minimum of 3 samples per	Adequate

Table 12.1: Key Management Procedures		
Key Procedure/Element of RWP	**Details**	**Auditor Comment**
	source • Analytical suite; metals, PAHS, phenols, TPH, BTEX, OPP, OCP, PCB and asbestos • Visual confirmation that the material is free from contamination as it is imported.	
9) Groundwater monitoring	Monitoring events before and after construction (one round each) A third round in the event of significant variation (defined as exceeding the assessment criteria or an order of magnitude variation between first and second rounds) between sampling events. Sampling of 14 existing wells. Review of well network in the event of unexpected finds (including soil). Thorough development to be undertaken prior to sampling to minimise sediment. Purging and sampling with low flow pumps. Analyse samples for TPH, BTEX, PAHs, metals. Field filtering for metals only.	This will provide additional data on which to further assess the potential risk of offsite migration and associated ecological risk. Details on method to be used for well development not provided. Thorough development recommended to minimise risk of false positives. Adequate. Further works (in relation to soil and/or groundwater) may be required based on outcome of the additional testing.
Recreational Open Space validation	Additional characterisation requirements to be determined based on final layout. Sampling protocol to be approved by site auditor.	Adequate

Based on the above, the Auditor considers that the management framework provided by the RWP is adequate to manage the known contamination in fill and the potential variation and uncertainty in distribution of contamination in fill and groundwater. Competent implementation of the RWP will ensure that the site is suitable for the proposed use.

13 Compliance with Regulatory Guidelines and Directions

Guidelines currently approved by the EPA under section 105 of the NSW *Contaminated Land Management Act 1997* are listed in Appendix C. The Auditor has used these guidelines.

The investigations were generally conducted in accordance with SEPP 55 Planning Guidelines and reported in accordance with the EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*.

14 Conclusions and Recommendations

The management framework acknowledges that the fill materials are heterogeneous and a low sampling density has been achieved across the site. There may be variation in soil and groundwater contaminant characteristics between sampling locations. However, it is the Auditor's opinion that:

- The nature and extent of contamination has been adequately characterised for the purpose of developing a management framework.
- The management framework is adequate to manage the "uncertainty" associated with the potential variation in the nature and extent of contamination.

Key elements have been incorporated in the RWP that are integral to the ultimate objective of certifying the suitability for the site for the proposed commercial/industrial and open space land uses. These elements are assessed in Section 12.

In summary, the key elements are:

- Appropriate identification of contaminant conditions that vary in nature or extent to the contamination that has currently been characterised.
- Appropriate response to the above including remediation or management if/where necessary.
- Appropriate assessment of site won soils that are to be reused at the surface or in service trenches.
- Validation of in situ soils where they remain near the surface in open space or accessible areas.
- Further assessment of groundwater conditions to provide a more robust data base for assessing potential risks to offsite ecological receptors.

The outcome of these key elements should be documented in an auditable validation report/s at the appropriate time.

15 Other Relevant Information

This audit was conducted on the behalf of Lend Lease Project Management & Construction (Australia) to ultimately provide an independent review by an EPA Accredited Auditor of whether the land is suitable for any specified use or range of uses. However, this initial stage of the audit was conducted to review the suitability and appropriateness of a plan of management as defined in Section 4 (1) (b) (v) of the NSW Contaminated Land Management Act 1997 (the CLM Act).

This summary report may not be suitable for other uses. Coffey and AECOM included limitations in their reports. The audit must also be subject to those limitations. The Auditor has prepared this document in good faith, but is unable to provide certification outside of areas over which he had some control or is reasonably able to check.

The Auditor has relied on the documents referenced in Section 1 of the Site Audit Report in preparing their opinion. If the Auditor is unable to rely on any of those documents, the conclusions of the audit could change.

It is not possible in a Site Audit Report to present all data which could be of interest to all readers of this report. Readers are referred to the referenced reports for further data. Users of this document should satisfy themselves concerning its application to, and where necessary seek expert advice in respect to, their situation.

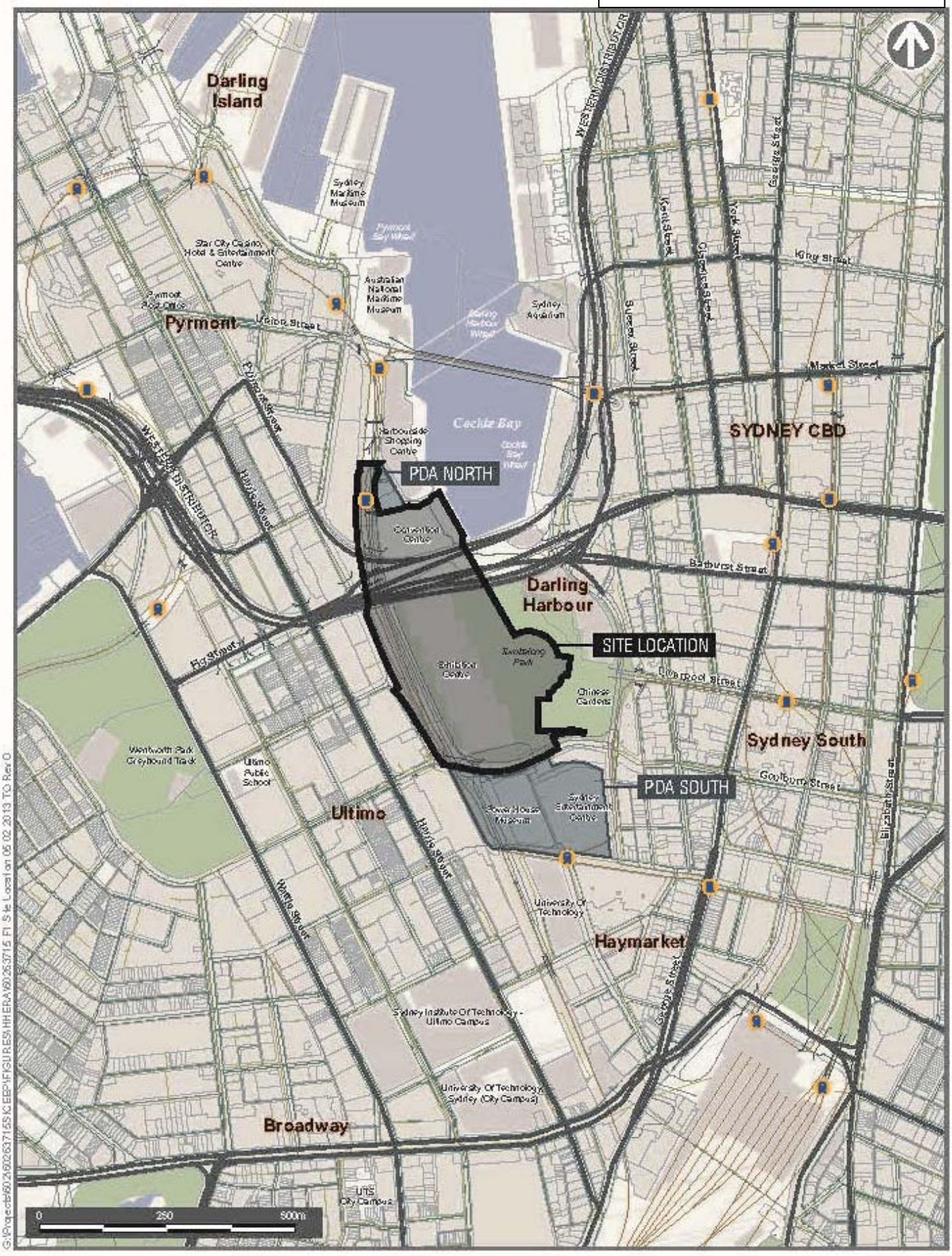
Appendix A: Attachments

Attachment 1: Site Location

Attachment 2: Site Layout

Attachment 3 Soil and Groundwater Investigation Locations

Attachment 1: Site Location



G:\Projects\60260263715\GIS\EPS\FIGURES\WHERA\60263715_F1_Site Location 05 02 2013 TG Rev 0

AECOM

SITE LOCATION

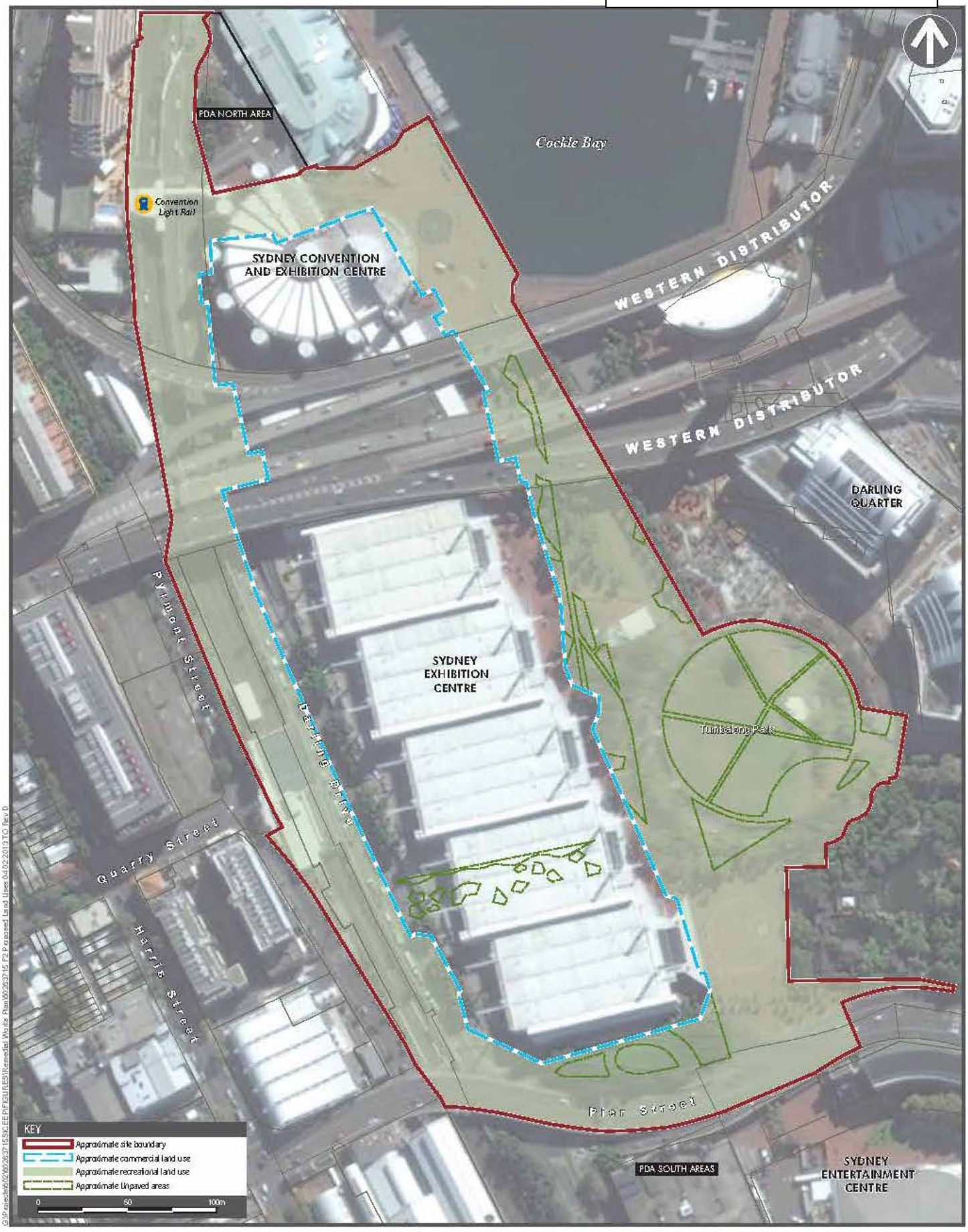
Human Health and Ecological Risk Assessment

Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct

Darling Harbour, New South Wales

FIGURE 1

Attachment 2: Site Layout



AECOM

PROPOSED LAND USES (APPROXIMATE ONLY)
Remedial Works Plan
Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct
Darling Harbour, New South Wales

FIGURE 2

Note: Landuse detail derived from Preferred Master Plan (21/12/2012)

Attachment 3 Soil and Groundwater Investigation Locations

AECOM

SITE LAYOUT AND SAMPLING LOCATIONS

Remedial Works Plan
Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct
Darling Harbour, New South Wales

FIGURE 3

Note: Borehole and Groundwater Monitoring well locations are based on Coffey Geotechnics Figure 1: Borehole location plan showing Coffey Investigations, Revision C, dated 11/01/2013

Appendix B:
Soil and Groundwater Criteria

Soil investigation levels for urban development sites

Department of Environment and Conservation NSW (April 2006)

Substance	Health-based investigation levels[1] (mg/kg)				Provisional phytotoxicity-based investigation levels[2] (mg/kg)
	Residential with gardens and accessible soil (home-grown produce contributing < 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools, primary schools, townhouses, villas (NEHF A)[3]	Residential with minimal access to soil including high-rise apartments and flats (NEHF D)	Parks, recreational open space, playing fields including secondary schools (NEHF E)	Commercial or industrial (NEHF F)	
	Column 1	Column 2	Column 3	Column 4	Column 5
Metals and metalloids					
Arsenic (total)	100	400	200	500	20
Beryllium	20	80	40	100	–
Cadmium	20	80	40	100	3
Chromium (III)[4]	12%	48%	24%	60%	400
Chromium (VI)	100	400	200	500	1
Cobalt	100	400	200	500	–
Copper	1,000	4,000	2,000	5,000	100
Lead	300	1,200	600	1,500	600
Manganese	1,500	6,000	3,000	7,500	500
Methyl mercury	10	40	20	50	–
Mercury (inorganic)	15	60	30	75	1[5]
Nickel	600	2,400	600	3,000	60
Zinc	7,000	28,000	14,000	35,000	200
Organics					
Aldrin + dieldrin	10	40	20	50	–
Chlordane	50	200	100	250	–
DDT + DDD + DDE	200	800	400	1,000	–
Heptachlor	10	40	20	50	–
PAHs (total)	20	80	40	100	–
Benzo(a)pyrene	1	4	2	5	–
Phenol[6]	8,500	34,000	17,000	42,500	–
PCBs (total)	10	40	20	50	–
Petroleum hydrocarbon components[7]					
> C16–C35 (aromatics)	90	360	180	450	–
> C16–C35	5,600	22,400	11,200	28,000	–
> C35 (aliphatics)	56,000	224,000	112,000	280,000	–
Other					
Boron	3,000	12,000	6,000	15,000	–[8]
Cyanides (complex)	500	2,000	1,000	2,500	–

Soil investigation levels for urban development sites Department of Environment and Conservation NSW (April 2006)					
Substance	**Health-based investigation levels[1] (mg/kg)**				**Provisional phytotoxicity-based investigation levels[2] (mg/kg)**
	Residential with gardens and accessible soil (home-grown produce contributing < 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools, primary schools, townhouses, villas (NEHF A)[3]	Residential with minimal access to soil including high-rise apartments and flats (NEHF D)	Parks, recreational open space, playing fields including secondary schools (NEHF E)	Commercial or industrial (NEHF F)	
	Column 1	Column 2	Column 3	Column 4	Column 5
Cyanides (free)	250	1,000	500	1,250	–

1 The limitations of health-based soil investigation levels are discussed in Schedule B(1) Guidelines on the Investigation Levels for Soil and Groundwater and Schedule B(7a) Guidelines on Health-based Investigation Levels, *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999)

2 The provisional phytotoxicity-based investigation levels proposed in this document are single number criteria. Their use has significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. They are intended for use as a screening guide and may be assumed to apply to sandy loam soils or soils of a closely similar texture for pH 6–8.

3 National Environmental Health Forum (NEHF) is now known as enHealth.

4 Soil discolouration may occur at these concentrations.

5 Total mercury

6 Odours may occur at these concentrations.

7 The carbon number is an 'equivalent carbon number' based on a method that standardises according to boiling point. It is a method used by some analytical laboratories to report carbon numbers for chemicals evaluated on a boiling point GC column.

8 Boron is phytotoxic at low concentrations. A provisional phytotoxicity-based investigation level is not yet available.

Notes:

This table is adapted from Table 5-A in Schedule B(1): Guidelines on Investigation Levels for Soil and Groundwater to the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC 1999).

Soil investigation levels (SILs) may not be appropriate for the protection of ground water and surface water. They also do not apply to land being, or proposed to be, used for agricultural purposes. (Consult NSW Agriculture and NSW Health for the appropriate criteria for agricultural land.)

SILs do not take into account all environmental concerns (for example, the potential effects on wildlife). Where relevant, these would require further consideration.

Impacts of contaminants on building structures should also be considered.

For assessment of hydrocarbon contamination for residential land use, refer to the *Guidelines for Assessing Service Station Sites* (EPA 1994).

Threshold Concentrations for Sensitive Land Use – Soils Guidelines for Assessing Service Station Sites (NSW EPA 1994)	
Contaminant	**Threshold Concentration (mg/kg)**
TPH (C_6-C_9)	65
TPH (C_{10}-C_{36})	1,000
Benzene	1
Toluene	1.4 / 130
Ethylbenzene	3.1 / 50
Xylenes (total)	14 / 25

Trigger Values (TV) for Screening Marine Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
Metals and Metalloids		
Arsenic – As (III/V)	2.3/4.5	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Cadmium – Cd	0.7	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Mercury – Hg	0.1	
Nickel – Ni	7	ANZECC (2000) 99% protection level due to potential for toxicity.
Manganese – Mn	80	Low reliability trigger values (derived from the mollusc figure) from Volume 2 of ANZECC (2000)
Chromium – Cr (III/VI)	27.4/4.4	ANZECC (2000) 95% protection levels.
Copper – Cu	1.3	
Cobalt – Co	1	
Lead – Pb	4.4	
Zinc – Zn	15	
Aromatic Hydrocarbons		
Benzene	700	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Toluene	180	
Ethylbenzene	5	
o-xylene	350	
m-xylene	75	
p-xylene	200	
Polycyclic Aromatic Hydrocarbons		
Naphthalene	50	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Anthracene	0.01	Low reliability trigger values from Volume 2 of ANZECC (2000)
Phenanthrene	0.6	
Fluoranthene	1	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Benzo(a)pyrene	0.1	
Chlorinated Alkanes and Alkenes		
Tetrachloroethene (PCE)	70	Low reliability trigger values (95% level of protection)
1,1,2-Trichloroethene (TCE)	330	
Vinyl chloride (chloroethene)	100	
1,1,1-Trichloroethane	270	
1,1-Dichloroethene	700	
1,1-Dichloroethane	250	
1,2-Dichloroethane	1900	
1,1,2-Trichloroethane	1900	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Chloroform	370	Low reliability trigger value (95% level of protection)
Non-Metallic Inorganics		
Ammonia Total – NH_3 (at pH of 8)	910	ANZECC (2000) 95% protection levels.
Cyanide (Free or unionised HCN)	4	

While the low reliability figures should not be used as default guidelines they will be useful for indicating the quality of groundwater migrating off-site.

Trigger Values (TV) for Screening Fresh Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
Metals and Metalloids		
Arsenic – As (III/V)	24/13	ANZECC (2000) 95% protection levels.
Boron - B	370	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Cadmium – Cd	0.2	ANZECC (2000) 95% protection levels.
Nickel – Ni	11	
Manganese – Mn	1900	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Mercury – Hg	0.06	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Chromium – Cr (III/VI)	3.3/1.0	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000) for Cr (III) and Co
Cobalt – Co	2.8	
Copper – Cu	1.4	ANZECC (2000) 95% protection levels.
Lead – Pb	3.4	
Zinc – Zn	8.0	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Aromatic Hydrocarbons		
Benzene	950	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Toluene	180	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Ethylbenzene	80	
m-xylene	75	
o-xylene	350	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
p-xylene	200	
Polycyclic Aromatic Hydrocarbons		
Naphthalene	16	ANZECC (2000) 95% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Anthracene	0.01	Low reliability trigger values from Volume 2 of ANZECC (2000)
Phenanthrene	0.6	
Fluoranthene	1	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Benzo(a)pyrene	0.1	
Organochlorine Pesticides		
Aldrin	0.001	Low reliability trigger values from Volume 2 of ANZECC (2000)
DDE	0.03	
Dieldrin	0.01	
Endosulfan α	0.0002	
Endosulfan β	0.007	
Chlordane	0.03	ANZECC (2000) 95% protection levels
DDT	0.006	
Lindane	0.2	
Endosulfan	0.03	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Endrin	0.01	
Heptachlor	0.01	
Organophosphorus Pesticides		
Azinphos methyl	0.01	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute

Trigger Values (TV) for Screening Fresh Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
		toxicity to particular species.
Methoxychlor	0.005	Low reliability trigger values from Volume 2 of ANZECC (2000)
Dementon-S-methyl	4	
Chloropyrifos	0.01	ANZECC (2000) 95% protection levels
Diazinon	0.01	ANZECC (2000) 95% protection levels
Dimethoate	0.15	
Fenitrothion	0.2	
Malathion	0.05	
Parathion	0.004	
Non-Metallic Inorganics		
Total Ammonia as N (pH of 8)	900	ANZECC (2000) 95% protection levels
Cyanide (Free or unionised)	7	
Nitrate	700	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
NO_x	40	ANZECC (2000) Default trigger values for physical and chemical stressors for slightly disturbed ecosystems in lowland rivers of South-east Australia. The trigger values for TP and TN are 25 µg/L and 350 µg/L, respectively, for east flowing coastal rivers in NSW.
Total Nitrogen	500	
Total Phosphorous	50	
Ammonium ($NH4^+$)	20	
Chlorine	3	ANZECC (2000) 95% protection levels.
Phenols		
Phenol	320	ANZECC (2000) 95% protection levels
2,4-dimethylphenol	2	Low reliability values (95% level of protection) from Volume 2 of ANZECC (2000)
Chlorinated Alkanes and Alkenes		
Tetrachloroethene (PCE)	70	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,1,2-Trichloroethene (TCE)	330	
Vinyl chloride (chloroethene)	100	
1,1,1-Trichloroethane	270	
1,1-Dichloroethene	700	
1,1-Dichloroethane	90	
1,2-Dichloroethane	1900	
Chloroform	370	
1,1,2-Trichloroethane	6500	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Chlorinated Aromatic Hydrocarbons		
1,3-dichlorobenzene	260	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,4-dichlorobenzene	60	
1,2,4-trichlorobenzene	85	
Hexachlorobenzene	0.05	Low reliability values (95% level of protection) from Volume 2 of ANZECC (2000). (QSAR derived)
Miscellaneous Industrial Chemicals		
Hexachlorobutadiene	0.04	Environmental Concern Level from Volume 2 of ANZECC (2000)

While the low reliability figures should not be used as default guidelines they will be useful for indicating the quality of groundwater migrating off-site.

Appendix C:
EPA Approved Guidelines

Guidelines made or approved by the EPA under section 105 of the *Contaminated Land Management Act 1997*

(*as of 12 July 2012*)

Section 105 of the Contaminated Land Management Act 1997 (CLM Act) allows the Environment Protection Authority (EPA) to make or approve guidelines for purposes connected with the objects of the Act. These guidelines must be taken into consideration by the EPA whenever they are relevant and by accredited site auditors when conducting a site audit. They are also used by contaminated land consultants in undertaking investigation, remediation, validation and reporting on contaminated sites.

Guidelines made by the EPA

- Guidelines for Assessing Service Station Sites (December 1994)
- Guidelines for the Vertical Mixing of Soil on Former Broad-acre Agricultural Land (January 1995)
- Sampling Design Guidelines (September 1995)
- Guidelines for Assessing Banana Plantation Sites (October 1997)
- Guidelines for Consultants Reporting on Contaminated Sites (reprinted August 2011)
- Guidelines for Assessing Former Orchards and Market Gardens (June 2005)
- Guidelines for the NSW Site Auditor Scheme, 2nd edition (April 2006)
- Guidelines for the Assessment and Management of Groundwater Contamination (March 2007)
- Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 (June 2009)

Note: All references in the EPA's contaminated sites guidelines to the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, November 1992) are replaced as of 6 September 2001 by references to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, October 2000), subject to the same terms.

Guidelines approved by EPA

ANZECC publications

- Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites, published by Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC) (January 1992)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, published by ANZECC and Agriculture and Resource Management Council of Australia and New Zealand, Paper No 4 (October 2000)

EnHealth publications (formerly National Environmental Health Forum monographs)

- Composite Sampling, Lock, W. H., National Environmental Health Forum Monographs, Soil Series No.3, 1996, SA Health Commission, Adelaide
- Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards, Department of Health and Ageing and EnHealth Council, Commonwealth of Australia (June 2002)

National Environment Protection Council publications

- National Environment Protection (Assessment of Site Contamination) Measure 1999

The Measure consists of a policy framework for the assessment of site contamination, Schedule A (Recommended General Process for the Assessment of Site Contamination) and Schedule B (Guidelines).

- Schedule B guidelines include:

  B(1) Guideline on Investigation Levels for Soil and Groundwater
  B(2) Guideline on Data Collection, Sample Design and Reporting
  B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils
  B(4) Guideline on Health Risk Assessment Methodology
  B(5) Guideline on Ecological Risk Assessment
  B(6) Guideline on Risk-based Assessment of Groundwater Contamination
  B(7a) Guideline on Health-based Investigation Levels
  B(7b) Guideline on Exposure Scenarios and Exposure Settings
  B(8) Guideline on Community Consultation and Risk Communication
  B(9) Guideline on Protection of Health and the Environment During the Assessment of Site Contamination
  B(10) Guideline on Competencies and Acceptance of Environmental Auditors and Related Professionals

Other documents

- Guidelines for the Assessment and Clean Up of Cattle Tick Dip Sites for Residential Purposes, NSW Agriculture and CMPS&F Environmental (February 1996)
- Australian Drinking Water Guidelines, NHMRC (2011)