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SPECIALISTS IN ENVIRONMENTAL,
SOCIAL AND SAFETY PERFORMANCE

OVERARCHING REMEDIAL ACTION PLAN HAYMARKET PRECINCT, DARLING HARBOUR, SYDNEY NSW

Prepared for:

Lend Lease Development
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ABBREVIATIONS

µg/L	micrograms per litre
AEC	Area of Environmental Concern
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASLP	Australian Standard Leaching Procedure
ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soil Management Plan
bgs	below ground surface
BH	Borehole
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
btoc	Below Top of Casing
C6-C36	Hydrocarbon chainlength fraction
COPC	Chemicals of Potential Concern
CSMP	Construction Site Management Plan
DBYD	Dial Before You Dig
DQO	Data Quality Objectives
EMP	Environmental Management Plan
EPA	Environmental Protection Authority of NSW
eV	Electron Volt
GIL	Groundwater Investigation Level
HHERA	Human Health & Environmental Risk Assessment
HIL	Health Investigation Level

HIL	Health Investigation Level
HSIS	Safe Work Australia's Hazardous Substance Information System (HSIS)
HSL	Health Screening Level
INSW	Infrastructure NSW
IP	Interface Probe
LLD	Lend Lease Development (Development Manager for The Haymarket on behalf of Darling Harbour Live)
LOR	Limit of Reporting
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mV	millivolt
MW	Monitoring Well
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NHMRC	National Health & Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
OEH	Office of Environment & Heritage of NSW
PAH	Polycyclic Aromatic Hydrocarbon
PASS	Potential Acid Sulfate Soils
PID	Photoionisation Detector
ppmv	parts per million by volume
PSH	Phase Separated Hydrocarbons
QA	Quality Assurance

QC	Quality Control
RAP	Remedial Action Plan
RB	Rinsate Blank
RPD	Relative Percent Difference
SAQP	Sampling Analysis & Quality Plan
SCEC	Sydney Convention and Exhibition Centre
SEC	Sydney Entertainment Centre
SEPP	State Environmental Protection Policy
SHFA	Sydney Harbour Federation Authority
SICEEP	Sydney International Conference Exhibition and Entertainment Precinct
SOP	Standard Operating Procedures
SVOC	Semi Volatile Organic Compound
SWL	Static Water Level
TB	Trip Blank
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbon
TS	Trip Spike
VENM	Virgin Excavated Natural Material
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

The site is located within the Haymarket district of Sydney's Central Business District and comprises the SEC, associated car park and surrounding public realm. The site covers an area of approximately 4ha and is bound by Pier Street to the north, Hay Street to the south, a light rail corridor to the west and Harbour Street to the east.

The site historically formed a part of Long Cove (i.e. currently known as Cockle Bay) which was reclaimed during the mid-1820s using dredged materials from Sydney Harbour. Following reclamation, historic land uses associated with the site included various industrial processes (e.g. milling, brewing etc.), metal works, a council depot, and more recently, a market place. The SEC, car park and associated public realm was established on the site in the 1980s.

The findings of the environmental desk studies concluded that the likelihood of widespread, unacceptable soil contamination to be low. However, as the localised presence of unacceptable contamination could not be precluded, ground investigations were subsequently carried out to characterise the quality of soil and groundwater conditions at the site.

In summary, four site investigation programmes were undertaken by Coffey between June 2011 and January 2013 across the SICEEP and a review was undertaken of results relevant to the site. The investigation works carried out to date, it is assessed that within practical limits, the density of investigation locations meets the minimum requirements set out in the NSW EPA Sampling Design Guidelines.

In the context of the proposed mixed residential and commercial development proposed by Darling Harbour Live, these investigations identified localised areas of soil contamination within fill materials and shallow natural soils. Potential acid sulfate soil is also present within the natural alluvium where it occurs within the site. No groundwater contamination, which is considered significant enough to warrant detailed investigation and/or remediation, has been encountered within the site.

This Overarching RAP presents remediation goals for the site and evaluates six remedial options to mitigate the potential risks associated with identified soil contamination. In consideration of the nature, type and extent of soil contamination identified, the preferred remedial option comprises a combination of source removal and the use of construction elements included in the proposed development to separate site users from existing soil conditions.

The scope of the remediation and/or management required for the site will be further clarified by the findings of a Human Health & Environmental Risk Assessment (HHERA) and a site specific RAP(s). If the remediation is carried out in accordance with this document including the preferred remedial option presented herein, Coffey concludes that the site can be made suitable for the proposed development.

1 INTRODUCTION

1.1 Background & Overview of the Development Proposals

Darling Harbour Live (formerly known as 'Destination Sydney'- a consortium comprising AEG Ogden, Lend Lease, Capella Capital and Spotless) was announced by the NSW Government in December 2012 as the preferred proponent to transform Darling Harbour and create the new Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP).

The SICEEP Site has been divided into three distinct redevelopment areas (from north to south) – Bayside, Darling Central and The Haymarket. The document relates to The Haymarket as shown in the figure below. Other areas of the SICEEP site are beyond the scope of this report.

Figure 1.1: Overview illustrating the location of The Haymarket relative to other areas within SICEEP

Key features of the Darling Harbour Live Preferred Master Plan for the SICEEP project include the delivery of world-class convention, exhibition and entertainment facilities, including:

- Up to 40,000m^2 exhibition space;
- Over 8,000m^2 of meeting rooms space, across 40 rooms;
- Overall convention space capacity for more than 12,000 people;
- A ballroom capable of accommodating 2,000 people; and
- A premium, red-carpet entertainment facility with a capacity of 8,000 persons.
- Providing up to 900 hotel rooms in a hotel complex at the northern end of the precinct.
- A vibrant and authentic new neighbourhood at the southern end of the precinct, called 'The Haymarket', home to an IQ Hub focused on the creative industries and high-tech businesses, apartments, student accommodation, shops, cafes and restaurants.
- Renewed and upgraded public domain, including an outdoor event space for up to 25,000 people at an expanded Tumbalong Park.
- Improved pedestrian connections linking to the proposed Ultimo Pedestrian Network drawing people between Central, Chinatown and Cockle Bay Wharf as well as east-west between Ultimo/Pyrmont and the City.

In response to separate contractual agreements with the NSW Government and staging requirements Darling Harbour Live is proposing to submit a number of separate development applications for key elements of the overall SICEEP Project.

This staged development application involves the establishment of building envelopes and design parameters for a new neighbourhood and a community hub referred to as The Haymarket (herein referred to as the 'site'). Detailed development applications will follow seeking approval for specific aspects of the site in accordance with the approved staged development application.

This Overarching Remedial Action Plan (Overarching RAP) supports a State Significant Development Application (SSD 12_5752) (herein referred to as the 'Application') being the first stage of a staged development application submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) for the establishment of building envelopes and design parameters for a new neighbourhood and a community hub at the site.

Subsequently, separate detailed development applications will be lodged for the other components of the site. The detailed development applications will be supported by site-specific RAP(s), where the need for remediation in that particular part of the site has been identified. This document and the findings of a Human Health and Environmental Risk Assessment (HHERA) (in preparation) will be used to formulate the site-specific RAP.

1.2 Brief

To support the Application, Coffey Environments Australia Pty. Ltd. (Coffey) was commissioned by LLD to collate and interpret available investigation data for the site and prepare an overarching RAP to detail requirements to mitigate ground contamination risks identified within the site and make the site suitable for the proposed mixed use development.

This work was carried out in general accordance with our proposal dated 5th February 2013 (ref: ENAURHOD04498AA-P01 Rev.1).

1.3 Previous Investigation Reports

Coffey was appointed by Sydney Harbour Foreshore Authority (SHFA) and subsequently by Infrastructure NSW (INSW) to carry out site investigations throughout the SICEEP, which includes the site. A summary of site investigation reports containing data relevant to the site is provided below:

- Coffey Geotechnics (July 2011); *Environmental Desk Study: Proposed Sydney International Convention and Entertainment Centre, Darling Harbour*.
- Coffey Geotechnics (August 2011a) *Geotechnical Investigation Report: Proposed Sydney International Convention and Entertainment Centre, Darling Harbour*.
- Coffey Geotechnics (August 2011b); *Contamination Investigation, Sydney International Convention and Entertainment Centre*.
- Coffey Geotechnics (May 2012); *Geotechnical Investigation Report: Proposed Sydney International Convention Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney*.
- Coffey Geotechnics (June 2012a); *Stage 1 – Preliminary Environmental Investigation, Sydney International Conference Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney*.
- Coffey Geotechnics (June 2012b); *Stage 2 – Detailed Site Investigation: Sydney International Convention Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney*.
- Coffey Geotechnics (August 2012); *Supplementary Site Investigation: Sydney International Convention Exhibition and Entertainment Precinct (SICEEP), Darling Harbour, Sydney*
- Coffey Geotechnics (January 2013); *Supplementary Site Investigation: Factual Report, Sydney International Convention Exhibition and Entertainment Precinct (SICEEP), Darling Harbour.*

Coffey was appointed by LLD to collate relevant factual data from the above reports into a single document as follows:

- Coffey Environments (February, 2013); *Site Investigation Factual Report: Haymarket Precinct, Darling Harbour, Sydney, NSW*.

Information from the above reports was used to prepare this Overarching RAP.

1.4 Objectives

The objectives of this Overarching RAP are:

- Demonstrate that the investigations carried out to date are sufficient to adequately characterise the site
- Interpret investigation results relevant to the site in the context of the development proposed by Darling Harbour Live and identify areas of soil and groundwater contamination which have the potential to pose a risk to human health and surrounding environmental receptors.
- Present remediation goals for the site.
- Evaluate remediation options to address identified areas of contamination, and justify selection of a preferred remedial option.

- Develop an overarching remediation strategy around the preferred remedial option to mitigate the potential contamination risks at the site to allow it to be made suitable for the proposed mixed use development in accordance with the requirements of Managing Contaminated Land: Planning Guidelines SEPP 55 – Remediation of Land (DUAP/EPA 1998).
- Outline procedures and activities that are required for validating remediation works.
- Outline requirements for a site management plan to be implemented during the remediation works and a long-term environmental management plan to be implemented on completion of remediation works.
- Outline requirements for management of unexpected finds during remediation and/or construction works and for a contingency plan for remediation works.
- Outline the regulatory compliance requirements for remediation works.

1.5 Description of the Proposed Development

Coffey were provided with the following documents which describe the proposed development:

- Destination Sydney Drawing No. MCD AR D101 'Architectural Concept Design – Ground Level Plan'(Rev. F; dated 21st February 2013)
- Destination Sydney Drawing No. MCD AR D102 'Architectural Concept Design – Podium Level Plan'(Rev. D; dated 21st February 2013)
- Destination Sydney Drawing No. MCD AR D103 'Architectural Concept Design – Typical Towers Plan'(Rev. B; dated 21st February 2013)
- Destination Sydney Drawing No. MCD AR D104 'Architectural Concept Design – Roof Level Plan'(Rev. E; dated 21st February 2013)
- Destination Sydney Drawing No. MCD AR SS110 'Architectural Concept Design – Section AA'(Rev. B; dated 18th February 2013)
- Destination Sydney Drawing No. MCD AR SS111 'Architectural Concept Design – Section BB'(Rev. B; dated 21st February 2013)
- Destination Sydney Drawing No. MCD AR SS112 'Architectural Concept Design – Section CC' (Rev. B; dated 18th February 2013)

The above listed drawings are provided in Appendix A.

With reference to the above drawings, the proposed development on the site comprises:

- Residential (with minimum access to soil), retail and commercial premises at ground level with associated public realm comprising managed landscaped and paved areas.
- Realignment of Darling Drive to provide space for residential (including student) accommodation in two multi-storey buildings along the western boundary of the site. It is likely that residential accommodation will be provided within the upper floors, with a lobby provided at ground floor.
- Car parking, commercial premises, residential accommodation (including private open space above the podium car parking), child day-care centre and retail premises above ground level.

- Areas of bio swales commensurate with the principles of water sensitive urban design.
- No basement structures are currently proposed.

1.6 Purpose of Document

The purpose of the Overarching RAP is to:

- Provide an assessment of the adequacy of the investigations carried out to date.
- Identify areas of soil and groundwater contamination which have the potential to pose a risk to human health and surrounding environmental receptors.
- Develop a Conceptual Site Model for the site.
- Develop a preferred approach to remediation of contaminated land that would mitigate the identified contamination risks and allow the site to be made suitable for the uses as set out within the proposed development in accordance with the requirements of Managing Contaminated Land: Planning Guidelines SEPP 55 – Remediation of Land (DUAP/EPA 1998).
- Present an outline remediation validation plan.
- Identify aspects which require further consideration within a Site Management Plan (SMP) for the remediation works based on the preferred remediation option established herein.
- Outline the scope of an Environmental Management Plan (EMP) for the management of the site over the longer term (if required).

Coffey notes that subject to Section 7, a HHERA may be proposed to assess in detail, the current contamination risk at the site and, if necessary, establish site-specific risk-based remediation criteria. These risk-based remediation criteria may be used as a basis to prepare site-specific RAP(s) for a staged implementation of the proposed development. Any site-specific RAP that is prepared will accompany the detailed development applications that will be submitted following approval of this Application.

2 SITE LOCATION & SETTING

2.1 Site Location and Description

The site is located within the Haymarket district of Sydney's Central Business District and comprises the Sydney Entertainment Centre (SEC), associated car park and surrounding public realm. The location of the site and study boundaries is shown in Figure 1.

The site occupies an area of approximately 4ha and is bound by Pier Street to the north, Hay Street to the south, a light rail corridor to the west and Harbour Street to the east. In general, the topography of the site is relatively level. The site layout provided in Figure 2.

The SEC covers the eastern part of the site and comprises a multi-storey building used principally for concerts, sporting and community events. A variety of restaurants, bars and administration/offices exist in areas surrounding a central performance arena. Two loading docks exist along the western façade of the building. Coffey understand that no significant basement structures exist within the SEC.

The SEC multi-storey car park is situated in the western portion of the site. A coach parking area is also established at ground level along the western façade of the car park.

The area between these two structures comprises a secure loading dock for the SEC. A portable cabin used by security staff is located on the north boundary of the loading dock area.

The public realm surrounding the SEC and adjoining car park comprises predominantly concrete, asphalt and brick paved footpaths. Various landscaped areas exist within the site where mature trees are present, having been introduced with construction of the SEC in the late 1980s.

An elevated monorail track crosses the south eastern corner of the site and continues parallel to the southern boundary of the site. The SEC Monorail stop is located on the central southern site boundary immediately adjacent to the car park.

A narrow landscaped verge exists to the west of Darling Drive, extending along the western site boundary. This verge slopes up from kerbside to approximately 1 to 2m above the road surface.

The north western boundary of the site is formed by Pier Street and the off-ramp linking Pier Street and Darling Drive. The north eastern site boundary is formed by the public realm just south of Little Pier Street.

2.2 Surrounding Land Uses

The land uses surrounding the site include:

Table 2.1: Summary of Land Uses Surrounding the Site

North	• Sydney Conference and Exhibition Centre (SCEC), Tumbalong Park and surrounding Darling Harbour public realm exist to the north/northwest. • The Novotel Rockford Hotel is located immediately north of Little Pier Street at the eastern part of the site, beyond which lies the Sydney Chinese Garden of Friendship.
South	• Immediately south lies the light rail monorail corridor.

	• Paddy's Markets and UTS Library are located further south beyond the light rail corridor.
East	• Harbour Street and a variety of restaurants and hotels beyond.
West	• The light rail corridor and the Powerhouse Museum beyond.

2.3 Geology

Published geological records indicate the fill material overlies Quaternary-aged alluvium, which comprises gravel, sand, silt and clay deposits.

Fill materials comprised heterogeneous mixtures of gravelly sand, sandy gravel, gravelly clay, clay and sandy clay/silt. The thickness of fill materials recorded at the site varied between 0.4mbgs and 5.0mbgs. Anthropogenic inclusions observed within the fill included discrete ash layers, fibrous board, concrete, brick, glass, porcelain/ceramic, and metal fragments.

Previous investigations (Coffey; August 2011b, June 2012b, August 2012) reported the presence of potential acid sulfate soils (PASS) and actual acid sulfate soils (ASS) within natural alluvial deposits. The alluvial deposits are underlain by residual soil and rock of Triassic-aged Hawkesbury Sandstone Formation which comprises sandstone, quartz and shale.

Sandstone bedrock beneath the SEC is intersected by the Great Sydney Dyke, which comprises a dolerite intrusion through the sandstone. The dyke is oriented southeast-northwest through the southern part of the site (Coffey, August 2011a).

Table 2.1: General Site-Specific Geology

Material / Origin	Depth to Top of Unit (mbgs)	Thickness of Unit (m)	Material Description
Fill	0	0.4 to 5.0	Fill materials were encountered across the site under surface covering typically comprising reinforced concrete, asphalt or brick paving of approx. 0.1m to 0.3m thick. Fill materials comprised heterogeneous mixtures of sand, gravel, clay and silt. Cobbles and boulders of sandstone were also encountered in several boreholes. Anthropogenic inclusions observed within the fill included discrete ash layers, fibrous board (BH119 only), concrete, brick, glass, porcelain/ceramic, and metal fragments. A number of in-ground obstructions were also encountered. Fill thicknesses typically ranged between 2m to 4m although thicker fill deposits were recorded along the western edge of the SEC car park (NBH25; BH4, BH1) and central area of the site associated with the reclamation of the low lying land at the southern end

Material / Origin	Depth to Top of Unit (mbgs)	Thickness of Unit (m)	Material Description
			of Cockle Bay. Thinner fill was encountered in boreholes along the western façade of the SEC although reliability of reported fill thickness in this area is uncertain due to the presence of obstructions.
Alluvium	2.1 to 4.5	1.3 to 12 (Where encountered)	Alluvium comprised clayey sands and clays with occasional shell layers and natural organic matter. Previous investigations (Coffey; August 2011b, June 2012b, August 2012) have reported the presence of PASS and ASS. Alluvial deposits were thickest within the central part of the site (i.e. BH5, BH6, BH7) with these deposits typically thinning to the east and west of the site.
Residual Soil	5.8 to 10.8	0.6 to 2.9 (Where encountered)	Previous investigations recorded residual soils comprising of Sand, clayey sand or sandy clay (Coffey; August 2011b, June 2012b, August 2012, January 2013).
Weathered Sandstone	5.6 to 15.8	0.1 to >4.0	Sandstone encountered during previous investigations (Coffey, August 2011b, June 2012b) comprised weathered, fine to medium grained orange, pale grey, brown sand or clayey sand.

2.4 Hydrogeology

Recent ground investigations (Coffey, January 2013) reported groundwater strikes at depths between 2.4mbgs (BH120) to 3.0mbgs (BH118, BH127) which generally coincided with the upper alluvial deposits. Coffey (August 2011) reported that groundwater flows in a northerly direction towards Cockle Bay.

Standing groundwater levels were measured in MW120 continually between 10 and 14 January 2013 using a data logger to assess a possible influence from tidal fluctuations in Cockle Bay (Coffey, January 2013). Groundwater levels measured over this 5 day period ranged between 0.751mAHD and 0.788mAHD. The observed period of variation was between one and several days, which suggests that tidal fluctuations in Cockle Bay have negligible influence on groundwater levels within the site.

2.5 Hydrology

No water bodies are located within the site. Cockle Bay is the nearest surface water feature and is located approximately 475m to the north.

Coffey (June 2012b) notes that several artificial water features are present within the SICEEP and surrounding areas (e.g. Sydney Chinese Garden of Friendship site). Coffey understands these water bodies are hydraulically separated from the underlying groundwater.

2.6 Site History

A detailed appraisal of the historical uses of the site is presented within the Environmental Desk Study report (Coffey, July 2011) and Stage 1 Preliminary Environmental Investigation (Coffey, June 2012). Copies of these reports are provided in Appendix E and F.

A summary of the sites historical uses are provided below:

Table 2.2: Chronological summary of historical site uses

Period	Description of Land Uses
1813	Commenced use of the land for grinding corn, soap making, brewing, and salting beef
c.1826	Reclamation of Long Cove (i.e. Cockle Bay) shoreline commenced. A review of historic maps indicated that Cockle Bay (referred to historically as Long Cove), extended south beyond the current alignment of Hay Street. The material used for reclamation comprised 'sand and silt ….. obtained by dredging in various parts of the harbour, the material being deposited where possible'
1831-1836	Construction of a mill/warehouse was completed on the reclaimed land.
1840s-1860s	The land was leased to several tenants and used for various purposes including storage, and manufacture and bottling of soda water.
1868	Lease of the land was transferred to Simon Zollner and a galvanising iron works established. Additional metal works were also conducted on-site throughout this period.
c.1890	Most of the land had been covered and was used as storage space. Railway had been established to the north of Pier Street.
1905-1925	A Salvation Army shelter was established on the site.
1932-1937	Most of the site was demolished to allow construction of a Council Depot.
1949	Site used as a City Market place.
1983	Sydney Entertainment Centre was officially opened.

A detailed appraisal of the historical uses of the site, including selected aerial photographs, historic parish map extracts and returns from various data searches is presented within the Environmental Desk Study report (Coffey, July 2011) and Stage 1 Preliminary Environmental Investigation (Coffey, June 2012).

2.7 Areas of Environmental Concern and Contaminants of Potential Concern

From a review of the historical information collated in the Stage 1 Preliminary Site Investigations (Coffey; July 2011, June 2012), no specific Areas of Environmental Concern (AEC) were identified and Coffey considered the likelihood of widespread, unacceptable soil contamination to be low. However, as the localised presence of unacceptable contamination could not be precluded, Coffey recommended investigations to characterise the quality of soil and groundwater conditions at the site. The following land uses were considered to have the potential to result in contamination:

- Historic reclamation of Long Cove (i.e. Cockle Bay) using materials dredged from unknown areas of Sydney Harbour, which may contain elevated levels of heavy metals, organic compounds and PASS[1].
- Records indicate historic uses of the site comprised various industrial processes (e.g. milling, brewing etc.), galvanising iron works and other metal works, various storage uses, a council depot, and a market place. Contaminants typically associated with such land uses comprise heavy metals, fuels and oils, asbestos and various solvents.
- The natural alluvial deposits may contain ASS.

In summary, the following Contaminants of Potential Concern (COPC) were identified and considered within subsequent investigations carried out in four separate phases between June 2011 and January 2013:

- Heavy metals including Arsenic, Cadmium, Copper, Chromium, Mercury, Nickel, Lead and Zinc.
- Total petroleum hydrocarbons (TPH)
- Benzene, toluene, ethylbenzene, xylene (BTEX)
- Polycyclic aromatic hydrocarbons (PAH)
- Volatile organic compounds (VOC)
- Semi volatile organic compounds (SVOC)
- Asbestos
- Acid sulfate soil

A summary of the previous investigations carried out within the site is provided within Section 3.

[1] Given that potential ASS is likely to have oxidised prior to placement on-site, the likelihood of ASS in fill soils is considered to be low.

3 PREVIOUS SITE INVESTIGATIONS

3.1 General

Four site investigation programmes were undertaken by Coffey between June 2011 and January 2013. Results from these investigations, without interpretation, have been collated into a single document (Coffey February 2013), which presents factual information from these investigations, a summary of investigation and sampling methods used and a summary of laboratory data relevant to the site.

The following section provides a general overview of the scope of these four investigation programmes. A detailed description of the investigation and sampling methods used during these investigations is provided within the individual reports as listed in Section 1.3.

3.2 Scope of Investigation Completed

The following investigation works have been completed within the site:

- Intrusive investigation of the subsurface including observation, logging and collection of soil samples for characterisation and quality control from 52 boreholes. Soil logging and sampling was undertaken by suitably qualified and experienced environmental professionals in accordance with Coffey's Standard Operating Practices (SOP), which are based on relevant Australian standards and good industry practice. Borehole logs are presented in Appendix B.
- Analysis of selected soil samples from each borehole for selected COPC from:
    a) Heavy metals (Arsenic, Cadmium, Copper, Chromium, Mercury, Nickel, Lead and Zinc)
    b) Total petroleum hydrocarbons (TPH),
    c) Polycyclic aromatic hydrocarbons (PAH),
    d) Benzene, toluene, ethylbenzene and total xylene (BTEX),
    e) Volatile and Semi-volatile organic compounds (VOC / SVOC), and
    f) Asbestos.
- Installation of nine groundwater monitoring wells; identified as MW1, MW6, MW9, MW12, MW13, MW25, MW30, MW120 and MW124.
- Analysis of groundwater samples from eight of the above wells for a range of COPC including TPH, BTEX, PAH, VOC, and SVOC. Location MW124 was found to be dry during the monitoring event.
- Collation of field records and tabulation of relevant laboratory results from the four investigation programmes.

The following additional aspects of investigation were included in the Supplementary Site Investigation (Coffey Jan 2013):

- Collection of field duplicate samples at a frequency of approximately 1 duplicate for every 3 primary samples and laboratory analysis for TPH, PAH, BTEX and VOC/SVOC to assess the heterogeneity of fill material.

- Analysis of selected samples in accordance with the Australian Standard Leaching Procedure (ASLP) using a neutral leaching solution as an indication of potential for groundwater impact, and the Toxicity Characteristic Leaching Procedure (TCLP) to provide results for a preliminary assessment of waste classification.
- Field filtered duplicate groundwater samples were collected from MW6, MW9, MW20, MW25, MW30 and MW120. These samples were analysed for PAH compounds to assess the proportion of reported PAH concentrations attributable to fine sediment suspended in groundwater samples.
- Installation of data loggers in four monitoring wells across the SICEEP, including well MW120 within the site, to record the variability of groundwater levels continually over several days.

The location of the investigation locations for the above works is also shown in Figure 3.

Analytical sample results are summarised in Table 1 to 9 provided in Appendix C. Laboratory analytical certificates included in Appendix D.

3.3 Sampling Analysis & Quality Plan

3.3.1 Soil Sampling Pattern and Density

As no specific AECs were identified within the site, boreholes were positioned to provide a regular sampling grid across the site. With the investigations undertaken successively, certain boreholes were used to target specific areas where elevated COPC were identified previously; namely:

- Boreholes CBH5/CBH5A, CBH6, CBH7/CBH7A and CBH8 were positioned to target the area surrounding Boreholes NBH24 and EB1where concentrations of TPH and PAH were identified.
- Boreholes CBH9, CBH10 and CBH11 were positioned to target the area surrounding Boreholes NBH29 and BH10 where concentrations of TPH and PAH were identified.

It is noted that drilling and access restrictions (predominantly the existing Sydney Entertainment Centre building and underground services) prevented establishment of a regular sampling grid within the footprint of the SEC. Because the existing Sydney Entertainment Centre building occupies a substantial area within the site, INSW negotiated for drilling of five boreholes within the SEC footprint (Coffey, January 2013).

On review of the available investigation data for the site, Coffey notes the following:

- The Sampling Design Guidelines (NSW EPA, 1995) recommends 50 sampling positions to identify a contamination hotspot of 33.4m diameter with 95% confidence in a site of 4ha in size.
- A total of 52 borehole locations have been established within the site, of which soil samples were obtained and analysed from 50 boreholes. Soil samples recovered from boreholes BH7 and BH16 were not scheduled for chemical analysis.

- Coffey considers that boreholes at 11 of the 52 locations[2] were too closely spaced to qualify as a separate sampling location on an approximately square grid used in calculation of detected hotspot diameter. Thus, the number of independent sampling locations reduces to 39. The existing Sydney Entertainment Centre building occupies approximately 1.1 hectares, and 5 sampling locations are within the building. Thus, 34 independent sampling locations are within the remaining 2.9 hectares of the site. Using Procedure A from the NSW EPA Sampling Design Guidelines, this density of locations is expected to detect a hotspot of 34.5m diameter with 95% confidence, which is slightly larger than the hotspot diameter of 33.4m for assessment of a 4 hectare site as listed in Table A of the NSW EPA Sampling Design Guidelines. Coffey considers that, within practical limits, the density of investigation locations meets the minimum requirements set out in the NSW EPA Sampling Design Guidelines. Coffey notes that, as detailed in Section 7.9, a number of contingency plans including an Unexpected Finds Protocol will be developed and in place prior to carrying out any remediation works on the site.
- Chemical testing was carried out for the range of COPC identified within the desk study, albeit the actual laboratory testing carried out was targeted to reflect field observations and soil headspace screening results regarding analysis for VOC and SVOC.

3.3.2 Groundwater Investigation & Sampling

The rationale for the establishment of groundwater monitoring well locations comprised:

- Establish wells around the perimeter of the site as well as within the site to assess groundwater flow direction because of the likely influence of sandstone ridges to the east and west of the site,
- Placement of two wells on the northern edge of the site and down gradient of areas where soil contamination had been previously identified; namely, MW6 and MW9.

3.3.3 Quality Assurance / Quality Control Procedures (QA/QC)

Previous investigation programmes adopted a range of quality control measures to assess the reliability of field and laboratory procedures. A detailed appraisal of the QA/QC procedures is presented within the individual investigation reports listed in Section 1.3 and findings are summarised in this section.

Field QC measures included the collection and analysis of duplicate and triplicate samples, equipment rinsate samples, and inclusion of laboratory prepared trip blank and trip spike samples. Samples were collected in laboratory provided containers and transported to the laboratory under Chain of Custody control.

All chemical testing was undertaken by Laboratories who are NATA-accredited for the analysis they performed. Furthermore, the project laboratories also performed an internal QA/QC assessment where laboratory prepared duplicates, method blanks, matrix spikes and surrogate spikes were analysed to assess measurement bias associated with particular analytical techniques.

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[2] Boreholes considered by Coffey to be in close proximity were: CBH5 / CBH5A; CBH7 / CBH7A; BH4 / NBH/MW25; EB2 / NBH26; BH10 / NBH29; BH9 / NBH/MW30 / BH125A; BH13(MW) / BH119; BH121 / BH121A; BH122 / BH122A; and BH123 / BH123A.

3.3.4 Sampling Density & Data Quality Assessment - Summary

Following review of the investigation data collated for the site, Coffey considers that the investigations carried out to date have adequately characterised ground contamination conditions at the site given that:

- The soil sampling density meets, within practical limitations, the recommendations set out in the NSW EPA Sampling Design Guidelines for a site covering 4ha. Samples were analysed for a range of COPC consistent with that identified in the desk study.
- Groundwater sampling has been carried out at eight locations with two of these wells positioned to target areas where soil contamination had been detected.
- Coffey considers that the sample handing, laboratory precision/accuracy, field and laboratory QA/QC procedures are adequate and the data can be directly used for the assessment of ground contamination conditions.

4 ASSESSMENT CRITERIA

4.1 Soil Investigation Levels

The assessment criteria proposed for this project were sourced from:

- NSW DEC (2006) Guidelines for the NSW Auditor Scheme (Second Edition)
- NSW EPA (1994) Guidelines for Assessing Service Station Sites
- NEPC (1999) National Environmental Protection (Assessment of Site Contamination) Measure (NEPM).

NEPC (1999) and NSW DEC (2006) provide soil investigation levels (health-based investigation levels (HIL)) and ecological investigation levels (EIL) for various exposure settings and the NSW DEC (2006) provides a decision-making process for assessing suitability of a site for proposed urban redevelopment, and this process is consistent with the Development Application Process outlined in Figure 3 of Managing Contaminated Land: Planning Guidelines SEPP 55 – Remediation of Land (DUAP/EPA 1998).

For the purposes of this report, it has been assumed that the site will be redeveloped for mixed uses. With reference to information provided to Coffey, we consider that the exposure setting for future mixed uses proposed after completion of construction is reasonably represented by that for high density residential use (i.e. residential with minimal opportunities for soil access including dwellings with permanently paved yard space, high rise apartments and flats).

It is currently understood that a child day-care centre may be provided within the upper floors of the development. Although no further, specific details of the child day-care centre are available at this stage, this Overarching RAP has been prepared on the assumption that the exposure setting for infants attending a day-care facility within the upper floors of the development would be similar to that of a high rise residential setting with minimal access to soils.

As the extent of public open space within the development has not been finalised, available soil data was also compared to HIL for public open spaces.

Coffey considers that the exposure setting for future remediation and construction works on the site is represented by that for commercial / industrial land uses. Therefore the following HILs were adopted for this assessment:

- Column D, Table 5-A, Soil Investigation Levels for Residential uses with minimum access to soil uses; Schedule B(1), Guideline on the Investigation Levels for Soil and Groundwater, NEPC (1999). It is assessed that the above criteria would also be suitable for the assessment of potential health risks to infants attending a child care facility within the upper floors of the development and minimal access to soils.
- Column E, Table 5A, Soil Investigation Levels for Parks, Recreational Open Space and Playing Fields to assess potential health risks to users of the public open spaces; Schedule B(1), Guideline on the Investigation Levels for Soil and Groundwater, NEPC (1999).
- Column F, Table 5-A, Soil Investigation Levels for Commercial/Industrial uses as a preliminary screening level to assess potential risks to assess potential risks to Construction Workers during future remediation and construction workers on the site and workers within the proposed

Commercial/Retail elements of the proposed development; Schedule B(1), Guideline on the Investigation Levels for Soil and Groundwater, NEPC (1999).

- Currently, there are no nationally endorsed HILs for volatile petroleum hydrocarbons. Sensitive land use thresholds (health-based) for petroleum compounds published in NSW EPA (1994) have been used to supplement those published by NEPC (1999).
- A criterion of 'no asbestos detected' was adopted as a screening level for assessing asbestos in soil.
- US EPA Region 9 Soil Screening Levels for Residential and Industrial land uses (dated November 2012) were adopted for SVOC that were reported above the Laboratory Limit of Reporting (LOR)[3]. For SVOC and VOC where no authoritative investigation levels are readily accessible, the LOR was used as a preliminary investigation level.

A summary of the adopted soil health investigation levels is provided in Table 4.1.

Table 4.1: Soil Assessment Criteria

Chemical Constituent	Health Investigation Levels for Future Mixed Used of the Site High Density Residential Adopted from HIL D (mg/kg)	Health Investigation Levels for Users of Public Open Space Adopted from HIL E (mg/kg)	Health Investigation Levels for Remediation/ Construction Workers & Future Commercial Workers Adopted from HIL F (mg/kg)
Arsenic	400	200	500
Cadmium	80	40	100
Chromium (VI)	400 [4]	200 [4]	500 [4]
Copper	4000	2000	5000
Nickel	2400	600	3000
Lead	1200	600	1500
Zinc	28000	14000	35000
Mercury	60	30	75
TPH C_6-C_9	65 [2]	65 [2]	65 [2]
TPH C_{10}-C_{36}	1000 [2]	1000 [2]	1000 [2]
Benzene	1 [2]	1 [2]	1 [2]
Toluene	130 [2]	130 [2]	130 [2]
Ethylbenzene	50 [2]	50 [2]	50 [2]
Total Xylene	25 [2]	25 [2]	25 [2]

[3] US EPA Region 9 Soil Screening Levels for Residential Land Uses available: http://www.epa.gov/region9/superfund/prg/

Chemical Constituent	Health Investigation Levels for Future Mixed Used of the Site High Density Residential Adopted from HIL D (mg/kg)	Health Investigation Levels for Users of Public Open Space Adopted from HIL E (mg/kg)	Health Investigation Levels for Remediation/ Construction Workers & Future Commercial Workers Adopted from HIL F (mg/kg)
Benzo(a)pyrene	4	2	5
Total PAHs	80	40	100
Lindane	0.52 [5]	0.52 [5]	2.1 [5]
Other VOC	LOR	LOR	LOR
Other SVOC	LOR	LOR	LOR
Asbestos	No asbestos detected [3]	No asbestos detected [3]	No asbestos detected [3]

Notes:

1. NSW DEC (2006) Guidelines for the NSW Site Auditor Scheme (2nd Ed.) and NEPC (1999) National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) NEHF F.
2. NSW EPA (1994) Guidelines for Assessing Service Station Sites, Table 3.
3. On the advice of the NSW Department of Health, the NSW EPA has advised NSW Site Auditors (Site Auditors Meeting 1st March 2000) that "no asbestos in the soil at the surface is permitted". The phrase 'at the surface' has not been defined.
4. Soils were tested for Total Chromium, which comprises both Chromium (III) and Chromium (VI) isomers. The HIL for Chromium (VI) has been adopted as a conservative assessment threshold.
5. US EPA Region 9 Soil Screening Levels for Residential Land Uses for Lindane (also referred to as Gamma-Hexachlorocyclohexane) was adopted as an initial screening level the future high density residential and open space scenarios, US EPA Region 9 Soil Screening Levels for Industrial Land Uses for Lindane was adopted as an initial screening level for the future Commercial/Retail scenario.

Where soil concentrations exceed the health investigation levels presented in Table 4.1 above, these exceedances will warrant further, site-specific assessment within the HHERA.

While HIL F has been adopted as a preliminary screening tool, a HHERA will be undertaken to assess potential risks to Construction Workers during future remediation and construction workers on the site in more detail.

4.2 Groundwater Investigation Levels (GIL)

Given historical industrial use and reclamation of land in the site locality, Coffey considers that the site is not located above a water bearing zone which has the potential for use as a drinking water resource, and because reticulated drinking water is readily available in this area, the adoption of Australian Drinking Water Guidelines (NHMRC & NRMMC, 2011) is not considered appropriate for investigation purposes. Coffey notes that the salinity of the groundwater also precludes its consideration as a potential drinking water resource.

Groundwater from the site is expected to flow to the north and discharge into the southern end of Cockle Bay, which is considered to be a marine habitat. Thus, protection of environmental values, groundwater data has been assessed against the following criteria:

- ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Protection of Aquatic Ecosystems. Marine trigger values for protection of 95% of species.
- ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Low Reliability Marine trigger values for Protection of Aquatic Ecosystems.

ANZECC/ARMCANZ (2000) advocates a site-specific approach to developing guideline trigger values based on such factors as local biological affects data, the current level of disturbance of the ecosystem, etc. The guidelines present 'low risk guidelines trigger values' which are defined as concentrations of key performance parameters below which there is a low risk that adverse biological effects will occur. It is important to note that these are not threshold values at which an environmental problem is likely to occur if exceeded. Rather, if the trigger values are exceeded, then further action is required which may include either additional site-specific investigations to assess whether or not there is an actual problem, or the implementation of management / remedial actions.

It is understood that the DECCW's policy is that the trigger values for the protection of 95% of aquatic ecosystems should be used except where contaminants are potentially bioaccumulative in which case the trigger values for protection of 99% of species should be used. Therefore, we have selected trigger values for protection of 95% of marine water species for the majority of contaminants, and 99% of marine water species for bioaccumulative contaminants for comparison purposes.

ANZECC/ARMCANZ (2000) states that there is currently insufficient data to derive high reliability trigger values for a number of COPC considered herein. For these contaminants, low reliability trigger values have been adopted.

ANZECC/ARMCANZ (2000) states that there is currently insufficient data to derive a high reliability trigger value for TPH but propose a low reliability trigger value for TPH of 7µg/L. This guideline is generally considered by industry to be overly conservative and is also well below the TPH detection limit that most laboratories can achieve. Therefore the laboratory limit of reporting (LOR) is adopted as an appropriate screening trigger for TPH assessment (NSW DECC, 2007).

NSW DECC (2007) *Guidelines for the Assessment and Management of Groundwater Contamination* states that where the generic groundwater investigation level (GIL) is below the laboratory LOR, the LOR should be used instead of the existing generic GIL.

A summary of the adopted groundwater assessment criteria is presented in Table 4.2.

Table 4.2: Summary of Groundwater Investigation Levels

Analyte	Laboratory Limit of Reporting	ANZECC 2000 95% Trigger Values[1] (µg/L)	Adopted GIL (µg/L)
Arsenic	-	2.3 [LR]	2.3
Cadmium	-	5.5	5.5
Chromium (Total)	-	4.4[c]	4.4
Copper	-	1.3	1.3
Lead	-	4.4	4.4
Mercury	-	0.4	0.4
Nickel	-	70	70
Zinc	-	15	15
Benzo(a)pyrene	0.1	0.2	0.2
Naphthalene	0.1	70	70

Analyte	Laboratory Limit of Reporting	ANZECC 2000 95% Trigger Values[1] (µg/L)	Adopted GIL (µg/L)
Anthracene	0.1	0.4 (LR)	0.4
Phenanthrene	0.1	2 (LR)	2
Fluoranthene	0.1	1.4 (LR)	1.4
TPH C_6-C_9	40	-	40 (a)
TPH C_{10}-C_{14}	100	-	100 (a)
TPH C_{15}-C_{28}	200	-	200 (a)
TPH C_{29}-C_{36}	200	-	200 (a)
Benzene	-	500	500
Toluene	-	180 (LR)	180
Ethylbenzene	-	5 (LR)	80
Xylene (m & p)	-	75 (LR) (b)	75
o-Xylene	-	200	200
VOC	Various	-	LOR (a)
SVOC	Various	-	LOR (a)

Australian and New Zealand Environment and Conservation (2000) National Water Quality Management Strategy – Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Trigger values under the 95% protection level for marine water – where biological or chemical data has not been gathered for a slightly to moderately disturbed ecosystem.

(LR) Low Reliability trigger values for 95% protection level (ANZECC/ARMCANZ (2000)).

(a) In the absence of a nominated guideline value, the laboratory LOR has been taken as the nominal trigger value for the presence of TPH compounds in groundwater as will be used as the GIL (NSW DECC, 2007).

(b) Adopted assessment criteria for Xylene is based on the m-Xylene, which is the lowest trigger value for the two Xylene isomers.

(c) Groundwater Investigation Level for Chromium (VI) adopted for Chromium (Total) as a conservative assessment measure.

5 DISCUSSION

5.1 Soil Contamination

Chemicals in soil reported at concentrations above health-based investigation levels on the site are summarised in Tables 1 and 10 in Appendix C. The location of the soil samples with reported concentrations above the health investigation levels for high density residential uses and public open spaces are shown on Figures 4 and 5 respectively.

In summary, elevated concentrations of TPH and PAH compounds characterised by heavier molecular weights were encountered in localised areas within the shallow fill materials. Benzo(a)pyrene comprised typically 5% to 10% of the proportion of Total PAH recorded at these locations, which is characteristic of combustion by-products such as ash and charcoal rather than directly attributable to other sources of hydrocarbon contamination (e.g. fuel spillages, waste oils etc.).

Where the characteristic relationship described above is not apparent, reported TPH concentrations are often indicative of diesel release of petroleum fuel or the disposal of waste oil. Potential locations of a localised fuel or oil spillage have been identified in:

- Boreholes NBH24 and EB1
- Borehole NBH29
- BH124

The impact at the above boreholes also correlates with field observations of moderate to strong hydrocarbon odours. Coffey notes that volatile petroleum hydrocarbon compounds characterised by higher solubilities and vapour pressure (e.g. benzene) were not detected within soils on site.

Concentrations of lead were detected above the health-based investigation level of 600mg/kg for public open space in two samples, with only one sample exceeding the health-based investigation level of 1200mg/kg for high density residential uses. The highest reported concentration of lead occurred in a sample from BH121A at 1.5-1.6mbgl. On review of other samples taken from BH121A and analysed for lead, a sample taken from 0.5-0.6mbgl did not report elevated concentrations of lead. A sample was taken from 2.5-2.6mbgl but not analysed for lead and hence, no comment can be made at this stage on the vertical extent of lead at this location. Concentrations of lead were reported above the public open space health-based investigation level in a sample from BH126 (1.4-1.5mbgl). Samples analysed from BH126 at depths 0.5-0.6mbgl and 2.4-2.5mbgl reported concentrations below 100mg/kg suggesting the elevated concentration of lead is relatively localised within the fill material at this location. In contrast of the 121 soil samples analysed for lead, concentrations of lead were reported in the large majority (approximately 90%) of soil samples at concentrations less than 130mg/kg, suggesting that the reported occurrence of the higher concentrations of lead at BH121A, BH126 are relatively isolated occurrences.

Total chromium was reported in one sample (NBH30; 4.5-4.9mbgl) at a concentration of 260mg/kg which exceeded the health-based investigation level of 200mg/kg adopted for public open space uses. No samples exceeded the health-based investigation level of 400mg/kg for high density residential uses. Of the 121 soil samples analysed for total chromium, approximately 95% of all samples reported a concentration less than 30mg/kg and all other samples reported concentrations of total chromium less than 110mg/kg, which indicates that the high concentration of total chromium reported at NBH30 is a relatively localised occurrence.

Coffey notes that the health-based investigation level for total chromium adopted for this assessment relates to the more toxic hexavalent chromium which is a strong oxidant typically employed in heavy industrial activities such as metal and chemical works. Hexavalent chromium readily oxidises to the less toxic form, trivalent chromium. Given that the site has not been used for industrial-type uses where chromium may have been used for over 100 years, Coffey considers that a substantial component of the total chromium reported is likely to comprise the less toxic trivalent chromium form, which has a health based investigation level of 240,000mg/kg.

Asbestos was detected in three soil samples from two borehole locations; namely BH119 and BH13. During drilling at location BH119, a fibrous sheet was encountered at 0.33mbgl. A fragment of this sheet, together with soil samples taken from one interval above the sheet and two different intervals below the sheet were collected from the borehole and scheduled for asbestos analysis. Analysis of the sheet fragment confirmed the presence of chrysotile asbestos. No asbestos fibres were identified in trace analysis of soil samples from above or below the location of the asbestos cement sheet, which suggests that asbestos fibres are unlikely to be present within fill material around the sheet. Asbestos was also encountered (in the form of fibre bundles) at location BH13 (approximately 5m north of BH119) at depths of 1.5mbgs and 2.5mbgs. Asbestos was not detected in any of the other 88 soil samples scheduled for asbestos analysis as part of the four investigation programmes.

Three SVOC compounds were reported in soil samples above the investigation level or laboratory LOR (as a default screening level). These included:

- Lindane (an organochlorine pesticide) and 2-Naphthylamine reported in sample BH124 (4.6-4.8mbgs) located within lower fill materials/reworked natural alluvial materials and correlated with moderate hydrocarbon odours and black staining.
- 4-Nitrophenol at BH128 (2.9-3.0mbgs) located within the upper Alluvium correlating with slight ‘organic’ odours.

No other VOC or SVOC were detected above the adopted assessment thresholds.

5.2 Assessment of Contaminant Distribution within Fill

Field duplicate samples (in addition to quality control duplicates) were collected during the December 2012 investigations (Coffey; Jan 2013) to assess the variability of COPC within fill materials on the site. In summary, 19 field duplicate samples were collected from 13 boreholes across the site and analysed for TPH, PAH, BTEX and VOC/SVOC (i.e. where elevated PID readings and/or visual/olfactory evidence of potential contamination was identified). As THP C_6-C_9 and BTEX compounds were reported consistently below the LOR, these compounds have not been considered further in the assessment of variability presented below. Table 5.2 summarises the primary and field duplicate sample pairs, and their corresponding RPD for TPH C_{10}-C_{36} and Total PAH.

Table 5.2: Summary of Primary and Field Duplicate Pairs & Relative Percent Differences

Borehole Reference	Primary / Field Duplicate Sample Depth	Relative Percent Difference	
		Total PAH	TPH C_{10}-C_{36}
BH120	0.03-0.13m	N/A	N/A

Borehole Reference	Primary / Field Duplicate Sample Depth	Relative Percent Difference	
		Total PAH	TPH C_{10}-C_{36}
	1.5-1.6m	71% **	83.6% *
BH121	0.5-0.6m	17% #	N/A
BH121A	1.0-1.1m	55% **	91% *
BH122A	1.5-1.6m	59% **	N/A
BH123	1.5-1.6m	75% **	71% *
BH123A	1.0-1.1m	67% **	40% #
BH124	2.9-3.0m	N/A	98% **
	4.6-4.8m	N/A	14% **
BH125	0.23-0.33m	5% **	19% **
BH125A	0.5-0.6m	N/A	N/A
	2.0-2.1m	N/A	N/A
BH126	0.5-0.6m	N/A	N/A
BH127	0.3-0.5m	N/A	N/A
	1.5-1.6m	62% **	27% *
BH128	0.28-0.38M	158% *	N/A
	1.5-1.6M	50% *	N/A
BH129	0.24-0.28M	N/A	N/A
	1.0-1.1m	0% #	N/A

Notes:

* = indicates the reported concentrations in one sample is greater than 10 times the LOR;

** = indicates the reported concentrations in both samples are greater than 10 times the LOR.

= both samples reported concentrations less than 10 times the LOR.

N/A indicates concentrations of one or both samples were reported below the LOR and hence, an RPD was not calculated.

The RPD for Total PAH (for samples which reported concentrations 10 times the LOR) ranged between 5% and 75% with an average RPD of 56%. Similarly, for samples which reported concentrations 10 times the LOR, the RPD for TPH C_{10}-C_{36} ranged between 14% and 98% with an average RPD of 44%. Based on the summary presented in Table 5.2, Coffey consider that the distribution of PAH and TPH C_{10}-C_{36} concentrations have a moderate degree of variability within discrete horizons of fill materials present on site.

VOC and SVOC were analysed in one primary and field duplicate sample pair from BH124 (4.6-4.8m). With the exception of Lindane and 2-naphthylamine, other SVOC and VOC were reported below the LOR. The RPD for Lindane and 2-naphthylamine was 36% and 13% respectively.

Comparison of analytical data from individual boreholes was also undertaken to assess variability in the vertical distribution of soil contamination within the fill materials present. In summary, Coffey considers that the vertical distribution of soil contamination within the fill:

- In general, typically appears to occur as layers within fill material, rather than being consistently present throughout the fill deposits at variable concentrations.
- The rate of change in contaminant concentration vertically through the fill, which is typically 2m to 4m deep, appeared to be substantially greater relative to the reported difference in concentration between the primary and field duplicate samples. For example, RPD for Total PAH and TPH C_{10}-C_{36} between sample intervals of 0.5m were reported above 150%. This variability may be indicative of different 'filling events' associated with the historic reclamation and redevelopment activities on the site, however distinct horizons of fill types were not distinguishable from borehole logs presented in Appendix B. Coffey notes that the use of excavations to assess fill materials on the site was not acceptable to the site owners (SHFA).

5.3 Groundwater Contamination

Analysis of groundwater samples collected from across the site indicates a pH neutral, brackish to saline environment which is consistent with historical reclamation of the land and with the proximity of the site to Cockle Bay.

The results of laboratory analyses reported concentrations of dissolved organic compounds less than the assessment thresholds listed in Section 4.2. No Phase Separated Hydrocarbon (PSH) was detected in any of the monitoring wells.

Concentrations of PAH compounds were identified above the LOR in groundwater samples from MW9, MW25, MW30. Duplicate samples were collected from these boreholes and filtered in the field to eliminate PAH compounds that are attributable to fine sediment suspended within the groundwater sample as a result of sampling disturbance. Coffey notes that for the hydrogeological conditions in the water bearing zone on the site, groundwater in an undisturbed state is not expected to include fine suspended sediment. In summary, the analysis of filtered duplicate samples reported no detectable concentrations of these PAH compounds. This suggests that PAH compounds reported in unfiltered samples are attributable to the inclusion of fine suspended sediment rather than dissolved within the groundwater itself. On this basis, Coffey considers that groundwater within the vicinity of these wells is not impacted by dissolved PAH compounds.

Compounds including BTEX, VOC and SVOC were reported below the LOR. TPH C_6-C_9 was identified in one groundwater sample from MW120 at 30µg/L which is slightly above the LOR (20µg/L). On review of the soil results, TPH C_6-C_9 and other indicator compounds such as Benzene, Toluene, Ethylbenzene,

Xylene were not recorded above the LOR in any of the seven soil samples from this borehole. Furthermore, soil headspace measurements ranged from 0.9ppm to 10ppm suggesting a low likelihood that volatile hydrocarbons are present within the soil.

Concentrations of TPH C_{10}-C_{14}, C_{15}-C_{28} and TPH C_{10}-C_{36} were also reported at concentrations less than the Laboratory's LOR in samples from across the site.

Results for groundwater quality obtained during three monitoring events showed that certain heavy metals were reported at concentrations above the relevant groundwater investigation levels, specifically:

- Copper and/or zinc concentrations exceeded the adopted investigation levels in at least one sample in each of the four groundwater monitoring events.
- Lead and chromium (total) were reported in one sample from BH1 at concentrations slightly above the adopted GIL of 4.4µg/L[4] (same for both metals). Lead and chromium were not detected in groundwater samples from other locations.
- Arsenic was recorded at concentrations slightly above the low reliability trigger value of 2.3µg/L in samples from BH13, MW25 and MW120.

Given that these heavy metals are widely utilised in industry, slightly elevated concentrations in groundwater are a common occurrence in urban environments. The reported concentrations are considered to be representative of background levels in the locality of the site rather than being attributable to current and/or historical activity specific to the site.

In summary, no groundwater contamination, which is considered significant enough to warrant detailed investigation or remediation, has been encountered.

5.4 Acid Sulfate Soils

The results of the laboratory analysis of field pH (pH_F) and pH after oxidation (pH_{FOX}) indicate a high likelihood for the presence of acid sulfate soils given:

- The nature of the stratum within which the samples were collected (i.e. natural alluvium comprising grey to black low to high plasticity clay or dark grey medium, plasticity silty clay);
- The difference between the pH_F and the pH_{FOX} values; and
- The vigorous chemical reactions that were observed during field screening.

[4] It is noted that the Chromium GIL adopted relates to the more toxic hexavalent form of chromium, however chromium present in this groundwater sample is likely to comprise the less toxic Chromium (III). Furthermore, ANZECC/ARMCANZ (2000) indicates high sulfate concentrations make chromium toxicity unlikely, in marine and estuarine conditions. Whilst specific sulfate testing was not carried out as part of this investigation, the site falls within a reclaimed estuarine environment where ASS screening and Chromium Reducible Sulfur analysis indicate the presence of available sulfate within the alluvial deposits.

Based on these results and the site geology, Coffey considers that potential acid sulfate soil (PASS) is present in in natural alluvium where it occurs within the site.

5.5 Preliminary Waste Classification

Results from laboratory analysis indicate that the majority of fill material underlying the site should classify as General Solid Waste – Non-Putrescible in accordance with the waste classification guidelines and following analysis using the Toxicity Characteristic Leaching Procedure (TCLP).

Soils within the vicinity of BH119 and BH13 should generally be classified as General Solid Waste – Non-Putrescible managed as asbestos waste.

Coffey notes that several individual samples reported concentrations of certain contaminants which exceed the General Solid Waste threshold (refer Table 8; Appendix C). Coffey recommended that the waste classification of these materials is reassessed through further investigation and sampling supported by the use statistical techniques in accordance with the procedures set out within the Waste Classification Guidelines (DECCW; 2009).

Given the presence of alluvial and residual clays beneath the fill underlying the site, PASS may be present within material that is to be excavated. Alluvial material that contains PASS will require neutralisation and would be classified as General Solid Waste for off-site disposal to landfill.

6 QUALITATIVE RISK ASSESSMENT & CONCEPTUAL SITE MODEL

6.1 Sources of Contamination

Based on the findings of recent ground investigations, the following contamination sources have been identified:

- Localised TPH (as oil) and PAH contamination encountered in unsaturated fill materials.
- Localised lead contaminated fill located at BH121A and BH126.
- Localised chromium (total) contaminated fill at NBH30
- Volatile hydrocarbon contamination encountered at BH128 and BH124.
- Asbestos containing materials encountered in shallow fill materials at BH119 and BH13.
- Potential and actual acid sulfate soils.

6.2 Exposure Pathways

The key environmental pathways and exposure routes by which potentially contaminants may reach environmental and human receptors are assessed to include:

- Ingestion of soils
- Dermal contact with soil
- Inhalation of dusts, vapours and fibres
- Infiltration and leaching from unsaturated soils to shallow groundwater
- Vertical and lateral contaminant migration through the saturated zone
- Contaminant migration along preferential flow pathways (e.g. existing service corridors, building foundations etc.)
- Surface runoff / overland flow
- Excavation dewatering (shallow excavations less than 2m deep are likely)

6.3 Receptors

6.3.1 Humans

The redevelopment of the site will introduce the following receptors:

- Construction workers
- Future residents on site
- Future workers within the retail/commercial premises on site
- Users accessing the surrounding public realm
- Maintenance workers

- Neighbouring site users

6.3.2 Environmental

The primary environmental receptor currently identified in relation to the site is Cockle Bay, approximately 475m north of the site. Groundwater within the fill and natural alluvium is considered to be hydraulically connected to Cockle Bay.

It is noted that stormwater drainage surrounding the site is also likely to discharge to Cockle Bay and potentially represents a preferential pathway between the site, particularly during the redevelopment of the site.

6.4 Discussion of Potential Human Health Risks and Environmental Risks

Based on the potential sources of contamination identified at the site, the following potential environmental and human health risks are identified in the context of the development proposed by Darling Harbour Live and the environmental setting of the surrounding area.

6.4.1 Potential Human Health Risks to Future Construction Workers

The proposed redevelopment of the site is reasonably expected to require removal of existing hardstanding ground cover, demolition of existing structures and ground works to establish the proposed development. Based on findings of the investigations discussed in this report, the potential exists for future construction workers to be exposed to contaminated fill materials.

The available soil analytical results were compared to health investigation levels for a commercial/industrial setting to assess the potential risks to construction workers exposed to soils within the site (refer Table 9; Appendix C). Concentrations of total PAHs, benzo(a)pyrene and lead exceeded the adopted investigation levels for commercial/industrial land uses, and thus pose a potential risk to the health of construction workers, through inhalation (as dust particles), incidental ingestion or via direct dermal contact.

Three SVOC compounds were reported in two discrete locations; namely Lindane and 2-Naphthylamine at BH124 (4.6-4.8m) and 4-Nitrophenol at BH128 (2.9-3.0m). These SVOC compounds were not reported above the LOR in shallower samples of fill at these locations. The depth below the surface of these chemicals means that they are below the expected maximum excavation depth of circa 2 metres and consequently, the direct exposure pathways (i.e. associated with dermal contact and ingestion of soil particles) for construction workers in not complete. With reference to published values for Henry's constant, as an indicator of volatility of a compound, Lindane and 2-Naphthylamine are no more volatile than is benzo(a)pyrene, and 4-Nitrophenol is considered to be semi-volatile, but less volatile than naphthalene. Coffey considers that a vapour inhalation pathway is incomplete for exposure to Lindane or 2-Naphthylamine, and is potentially complete for 4-Nitrophenol.

Asbestos was also encountered in fill materials from BH119 and BH13 in a localised area immediately south of the SEC. Asbestos located at BH119 was identified as a fibrous board at a discrete depth of 0.33mbgs. Asbestos located at BH13 was reported as fibre bundles in fill at depths between 1.5mbgs and 2.5mbgs although no respirable fibres were detected using trace analysis techniques. Asbestos has the potential to pose a health risk to construction workers via the inhalation of airborne fibres of respirable size.

The concentrations of heavy metals in groundwater are unlikely to pose a direct health risk to construction workers as the salinity of the water would make it unpalatable and if ingested accidentally this would only be as a small quantity. Reference to the Australian Drinking Water Guidelines (NHMRC 2011) showed that the reported concentrations of heavy metals did not exceed relevant guideline values.

A HHERA is proposed to further assess potential human health risks to Construction Workers.

Contractors undertaking the remediation and in-ground construction works should consider this (and the future HHERA) information in preparation of their safe work method statements as indicated in Section 7.8.

6.4.2 Potential Health Risks to Future Site Users

Future site users of the proposed mixed use development will likely comprise residential users, infants within a day-care centre located on the upper floors of the development, workers within retail/commercial space, and site visitors using publicly accessible areas of the site (e.g. predominantly the surrounding public realm).

Investigations carried out to date have recorded elevated concentrations of total PAH, benzo(a)pyrene and lead at concentrations exceeding health investigation levels. Based on the reported concentrations, these compounds in localised areas of the site pose potential health risks via direct exposure to future site users including maintenance and construction workers. Similarly, one SVOC compound, 4-Nitrophenol, was reported in one localised area of the site and may pose a potential risk to future construction workers via an inhalation pathway. Asbestos was also encountered in fill materials from BH119 and BH13, which has the potential to pose health risks via the inhalation of respirable airborne fibres.

The development proposals include placement of hard ground cover (e.g. buildings, roads, paved footpaths, concrete slab to form water features etc.) across some of site, with landscaped areas planned generally for the public realm. An approved landscaping scheme is yet to be finalised for the site. Based on information provided by LLD, landscaping is likely to comprise a mixture of the following elements, however the exact locations of each element have not yet been determined at this stage:

- Areas of turf, which will be laid on up to 50mm of imported soil laid over existing soils
- Areas of possible bio-swales commensurate with the principles of Water Sensitive Urban Design. Planting in this case is proposed directly into existing soils, with layer of rip rap (e.g. pebbles, etc.) provided for surface scour protection.
- Areas of planting directly into existing soil.
- Areas of paving comprising concrete or stone pavers over 100-150mm of cement stabilised sub base, or over 100mm concrete slab.
- Decomposed granite typically comprising 75mm of decomposed granite over 100-150mm of cement stabilised sub base.
- Tree planting in planter beds within paved areas, filled with up to 1m of imported soils
- Areas of water features likely to comprise concrete-lined ponds filled with water either recycled from development lots of from potable water supply. Groundwater will not be used within water features constructed on site.

LLD note that excavated material may be reused on site, both within/below the public realm generally, for the purposes of localised site filling.

The presence of hard ground surfacing and designed landscaping as outlined above would generally separate site users from residual soils after completion of construction works. Where planting is proposed directly into existing exposed soil, a suitable separation layer will be provided if required based on the findings of a HHERA. Where required, the details of the separation layers proposed will be provided within a site-specific RAP(s).

Coffey considers that a vapour inhalation pathway is potentially complete for 4-Nitrophenol, particularly where the footprint of a proposed building is located over BH128. This risk pathway requires more detailed assessment within the HHERA. Where a HHERA indicates 4-Nitrophenol located over BH128 poses a potentially unacceptable risk associated with the vapour inhalation pathway, Coffey considers that these risks could be mitigated using appropriate management and/or remediation techniques described within Section 7.4.

6.4.3 Potential Health Risks to Neighbouring Site Users

The site is surrounded by land uses which attract many visitors. Given the current and proposed future use of the site will retain or provide surface layers that would minimise the potential for users of neighbouring sites to be exposed to contamination identified on site via the inhalation of airborne emissions (e.g. dusts or fibres), soil conditions within the site are considered not to pose potential health risks to users of neighbouring sites. Where this is not the case, and a HHERA identifies a potentially unacceptable risk is present, suitable separation layers can be provided. The details of the separation layers will be set out within site-specific RAP(s). However, the redevelopment of the site, albeit over the short term, may have the potential to generate airborne emissions. These potential risks can be appropriately managed during the construction works through the effective use of controls such as soil management and dust suppression techniques. Further detail is provided within the Construction Site Management Plan in Section 7.8.

6.4.4 Potential Health Risks to Maintenance Worker

Future shallow below ground maintenance works within the site have the potential to expose impacted fill materials which may pose a potential health risks to workers undertaking these works. The potential for unacceptable health risk can be assessed as part of a HHERA. If unacceptable risks are identified, control of those risks may be achieved through implementation of a long-term site environmental management plan which includes measures for managing future disturbance of the subsurface for maintenance of buried services.

6.4.5 Potential Environmental Risks to Surface Water

The nearest surface water body to the site is the southern end of Cockle Bay, which is located approximately 475m north of the site. For current site conditions, groundwater quality does not appear to be impacted by the presence of contaminants in fill materials on the site. Consequently, changes to current site conditions resulting from redevelopment of the site are unlikely to have the potential to increase the risk to aquatic ecosystems in Cockle Bay.

Analysis of soil samples identified localised areas of fill materials impacted by hydrocarbon compounds (i.e. TPH, BTEX, PAH and certain SVOC), and heavy metals. Analysis of groundwater samples recovered from eight monitoring wells reported no concentrations of dissolved phase hydrocarbon

compounds above the investigation levels adopted for this assessment, or above the laboratory LOR in many of these samples. No PSH was detected in any of the monitoring wells. On this basis, it is assessed that hydrocarbon contamination reported within the soil has not significantly impacted the underlying groundwater and therefore, is considered unlikely to represent a significant risk due to changes in site conditions during redevelopment to aquatic receptors in Cockle Bay.

Concentrations of heavy metals including arsenic, chromium, copper, lead and zinc were detected in groundwater samples and are considered typical of background levels within this locality and many urban environments, it is assessed that these heavy metals do not pose an unacceptable risk to aquatic species.

In summary, based on available investigation data, it is assessed that soil and groundwater conditions do not pose a significant risk to aquatic species in Cockle Bay.

Stormwater drainage surrounding the site is likely to discharge into Cockle Bay. The demolition of existing buildings and removal of surrounding hard paved surfaces during construction will expose soils. During the construction period, surface water runoff from the site has the potential to carry soils into the surrounding stormwater system and discharge into Cockle Bay and may pose a potential risk to aquatic species in Cockle Bay.

6.5 Summary of Key Pollutant Linkages & Remediation Options

Table 6.1 provides an overview of the primary pollutant linkages identified in relation to human receptors. Similarly, Table 6.2 provides an overview of the pollutant linkages relevant to environmental receptors. Remediation options are considered in more detail within Section 7.4.

Table 6.1: Summary of Primary Pollutant Linkages for Human Health & Outline of Remediation Options

Land Use Scenario	Source	Contaminant Type	Identified Pathways (without controls)	Receptors	Outline of Remediation Options
Construction	Soil	Locally Contaminated Soils Organics: TPH, PAH, SVOC Inorganics: Lead	• Dermal contact	• Construction Workers	• Maintenance of secure boundary fence • Provision of appropriate PPE during ground works • Design of good health, safety and welfare facilities and practice during ground works • Dust suppression techniques during ground works • Boundary monitoring for vapours, dusts and fibres
			• Inhalation/ingestion of soil particles/dusts	• Construction Workers • Neighbouring site users	
		Asbestos	• Inhalation of fibres		
Future Mixed Use Development	Soils (<1mbgs)	Locally Contaminated Soils Organics: TPH, PAH Inorganics: Lead	• Dermal contact, • Inhalation/ingestion of soil particles/dusts	• Residential users • Retail/Commercial Workers • Users of Public Open Space • Neighbouring Site Users	• Excavation and segregation of contaminated materials. • On-site treatment of contaminated soils and/or disposal to licensed landfill • Backfill excavation with selected suitably validated excavated materials, and validated imported materials. • Reinstatement of Separation Layer to prevent possible exposure of receptors to residual in-ground ground contaminants. • Provide separation Layer where required
		Asbestos	• Inhalation of fibres		
	Soils (>1mbgs)	Locally Contaminated Soils Organics: SVOC	• Inhalation of soil vapours		
Future Subsurface Infrastructure Maintenance– excavation <1mbgs	Soils	Locally Contaminated Soils Organics: TPH, PAH Inorganics: Lead	• Dermal contact, • Inhalation/ingestion of soil particles/dusts	• Future maintenance workers	• Development of a detailed Environmental Management Plan (EMP) to mitigate potential environmental risks associated with future ground maintenance events. • Reinstatement of Separation Layer to prevent possible exposure of receptors to residual in-ground ground contaminants.
		Asbestos	• Inhalation of fibres		
		Locally Contaminated Soils Organics: SVOC	• Inhalation of soil vapours		

Table 6.2: Summary of Primary Pollutant Linkages for Environmental Receptors & Outline of Remediation Options

Source	Contaminant Type	Identified Pathways (without controls)	Receptors	Outline of Remediation Options
Unsaturated Soils	Locally Contaminated Fill Organics: TPH, PAH, SVOC Inorganics: Lead	• Leaching • Lateral groundwater migration • Migration along preferential flow pathways (e.g. stormwater drainage)	• Aquatic species in Cockle Bay	• Excavation and segregation of identified contaminated materials • On-site treatment of contaminated soils and/or disposal to licensed landfill • Backfill excavation with suitably validated excavated materials, and validated imported materials. • Redevelop the site with hard surfaces and site drainage thereby reducing infiltration. • Separation Layer where required
Saturated Soils	Locally Contaminated Fill / Natural Soils Organics: TPH & SVOC	• Lateral groundwater migration • Migration along preferential flow pathways	• Aquatic species in Cockle Bay	
	ASS and Potential ASS	• Excavation – localised areas	• Aquatic species in Cockle Bay • Buildings and underground services	• Prepare an ASS Management Plan (ASSMP) • Co-ordinate construction excavation and dewatering activities alongside ASSMP • On site treatment of ASS

7 OVERARCHING REMEDIAL ACTION PLAN

7.1 Remediation Goal

The goal of the proposed remediation works is to make the site suitable for the proposed uses by mitigating potential risks associated with contamination. Based on comparison of the nature, type and extent of contamination on the site with HILs for soil, potential risks associated with contamination have been identified. Coffey notes that HILs are generic and are inherently conservative, and that the extent of remediation works may reduce using a site-specific human health and environmental risk assessment. A more detailed assessment of risks can be undertaken as part of a HHERA to clarify the need for remediation and/or management at the site. If remediation works are required, it is considered that these remediation works could be integrated with early stage of construction works rather than being a separate phase of remediation.

A further goal in implementing the proposed remediation works is to carry out the remediation works in a manner so as to minimise exposure risks to the public in the areas surrounding the site.

7.2 Regulatory & Planning Context

Darling Harbour Live developed a concept for the proposed redevelopment of the SICEEP, of which the site comprises the southern part. In response to this concept, Darling Harbour Live obtained the Director General's Requirements from the Department of Planning and Infrastructure (Ref: SSD 5752-2012; dated 12 March 2013). With regard to contamination issues, the Director General's Requirements comprise an assessment to demonstrate that the site can be made suitable for the proposed use in accordance with guidelines set out within Managing Land Contamination: Planning Guidelines- SEPP 55 Remediation of Land (DUAP/EPA, 1998).

The Darling Harbour Live consortium proposes to lodge an application for the redevelopment of the site. This Overarching RAP demonstrates that the site can be made suitable for the proposed uses.

7.3 Extent of Remediation & General Management Measures Required

Based on generic health investigation levels adopted for this assessment, the location of soil impacts identified is shown on Figure 4. A human health and environmental risk assessment (HHERA) can be used to further assess risk and, if necessary, establish site-specific risk based remediation criteria to refine and finalise the scope and extent of soil remediation required in site specific RAPs for the development of individual components of the site. Based on available information, no groundwater remediation is proposed.

Although no final site levels are currently available, concept sketches indicate that a proportion of the site will require some excavation to allow construction of pile caps for building foundation, trenches for below ground services, lift pits etc. which are not likely to extend below 2m depth. In-ground obstructions may also require removal to establish construction formation levels. Soils and oversize materials from these excavations will need to be characterised for beneficial reuse on site (where practicable), or classified in accordance with Waste Classification Guidelines (NSW DECCW; 2009) prior to disposal off site to a licensed landfill.

Section 7.4 provides an overview of the remedial options considered appropriate for the management of soils excavated for remediation and construction purposes.

Deeper excavations may also require excavation support and dewatering. Whilst the analysis of groundwater reported limited chemical impact, it is considered likely that on-site treatment of water arisings from excavations would be required to meet quality limits to enable discharge to local sewer or stormwater drainage systems, with prior discharge consent. The discharge of groundwater arisings direct to ground may require a licence under the NSW Aquifer Interference Policy from the NSW Office of Water.

The presence of PASS and ASS has been identified in natural alluvium beneath the site. These soils, if disturbed and brought into contact with air, would need to be managed in accordance with an Acid Sulfate Soil Management Plan (ASSMP). The ASSMP would need to set out the protocols to undertaking deep excavation and excavation dewatering to mitigate potentially adverse effects associated with ASS. A Preliminary ASSMP will be submitted separately from the Overarching RAP in support of the Application.

The treatment of ASS would comprise neutralisation with the addition of lime and subsequent disposal of treated material to a licensed landfill as General Solid Waste. Natural soils that contain PASS or actual ASS do not classify as Virgin Excavated Natural Materials (VENM).

The preliminary waste classification of fill within the site identified materials that may exceed the General Solid Waste thresholds. It is proposed that the waste classification of these materials is further evaluated through sampling supported by the use statistical techniques in accordance with the procedures set out within the Waste Classification Guidelines (DECCW; 2009).

7.4 Remedial Options

Based on the findings of the recent ground investigations and the likely extent of remediation outlined above, the following remediation options were considered for materials at the site.

7.4.1 'Do Nothing' Approach

Given that the overarching remedial goal is to make the site suitable for the proposed mixed uses, a 'do nothing' option is not considered to be acceptable because risk mitigation measures to protect the health of construction workers, and the public during the entire construction period would not be practical.

7.4.2 On-Site Management

A HHERA can be undertaken to further assess the potential risks associated with ground conditions recorded at the site in the context of the proposed development. This option refers to the management of soil materials in accordance with the assumptions built into a HHERA. This option would not involve intrusive soil remediation works but would involve the segregation (such as through the utilisation of separation layers) and selective placement of materials in certain areas or below certain depths that would effectively mitigate human health risks.

The applicability of this option is dependent on the outcome of a HHERA with management requirements setout in future site specific RAP(s).

7.4.3 Source Removal & Replace with Imported Materials

This option would comprise the excavation of contaminated material that exceed the adopted remediation criteria and disposal of these materials to an appropriately licensed facility. Excavation

voids would then be backfilled with imported materials to the extent required.

The advantages of this option include the removal of the contaminant, reducing the need for on-going management of the land, as well as reducing restrictions on future land use following remediation and validation. The disadvantages of utilising this option include increased costs and environmental impacts associated with waste transport and disposal, and importation of appropriate materials to backfill the void created by removal of contaminated soils.

7.4.4 On Site Treatment and Reuse

The treatment of contaminated soils could involve either ex-situ or in-situ techniques utilising biological, chemical and/or physical processes.

In-situ treatment techniques are likely to be less successful in treating organic contaminants within heterogeneous fill materials and given that some excavation is likely to be required for construction of foundations and the removal of in-ground obstructions, ex-situ treatment techniques are considered more applicable.

Excavated materials could be beneficially reused as backfill following successful treatment and validation thereby offering cost and environmental benefits through the reduction of soils requiring offsite disposal. Volumes of fill required may be less than the volume of soil requiring remediation where extensive construction works are required for foundations, lift pits, service trenches etc. Furthermore, space and time constraints may also limit the applicability of some ex-situ treatment technologies.

7.4.5 Isolation of Contamination and On-site Management

Isolation of contamination may be achieved by a layer separating future site users on the surface of the redeveloped site from contact with contaminated material below the separation layer. It may comprise soils, road or pavement construction materials of a specified form and thickness, the ground slab for a building or other techniques such as separation layers.

The potential risks associated with the contamination identified within the site predominantly result from direct exposure (e.g. ingestion/inhalation and dermal contact). Investigation data has also indicated that soil contamination identified is not significantly mobile as it does not appear to have adversely affected the quality of groundwater underlying the site.

The redevelopment of the site will maintain hard surfacing which would effectively separate site users from existing fill materials. Areas of soft landscaping could also be engineered to form a separation layer. This may comprise the placement of geotextile barriers to separate and reduce mixing of imported topsoil from the existing fill material.

The isolated occurrence of a semi-volatile organic compound at depth at one location on the site may pose a potential health risk. A HIL is not available for this compound (4-Nitrophenol) and the compound is not listed in the Safe Work Australia Hazardous Substance Information System (HSIS). This compound should be assessed in more detail within a HHERA. Management options to mitigate potential risks associated with 4-Nitrophenol include localised excavation and relocation to a position posing no unacceptable human health risks defined by the HHERA or the use of vapour barriers to disrupt the exposure pathway. The primary advantages associated with this option are reduced costs and environmental impacts associated with waste transport and disposal, and importation of appropriate materials to backfill the void created by removal of contaminated soils.

An EMP would be required to manage potential risks associated with possible future disturbance of the contained contamination.

7.4.6 Combination of Source Removal, Isolation of Contamination and On-Site Management

The combination of excavation to remove contamination sources and the use of separation layers introduced by the proposed development offers the flexibility to effectively mitigate contamination risks whilst minimising the cost and environmental impacts associated with the disposal of soil materials to landfill.

Excavations could target specific contaminant types (e.g. asbestos, soils impacted with SVOCs etc.) to simplify longer term management requirements. Soils excavated as part of this approach could be characterised, treated (if required) and beneficially reused where development formation levels allows.

This option can utilise a HHERA with management requirements set out in future site specific RAP(s).

7.5 Preferred Remediation Option

The preferred remediation option is likely to be a combination of Source Removal and Isolation of Contamination and on-site management as outlined in Section 7.4.6 above in combination with a HHERA. It is noted that this preferred option will also be combined with on-site management option proposed in Section 7.4.2 although such would need to be consistent with the assumptions adopted within the HHERA.

The primary factors considered during the appraisal of the options outlined above are as follows:

- Source removal provides improved confidence in remediation performance
- Source removal of certain contaminant types may simplify longer term management measures
- Utilising the development form to separate site users from existing contaminated fill thereby minimising costs and environmental impacts associated with offsite disposal and importation of suitable replacement materials.
- Increased flexibility for the development as it progresses from concept to final design.
- Greater certainty in remediation work programme and cost plan.
- The option would allow the site to be made suitable for the proposed mixed uses.

7.6 Approach to Remediation Design

At this stage, the following additional measures to finalise the design of the proposed remediation works are identified:

1. Completion of a site-specific HHERA to finalise the scope and extent of remediation works required. The HHERA will consider site-specific factors that may modify the exposure routes and durations and calculate risk-based remediation criteria for the site.
2. If remediation is required, prepare a site specific RAP taking account of the HHERA and provide further detail on the validation plan proposed for the works.
3. Develop the remediation specification or Works Plan which details the remediation measures (supported by engineering design) for the remediation contractor to implement on site.

4. Prepare supporting Construction Site Management Plan (CSMP) for the remediation works, which provide an overview of the site set up proposed, and detail the controls proposed to mitigate potential health and safety, and environmental risks associated with ground contamination present within the site. The CSMP would also detail the monitoring programmes proposed as part of the remediation works to check periodically that these works are not resulting in adverse impacts to the surrounding community and environment. Coffey recommends that the CSMP be prepared as part of the site-specific RAP in support of the detailed Development Applications.
5. If relevant, prepare an EMP which addresses long term requirements following completion of remediation and construction works.

7.7 Outline Remediation Validation Plan

Based on the preferred remediation option, validation that the remediation has been successfully implement will rely on the following types of records:

- Soil samples will be collected from the base and walls of the remediation excavations at regular intervals for chemical analysis to assess residual ground conditions at the boundary of the remediation excavation.
- Survey records of the remediation excavations and providing spatial context for soil validation samples.
- Samples will be collected from any suitable replacement materials imported to site as engineered fill.
- QA / QC records from field sampling and laboratory analysis undertaken.
- Photographic records to demonstrate the proposed cover layers have been established in accordance with the remediation design.
- Boundary monitoring records.
- Ongoing construction verification and review of as constructed records to verify that HHERA assumptions and commensurate requirements of RAP(s) have been implemented

The validation records will be collated and presented within a Validation Report which shall be prepared in accordance with the requirements set out within the NSW EPA Guidelines for Consultants Reporting on Contaminated Sites (NSW OEH, 2011).

7.8 Construction Site Management Plan

The CSMP presented within the final RAP will provide an overview of the site set up, health and safety controls and provide further details on:

- Site boundary conditions and access controls. This would need to consider existing pedestrian areas along the southern, eastern and northern site boundaries, and other constraints associated with the elevated monorail and light rail corridors.
- Health and safety controls to be adopted during ground works, supported by specific Site Work Method Statements.
- Surface water management and erosion controls.
- Soil management within the site.

- Controls proposed to mitigate health and environmental impacts associated the above environmental emissions.
- A programme for environmental monitoring of boundary conditions. This is likely to include noise, dust, vapour and airborne fibres (locally within the vicinity of BH119 and BH13).
- Document the permissible hours of operation.
- Present a procedure to manage communications and complaints.
- Identify key project stakeholders.
- Contingency measures to be implemented in the event of unexpected finds during the remediation works

Coffey recommends that the CSMP be prepared as part of the site-specific RAP in support of the detailed Development Applications..

7.9 Contingency Plan

A detailed contingency plan will be presented within the site-specific RAP. At this stage, it is envisaged that contingency plans would be developed to address the following aspects:

7.9.1 Unexpected Finds

Where soil or groundwater contamination is encountered in areas which do not correlate with available investigation data, works would cease in the affected part of the site and be reassessed by an appropriately qualified environmental professional. This area would be isolated to minimise potential for disturbance to the affected soils and potential cross contamination of other areas of the excavation.

The reassessment would consider whether the materials can be managed in accordance with the existing strategy. Where this is not considered possible, an addendum to the site-specific RAP would be prepared, documenting the proposed approach adopted to manage the unexpected contamination. The Site Auditor would be informed of the occurrence and would review the addendum to the site-specific RAP. Additional remediation work undertaken, as required, would be documented within the final validation report.

7.9.2 Increase Volumes of Contaminated Materials

Soil remediation volumes will be estimated following the completion of the HHERA and documented within the site-specific RAP. Soil volumes requiring remediation will be monitored during the works. Where greater volumes of contaminated soils are encountered and which require removals, it may be necessary to review the adopted remediation strategy.

7.9.3 Validation Result Exceeds a Remediation Criterion

In the event that the chemical analysis of a soil sample exceeds the adopted remediation criteria, the following options will be considered:

(i) Progress the remediation excavation laterally/vertically where the exceedance was noted and resample the face/base of the excavation. Observations, olfactory indicators and soil headspace screening techniques will be used to guide the extent of the excavation.

(ii) Evaluate the soil validation data alongside other available investigation data to assess whether the soil validation test result is a statistical outlier, or whether the data falls within the observed chemical variability identified within the fill materials on site and statistically representative concentrations are below the adopted remediation criteria. Where evidence is collated which supports the latter scenario, the remediation excavation would not be progressed further.

7.10 Environmental Management Plan

An Environmental Management Plan (EMP) will be developed (where relevant) which outlines the long term maintenance and monitoring requirements following the completion of the remediation and construction works. The EMP would include:

- A summary of site setting and remedial works undertaken, including a drawing which clearly shows:
  - (i) Areas previously subject to remediation excavations.
  - (ii) Areas affected by management measures which have been used to separate site users from residual ground conditions. Where appropriate, this should include details of the separation layers adopted throughout the scheme.
- Assumptions on which exposure settings and risk management protocols are based.
- If required, a long term maintenance and monitoring/inspection programme to maintain the effectiveness of the separation layer installed as part of the remediation project.
- Controls to mitigate health risks during future excavations and subsurface ground works, including those relating to areas of soft landscaping introduced as part of the development.
- Reinstatement requirements where separation layers used as part of the remediation works are breached.
- Health and safety and other environmental management controls for construction workers and other site personnel involved in works which may result in exposure to residual soil or groundwater.

Coffey recommends that the EMP (where relevant) be prepared as a standalone document alongside the site-specific RAP in support of the detailed development applications.

8 CONCLUSIONS

The site is located within the Haymarket district of Sydney's Central Business District and comprises the SEC, associated car park and surrounding public realm. The site covers an area of approximately 4ha and is bound by Pier Street to the north, Hay Street to the south, a light rail corridor to the west and Harbour Street to the east.

Coffey prepared this Overarching Remediation Action Plan to be consistent with EPA reporting guidelines and to address issues for consideration listed in Section 3.5.4 of the Managing Contaminated Land: Planning Guidelines SEPP 55 – Remediation of Land (DUAP/EPA 1998).

Darling Harbour Live is seeking to lodge the Application to redevelop the site for a mixture of residential and commercial uses with associated public realm comprising managed landscaped and paved areas.

In summary, four site investigation programmes were undertaken by Coffey between June 2011 and January 2013 across the SICEEP and a review was undertaken of results relevant to the site. The investigation works carried out to date, it is assessed that within practical limits, the density of investigation locations meets the minimum requirements set out in the NSW EPA Sampling Design Guidelines. Coffey considers that the investigations carried out to date have adequately characterised contamination at the site for the purposes of supporting the Application.

In the context of the mixed residential and commercial development proposed by Darling Harbour Live, these investigations identified:

- Localised areas of soil contamination within fill materials and shallow natural soils that warrant further consideration in the context of the site redevelopment proposals.
- Potential acid sulfate soil within the natural alluvium where it occurs within the site. An Acid Sulfate Soil Management Plan has been prepared under separate cover to mitigate issues associated with acid sulfate soils.
- No groundwater contamination, which is considered significant enough to warrant detailed investigation or remediation, has been encountered.

This Overarching RAP presents remediation goals for the site and evaluates six remedial options to mitigate the potential risks associated with identified soil contamination. In consideration of the nature, type and extent of soil contamination identified, the preferred remedial option comprises a combination of source removal and the use of construction elements included in the proposed development to separate site users from existing soil conditions. The preferred approach would be informed by a HHERA.

The scope of the remediation and/or management required for the site will be further clarified by the findings of a Human Health & Environmental Risk Assessment (HHERA). If the remediation is carried out in accordance with this document including the preferred remedial option presented herein, Coffey concludes the site can be made suitable for the proposed development.

9 REFERENCES

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- NSW EPA (2006) Guidelines for the NSW Site Auditor Scheme. ISBN 0-7313 0177 3
- ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment & Conservation Council. ISBN 0-642-18297-3.
- NEPC (1999) National Environmental Protection (Assessment of Site Contamination) Measure (NEPM).
- Friebel and Nadebaum (2011); CRC CARE Technical Report No. 10: Health Screening Levels for Petroleum Hydrocarbons in Soil – Part 2: Application Document
- DECCW (2009); Waste Classification Guidelines - Part 1: Classifying Waste
- DUAP/EPA (1998); Managing Land Contamination: Planning Guidelines - SEPP 55 Remediation of Land

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Important information about Coffey Environmental Report

Uncertainties as to what lies below the ground on potentially contaminated sites can lead to remediation costs blow outs, reduction in the value of the land and to delays in the redevelopment of land. These uncertainties are an inherent part of dealing with land contamination. The following notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report has been written for a specific purpose

Your report has been developed on the basis of a specific purpose as understood by Coffey and applies only to the site or area investigated. For example, the purpose of your report may be:

- To assess the environmental effects of an on-going operation.
- To provide due diligence on behalf of a property vendor.
- To provide due diligence on behalf of a property purchaser.
- To provide information related to redevelopment of the site due to a proposed change in use, for example, industrial use to a residential use.
- To assess the existing baseline environmental, and sometimes geological and hydrological conditions or constraints of a site prior to an activity which may alter the sites environmental, geological or hydrological condition.

For each purpose, a specific approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible, quantify risks that both recognised and unrecognised contamination pose to the proposed activity. Such risks may be both financial (for example, clean up costs or limitations to the site use) and physical (for example, potential health risks to users of the site or the general public).

Scope of Investigations

The work was conducted, and the report has been prepared, in response to specific instructions from the client to whom this report is addressed, within practical time and budgetary constraints, and in reliance on certain data and information made available to Coffey. The analyses, evaluations, opinions and conclusions presented in this report are based on those instructions, requirements, data or information, and they could change if such instructions etc. are in fact inaccurate or incomplete.

Subsurface conditions can change Interpretation of factual data

Subsurface conditions are created by natural processes and the activity of man and may change with time. For example, groundwater levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project and/or on the property.

Interpretation of factual data

Environmental site assessments identify actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from indirect field measurements and sometimes other reports on the site are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of Coffey through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other problems encountered on site.

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Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered with redevelopment or on-going use of the site. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. In particular, a due diligence report for a property vendor may not be suitable for satisfying the needs of a purchaser. Your report should not be applied for any purpose other than that originally specified at the time the report was issued.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other professionals who are affected by the report. Have Coffey explain the report implications to professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), field testing and laboratory evaluation of field samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Contact Coffey for additional assistance

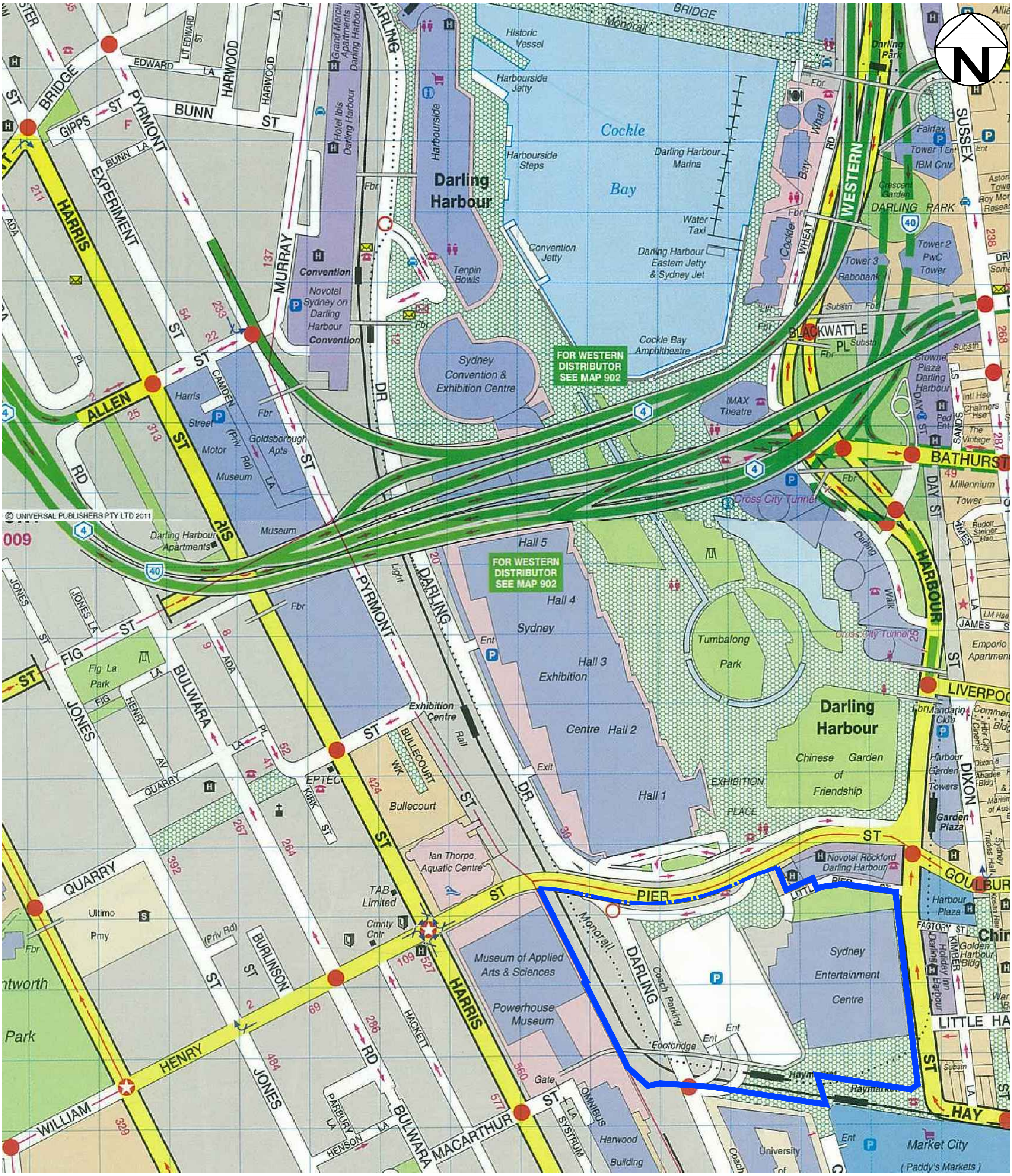
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to land development and land use. It is common that not all approaches will be necessarily dealt with in your environmental site assessment report due to concepts proposed at that time. As a project progresses through planning and design toward construction and/or maintenance, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Environmental reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

Figures

Overarching Remedial Action Plan
Haymarket Precinct, Darling Harbour, Sydney NSW



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Horizontal Scale (metres) 1:5000

LEGEND

SITE BOUNDARY

SOURCE: UBD STREET DIRECTORY GREGORYS SYDNEY, NEW SOUTH WALES 47TH EDITION, 2012, MAP: E & G

DRAFT

drawn	MV	coffey environments SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE	client: LEND LEASE DEVELOPMENT	
approved	ML		project: HAYMARKET PRECINCT, DARLING HARBOUR SYDNEY, NEW SOUTH WALES	
date	11/02/13		title: SITE LOCATION MAP	
scale	AS SHOWN		project no: ENAURHOD04498AA-D01	figure no: FIGURE 1
original size	A4			

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PIER STREET

LITTLE PIER STREET

HARBOUR STREET

DARLING DRIVE

SYDNEY ENTERTAINMENT CENTRE CAR PARK

SYDNEY ENTERTAINMENT CENTRE

WILLIAM HENRY STREET

MACARTHUR STREET

LEGEND

- SITE BOUNDARY
- SYDNEY MONORAIL ELEVATED TRACK
- LIGHT RAIL CORRIDOR

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revision	description	drawn	approved	date

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Scale (metres) 1:1500

drawn	MV
approved	ML
date	11/02/13
scale	1:1500
original size	A3

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SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

client: LEND LEASE DEVELOPMENT

project: HAYMARKET PRECINCT, DARLING HARBOUR
SYDNEY, NEW SOUTH WALES

title: SITE LAYOUT PLAN

project no: ENAURHOD04498AA-D01

figure no: FIGURE 2

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PIER STREET

DARLING DRIVE

POWERHOUSE MUSEUM

PARKING STATION

ENTERTAINMENT CENTRE

CBH/MW6
CBH/MW9
CBH10
BH118
NBH24
NBH23
NBH29
BH12(MW)
BH5
BH6
CBH11
BH10
CBH7
CBH7A
EB1
BH7
BH124/MW124
CBH5A
CBH5
CBH8
BH128
BH129
BH1(MW)
BH120/MW120
NBH27
BH14
NBH26
EB2
BH123A
BH2
BH127
BH123
BH8
BH15
BH125
BH3
BH121A
BH9
BH125A
NBH/MW25
BH121
NBH/MW30
BH122
EB3
BH16
BH4
BH126
BH122A
BH13(MW)
BH119
BH11
BH17

AERIAL IMAGE SOURCE: GOOGLE EARTH PRO 6.6.2.6613
AERIAL IMAGE ©: 2012 SINCLAIR KNIGHT MERZ
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LEGEND

- EB — COFFEY BOREHOLE LOCATIONS (JULY / JULY 2011)
- COFFEY BOREHOLE LOCATION (AUGUST 2011)
- NBH — COFFEY BOREHOLE LOCATION (APRIL / MAY 2012)
- NBH/MW — COFFEY GROUNDWATER MONITORING WELL (APRIL / MAY 2012)
- CBH — COFFEY SUPPLEMENTARY BOREHOLE LOCATION (JULY 2012)
- CBH/MW — COFFEY GROUNDWATER MONITORING WELLS (JULY 2012)
- SITE BOUNDARY
- BORE HOLES (NOV / DEC 2012)
- MONITORING WELLS (NOV / DEC 2012)

revision	description	drawn	approved	date

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Scale (metres) 1:1000

drawn	MV
approved	ML
date	11/02/13
scale	1:1500
original size	A3

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SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

client: LEND LEASE DEVELOPMENT

project: HAYMARKET PRECINCT, DARLING HARBOUR
SYDNEY, NEW SOUTH WALES

title: SITE INVESTIGATION LOCATION PLAN

project no: ENAURHOD04498AA-D01 figure no: FIGURE 3

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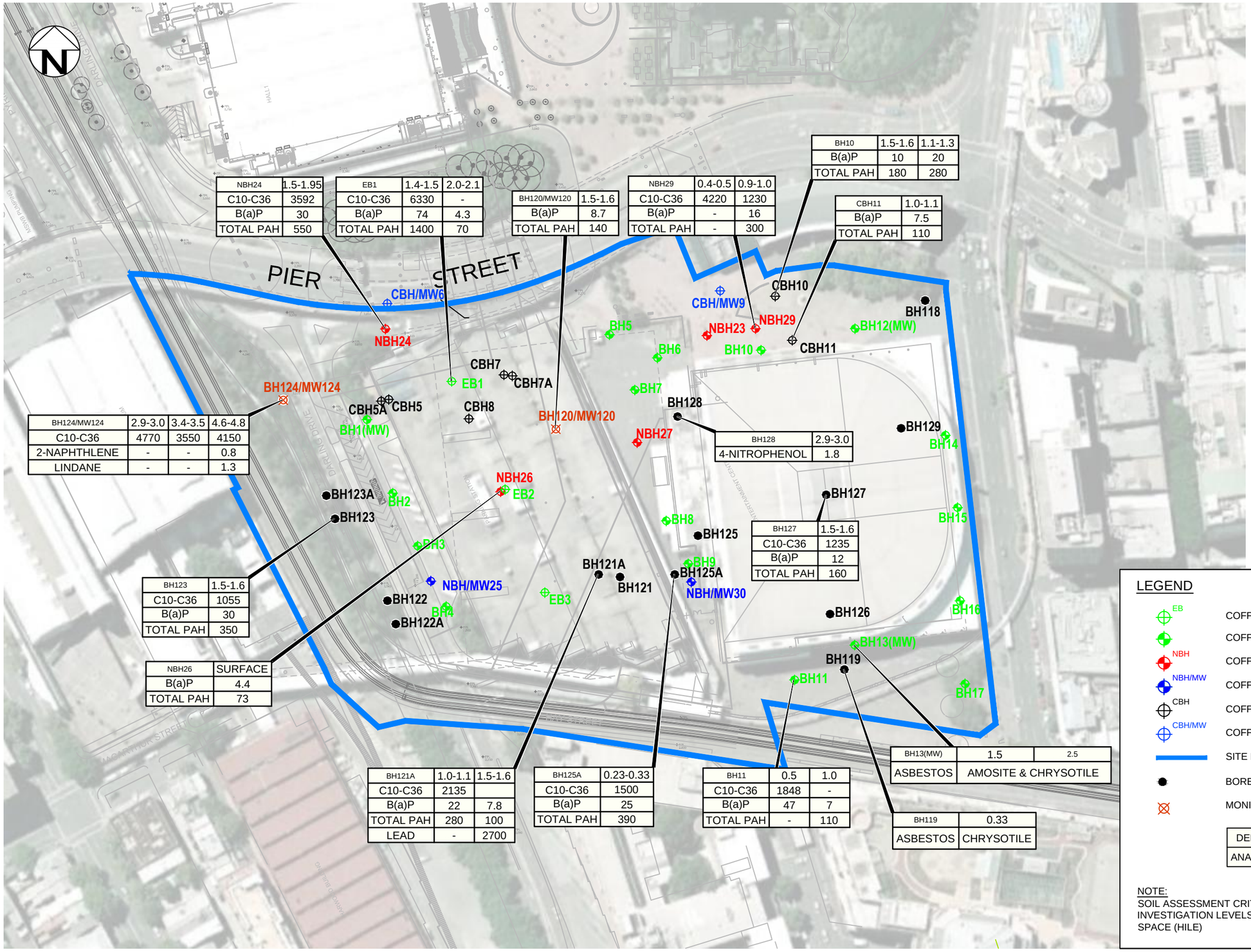

NBH24	1.5-1.95
C10-C36	3592
B(a)P	30
TOTAL PAH	550

EB1	1.4-1.5	2.0-2.1
C10-C36	6330	-
B(a)P	74	4.3
TOTAL PAH	1400	70

BH120/MW120	1.5-1.6
B(a)P	8.7
TOTAL PAH	140

NBH29	0.4-0.5	0.9-1.0
C10-C36	4220	1230
B(a)P	-	16
TOTAL PAH	-	300

BH10	1.5-1.6	1.1-1.3
B(a)P	10	20
TOTAL PAH	180	280

CBH11	1.0-1.1
B(a)P	7.5
TOTAL PAH	110

BH124/MW124	2.9-3.0	3.4-3.5	4.6-4.8
C10-C36	4770	3550	4150
2-NAPHTHLENE	-	-	0.8
LINDANE	-	-	1.3

BH128	2.9-3.0
4-NITROPHENOL	1.8

BH127	1.5-1.6
C10-C36	1235
B(a)P	12
TOTAL PAH	160

BH123	1.5-1.6
C10-C36	1055
B(a)P	30
TOTAL PAH	350

NBH26	SURFACE
B(a)P	4.4
TOTAL PAH	73

BH121A	1.0-1.1	1.5-1.6
C10-C36	2135	
B(a)P	22	7.8
TOTAL PAH	280	100
LEAD	-	2700

BH125A	0.23-0.33
C10-C36	1500
B(a)P	25
TOTAL PAH	390

BH11	0.5	1.0
C10-C36	1848	-
B(a)P	47	7
TOTAL PAH	-	110

BH13(MW)	1.5	2.5
ASBESTOS	AMOSITE & CHRYSOTILE	

BH119	0.33
ASBESTOS	CHRYSOTILE

LEGEND

- EB — COFFEY BOREHOLE LOCATIONS (JULY / JULY 2011)
- COFFEY BOREHOLE LOCATION (AUGUST 2011)
- NBH — COFFEY BOREHOLE LOCATION (APRIL / MAY 2012)
- NBH/MW — COFFEY GROUNDWATER MONITORING WELL (APRIL / MAY 2012)
- CBH — COFFEY SUPPLEMENTARY BOREHOLE LOCATION (JULY 2012)
- CBH/MW — COFFEY GROUNDWATER MONITORING WELLS (JULY 2012)
- SITE BOUNDARY
- BORE HOLES (NOV / DEC 2012)
- MONITORING WELLS (NOV / DEC 2012)

DEPTH	(metres)
ANALYTE	(mg/kg)

NOTE:
SOIL ASSESSMENT CRITERIA APPLIED COMPRISES HEALTH INVESTIGATION LEVELS CONSIDERED APPROPRIATE FOR PUBLIC OPEN SPACE (HILE)

DRAFT

revision	description	drawn	approved	date

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Scale (metres) 1:1500

drawn	MV
approved	ML
date	11/02/13
scale	1:1500
original size	A3

coffey environments
SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

client: LEND LEASE DEVELOPMENT

project: HAYMARKET PRECINCT, DARLING HARBOUR
SYDNEY, NEW SOUTH WALES

title: SOIL EXCEEDANCES

project no: ENAURHOD04498AA-D01 figure no: FIGURE 4

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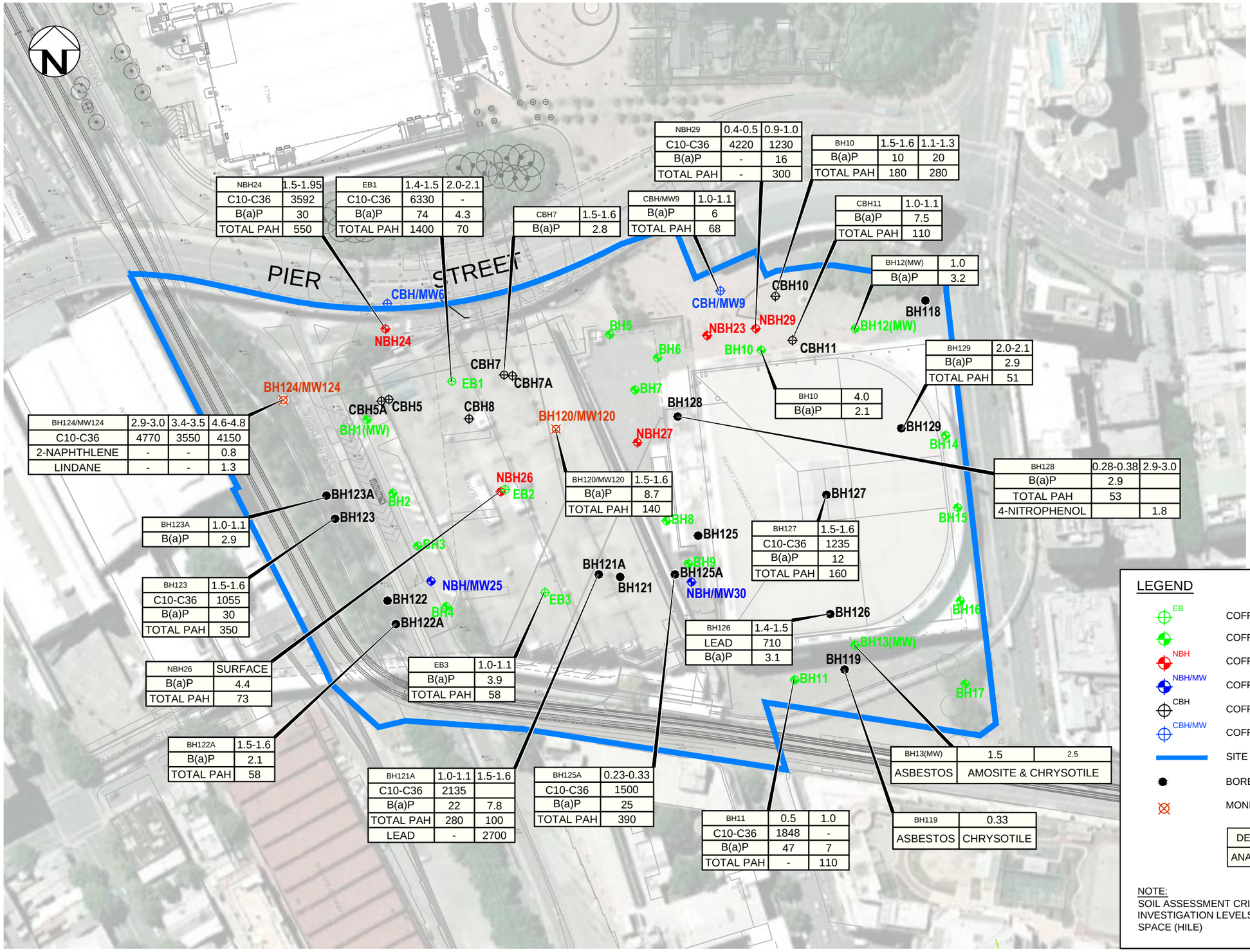

NBH24	1.5-1.95
C10-C36	3592
B(a)P	30
TOTAL PAH	550

EB1	1.4-1.5	2.0-2.1
C10-C36	6330	-
B(a)P	74	4.3
TOTAL PAH	1400	70

CBH7	1.5-1.6
B(a)P	2.8

CBH/MW9	1.0-1.1
B(a)P	6
TOTAL PAH	68

NBH29	0.4-0.5	0.9-1.0
C10-C36	4220	1230
B(a)P	-	16
TOTAL PAH	-	300

BH10	1.5-1.6	1.1-1.3
B(a)P	10	20
TOTAL PAH	180	280

CBH11	1.0-1.1
B(a)P	7.5
TOTAL PAH	110

BH12(MW)	1.0
B(a)P	3.2

BH129	2.0-2.1
B(a)P	2.9
TOTAL PAH	51

BH10	4.0
B(a)P	2.1

BH124/MW124	2.9-3.0	3.4-3.5	4.6-4.8
C10-C36	4770	3550	4150
2-NAPHTHLENE	-	-	0.8
LINDANE	-	-	1.3

BH120/MW120	1.5-1.6
B(a)P	8.7
TOTAL PAH	140

BH128	0.28-0.38	2.9-3.0
B(a)P	2.9	
TOTAL PAH	53	
4-NITROPHENOL		1.8

BH123A	1.0-1.1
B(a)P	2.9

BH123	1.5-1.6
C10-C36	1055
B(a)P	30
TOTAL PAH	350

BH127	1.5-1.6
C10-C36	1235
B(a)P	12
TOTAL PAH	160

NBH26	SURFACE
B(a)P	4.4
TOTAL PAH	73

BH126	1.4-1.5
LEAD	710
B(a)P	3.1

EB3	1.0-1.1
B(a)P	3.9
TOTAL PAH	58

BH122A	1.5-1.6
B(a)P	2.1
TOTAL PAH	58

BH121A	1.0-1.1	1.5-1.6
C10-C36	2135	
B(a)P	22	7.8
TOTAL PAH	280	100
LEAD	-	2700

BH125A	0.23-0.33
C10-C36	1500
B(a)P	25
TOTAL PAH	390

BH11	0.5	1.0
C10-C36	1848	-
B(a)P	47	7
TOTAL PAH	-	110

BH13(MW)	1.5	2.5
ASBESTOS	AMOSITE & CHRYSOTILE	

BH119	0.33
ASBESTOS	CHRYSOTILE

LEGEND

- EB — COFFEY BOREHOLE LOCATIONS (JULY / JULY 2011)
- COFFEY BOREHOLE LOCATION (AUGUST 2011)
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- CBH/MW — COFFEY GROUNDWATER MONITORING WELLS (JULY 2012)
- SITE BOUNDARY
- BORE HOLES (NOV / DEC 2012)
- MONITORING WELLS (NOV / DEC 2012)

DEPTH	(metres)
ANALYTE	(mg/kg)

NOTE:
SOIL ASSESSMENT CRITERIA APPLIED COMPRISES HEALTH INVESTIGATION LEVELS CONSIDERED APPROPRIATE FOR PUBLIC OPEN SPACE (HILE)

revision	description	drawn	approved	date

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Scale (metres) 1:1500

drawn	MV
approved	ML
date	11/02/13
scale	1:1500
original size	A3

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SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

client: LEND LEASE DEVELOPMENT

project: HAYMARKET PRECINCT, DARLING HARBOUR SYDNEY, NEW SOUTH WALES

title: SOIL EXCEEDANCES - PUBLIC OPEN SPACE

project no: ENAURHOD04498AA-D01 figure no: FIGURE 5

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