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AECOM

SITE LAYOUT AND SAMPLING LOCATIONS

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

FIGURE 3

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

Appendix B

Sampling & Analytical Quality Plan (AECOM, 2013a)

AECOM

Sydney International Convention Exhibition and Entertainment Precinct

Lend Lease Project Management and Construction

11 March 2013

Commercial-in-Confidence

Sampling Analysis and Quality Plan

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

Sampling Analysis and Quality Plan

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

Prepared for

Lend Lease Project Management and Construction

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Quality Information

Document Sampling Analysis and Quality Plan

Ref

Date 11 March 2013

Prepared by Ainslie Sumner/Andrew Rolfe

Reviewed by Rachel Casson

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Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
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1.0 Introduction

1.1 Background

AECOM Australia Pty Ltd (AECOM) has prepared this Sampling, Analysis and Quality Plan (SAQP) for Lend Lease Project Management & Construction (Lend Lease). This SAQP has been developed for the redevelopment of the Sydney International Conference, Exhibition and Entertainment Precinct (SICEEP) at Darling Harbour, NSW. The SICEEP site has been divided into two areas:

- The Public Private Partnership (PPP) area (hereafter referred to as 'the PPP' (refer to **Figure 1**); and
- The Private Developer Agreement (PDA) area.

This SAQP relates exclusively to the redevelopment works to be conducted within the PPP, which encompasses the current Convention Centre, Exhibition Centre and public access areas including Tumbalong Park and occupies an approximate area of 14.8 hectares (refer **Figure 2**).

AECOM understands that future redevelopment works will include demolition of the Convention and Exhibition Centres to slab level, with the proposed earthworks at the PPP limited to:

- Bored piers extending to the depth of rock for the installation/construction of foundation/piles and lift pits;
- Relatively shallow excavations for the installation of utilities; and
- Minor cut and fill of soils at the proposed Public Realm landscape area that is currently occupied by Tumbalong Park.

Redevelopment works will generate approximately 26,000 m^3 of spoil that can potentially be reused on-site or will require off-site disposal. Some imported fill may be required for landscaping in the Tumbalong Park area. The current slabs presently located beneath the Convention and Exhibition centre will remain.

The sampling and analytical strategy described within this SAQP is based on the findings of the Coffey Environments Pty Ltd (Coffey) investigations previously conducted at the PPP.

1.2 Objectives

The purpose of the SAQP is to:

- Define the data quality objectives (DQOs) and quality control / quality assurance (QA/QC) procedures to be implemented for the soil and groundwater testing works.
- Describe a sampling strategy and methodology to manage soil and groundwater encountered during the redevelopment works at the PPP;
- Describe applicable soil and groundwater guidelines to be used for assessing the analytical results obtained; and
- Ensure the soil and groundwater data are obtained in accordance with relevant guidelines.

2.0 Data Quality Objectives

In determining the type, quantity and quality of data needed to support decisions relating to the environmental condition of the PPP, AECOM has undertaken the seven-step process to develop the DQOs in accordance with NSW DEC *Guidelines for the NSW Site Auditor Scheme 2nd Edition* (2006). The DQOs set quality assurance and quality control parameters for the sampling and laboratory programs to ensure data of appropriate reliability have been used to assess the environmental condition of the PPP.

The adopted DQOs for the future soil and groundwater testing works are presented below.

2.1 Step 1 – State the Problem

The PPP was initially reclaimed using materials dredged from the Harbour prior to the 1850's to accommodate for the development of Sydney's first Mains Goods Terminal. Rail and port infrastructure were progressively developed to accommodate for the evolution of energy sources and train and shipping technologies. The gentrification of the City limits and relocation of shipping and rail infrastructure/terminals lead to the redevelopment of the current Site in the 1980's as a hub of public recreation, entertainment and assembly.

Following a review of the previous site investigations (refer to **Section 3.0**), AECOM (2013a) concluded that the following Contaminant of Potential Concern (CoPC) were reported above the assessment criteria:

- TPH (soil);
- PAHs (soil); and
- Metals (chromium, copper, lead and zinc) (groundwater).

Based on the current dataset (as detailed in AECOM 2013b), reclamation and historical rail and port operations conducted on the PPP appear to have impacted the quality of fill, soil and groundwater conditions. However, the extent of the identified impacted soil was not fully evaluated, nor does the current dataset adequately demonstrate that the contamination was limited to '*hotspots'* in the heterogeneous fill material. In addition, data gaps/uncertainties have been identified, including but not limited to:

- The quality of the current dataset with respect to sampling techniques and selected analytical program including:
  - Samples collected from the solid flight auger for description and analysis; and
  - Logging and description of Site fill types and associated observable indicators of contamination (e.g. ash/slag and/or fragments of asbestos containing materials.
- Understanding the history of filling conducted at the PPP, including whether waste materials were historically sourced from nearby former power stations and/or were sporadically dumped across the PPP during rail related operations;
- Understanding the variability of contaminants of concern on the heterogeneous fill;
- The reported possibility of underground storage tanks being present at the PPP but not adequately assessed;
- Waste classification of Site fill materials; and
- Leaching potential or mobility of contaminants from fill to groundwater and from groundwater to Cockle Bay (Darling Harbour).

The various stakeholders for the project include:

- Infrastructure New South Wales (INSW);
- NSW Department of Planning and Infrastructure (DoPI) and the Minister;
- NSW Environment Protection Authority (EPA);
- A NSW Site Auditor;
- The Land Owner (Sydney Harbour Foreshore Authority);
- The Developer (Lend Lease); and

- The Community

2.2 Step 2 – Identify the Decisions (Goals)

The decisions to be made relate to whether the soil and groundwater testing program has demonstrated that the objectives of the *RWP* (AECOM, 2013b) have been met:

- has the variability of contaminants of concern in the fill been adequately assessed and does it significantly impact on the decisions being made?
- Is the PPP protective of human health in the context of the proposed land uses?
- Is there a sufficiently robust groundwater data set to conclude that groundwater quality is not impacting on the nearest sensitive receptor (Cockle Bay)?
- Will the proposed construction works have any adverse impact on Cockle Bay?
- Do the completed testing works comply with applicable legislative requirements including the appropriate requirements of the NSW DoPI and NSW EPA?

2.3 Step 3 – Identify Information Inputs to the Decisions

Inputs to the decision that need to be made with respect to whether the proposed remediation works at the PPP have achieved the stated objectives are:

- The results of previous investigations (refer to **Section 3.0**);
- The use of appropriate site assessment criteria (refer to **Section 4.0**);
- The development and implementation of remedial options, if required;
- The data to be obtained during soil sampling during the testing discussed in **Section 5.1**;
- The data to be obtained during groundwater sampling during the monitoring discussed in **Section 5.3**;
- The use of appropriate field methods, including sampling and preservation of soil and groundwater samples;
- The use of NATA registered methods for all analysis; and
- Confirmation that the data quality objectives (DQIs) have been achieved.

2.4 Step 4 – Define the Study Boundaries

The boundaries of the proposed investigation have been identified as follows:

- **Spatial boundaries:**
  - The PPP boundaries have been clearly defined as follows:

Table 1 PPP Site Details

Item	Description
Site Identification	Sydney International Convention, Exhibition and Entertainment Precinct, PPP Area
Site Address	Darling Drive, Darling Harbour, NSW 2000
Title Identification Details (1)	part of Lot 1010 DP 1147364 - Sydney Convention and Exhibition Centre area part of Lot 2 DP 1048307 - air space over and area around Western Distributer overpass part of Lot 900 DP 1132344 - Tumbalong Park area Lot 901 DP 1132344 - small portion of Tumbalong Park area part of Lot 200 DP 1165804 - residue Pier Street underbridge part of Lot 1 DP612907 - southern edge of Pier Street area part of Lot 602 DP 1009796 - Darling Drive area part of Lot 33 DP 870306 - Darling Drive area
Site Owner (2)	Sydney Harbour Foreshore Authority

Item	Description
Zoning (2)	The PPP is affected by the Darling Harbour Development Plan No. 1, which is deemed a regional environmental plan under the EP&A Act.
Current Land Use (2)	Commercial, recreational and open space land use.
Site Area	Approximately 14.84 hectares
Site Elevation (2)	0m to 10m AHD (Australian Height Datum).
Site Location	**Figure 1** (**Appendix A**).
Site Layout	**Figure 2** (**Appendix A**).

Notes: 1. SIX (http://maps.six.nsw.gov.au)

- The vertical investigation boundary will be variable and limited to the bottom of the fill in some locations and to the top of bedrock in others and/or encountered groundwater table.
- **Temporal boundaries:**
  - Soil and groundwater data for the PPP between 2011 (date of the earliest known Coffey data sets) and the date of the soil and groundwater testing works.

2.5 Step 5 – Develop a Decision Rule (Analytical Approach)

The quality of data from field and laboratory procedures will be achieved by assessing the analytical data with reference to DQIs. The criteria will be as follows:

Table 2 Field and Laboratory Data Quality Indicators

Data	Data Quality Indicators
Field	
Field Personnel	Use appropriately trained field personnel.
Field data collection	Site conditions and sample locations properly described. All soil sample and groundwater monitoring well locations will be surveyed. Information to be recorded in field notes. Field notes are appropriately completed.
Sample handling (storage and transport)	Soil and groundwater samples will be collected will be collected in accordance with **Section 5.2** and **5.4**.
Field duplicates	As per the requirements of **Section 5.2.2**.
Field blanks	As per the requirements of **Section 5.2.2**.
Calibration of Field Equipment	On-site screening of samples for volatile organic compounds (VOCs) in the field will be undertaken using a portable photoionisation detector (PID). The PID will be calibrated at least once daily (at the start of each sampling day) with a known concentration of isobutylene. Water quality meters will be calibrated prior to the commencement of field activities with relevant solutions. The calibration will be in accordance with manufacturer's instructions or NATA publications *General Requirements for Registration: Supplementary Requirement: Chemical Testing (NATA 1993) and Technical Note N0. 19* (NATA 1994). Where satisfactory calibration cannot be achieved, the equipment will not be used. Calibration details will be recorded on field sheets, which will be included in the final report.
Laboratory	
Sample Analysis	All sample analyses to be conducted using National Association of Testing Authorities (NATA) certified laboratory using NEPM procedures. Use NATA certified check laboratory.

Data	Data Quality Indicators
Holding times	Maximum acceptable sample holding time is 14 days for organic analyses and 6 months for metal analyses (28 days for mercury).
QA/QC samples	As per the requirements of **Section 5.2.2**.
Practical Quantitation Limits (PQLs)	All PQLs to be less than the SAC (refer to **Section 4.0**).
Laboratory Relative Percentage Difference (RPD)	The RPDs of replicates will be determined and compared to the following criteria for acceptability: - Less than 20 percent for laboratory duplicates where the detection is greater than 20 times the PQL; - Less than 50 percent for laboratory duplicates where the detection is greater than 10 times the PQL and less than 20 times the PQL; and - No limit where concentration less than 10 times PQL
Control Spike Duplicate RPDs	RPDs for Control Spike Duplicates will be compared to an acceptable limit of 20% and undertaken at 1 in 20 samples or a minimum of 1 per batch.
Matrix Spike Duplicates RPD	RPDs for Matrix Spike Duplicates will be compared to an acceptable limit of 20% and undertaken at a minimum of 1 in 20 samples.
Control Spike and Matrix Spike Recoveries	Percent recoveries of control spikes and matrix spikes will be compared to an acceptable range of 75–130 % and/or the laboratories internal DQI limits.

Corrective Actions

Analytical data that fail to meet the predetermined DQIs listed in **Table 2** above will be managed using the following corrective actions on a case-by-case basis:

- Inspect samples to determine heterogeneity;
- Reanalyse suspect samples;
- Evaluate and amend sampling and/or analytical procedures;
- Re-sampling and re-analysis;
- Accept the data with an acknowledged level of bias and imprecision; and
- Discard the data.

In the event that data of questionable reliability are used, then it is essential that any restrictions and limitations associated with the use of such data are clearly identified. Failure to meet the DQIs will be reported and the implications to data quality will be assessed.

If the DQIs are considered to have been achieved satisfactorily then it will be concluded that the data are suitable for use for testing purposes. If the DQIs are not achieved, the significance of possible errors will be assessed to decide whether the data is useable.

2.6 Step 6 – Specification of the acceptable limits on decision errors

Specification of the acceptable limits on decision errors will be achieved by reference to the DQIs outlined below:

2.6.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. The precision of the laboratory data and sampling techniques will be assessed by calculating the Relative Percent Difference (RPD) of duplicate (laboratory and field) samples. The criteria to be used for the assessment of RPD will be based on guidelines given in AS4482.1 1997. These criteria listed in **Table 3** below:

Table 3 RPD Assessment Criteria

Sample Type	Typical Acceptable RPD [a]
Intra-Laboratory Duplicate	30-50% [b]
Inter-Laboratory Duplicate	30-50% [b]

Notes: a) The significance of RPDs of results should be evaluated on the basis of sampling technique, sample variability, absolute concentration relative to criteria and laboratory performance.

b) This variation can be expected to be higher for organic analysis than for inorganics and for low concentrations of analytes which are close to the laboratory LOR.

If duplicate results are not within the acceptable RPD range, investigation into the cause will be initiated. The results of the investigations will be written up and filed, and followed up with the laboratories to achieve resolution. Thus the precision of the laboratory will be assessed by the acceptability of the RPD of laboratory duplicate samples, which should be within the acceptable RPD limits as established for intra-laboratory and inter-laboratory duplicates.

2.6.2 Accuracy

Accuracy measures the bias in measurement. Accuracy can be impacted by factors such as field contamination of samples, poor preservation of samples, poor sample preparation techniques and poor selection of analysis techniques by the analysing laboratory and improper analyses.

The accuracy of the laboratory data that will be generated during the project is a measure of the closeness of the analytical results obtained by a method to the 'true' value. For reference laboratory methods (e.g. USEPA methods), the following levels of accuracy should generally be achievable within ± 15 % of:

- The expected value of a certified reference material of similar matrix; or
- The value obtained by a separately validated and recognised quantitative method for the sample matrix.

Accuracy will be assessed by:

- Reference to the analytical results of laboratory control samples;
- Use of trip, equipment and field blanks to check the accuracy of sampling techniques; and
- Evaluating the results of laboratory spikes and analyses against reference standards.

Analytical results of these should be sufficient to establish that accuracy has been achieved in the work of the sampling team.

2.6.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population or an environmental condition. Representativeness will be achieved by collecting samples on a grid basis from an adequate number of sample locations, to validate the subject area to the required accuracy and ensuring that an appropriate number of reliable analyses have been reported for each population or environmental condition, and that the concentrations of CoPC have been maintained in the samples during and after their collection. Consistent techniques and methods using written procedures will be utilised throughout the sampling program.

2.6.4 Completeness

Completeness is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being a sufficient amount of valid data generated during the testing works. If there are insufficient valid data, as determined by the other DQIs, then additional data will be required to be collected.

2.6.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This will be achieved through maintaining a level of consistency in techniques used to collect samples, and ensuring the selected laboratories use consistent analytical techniques and reporting methods. Reporting of results will be done in consistent units and nomenclatures, and comparability will be achieved by ensuring that precision and accuracy objectives are met.

2.7 Step 7 – Optimisation of the design of the collection of data

This will be achieved by meeting the DQOs detailed in Steps 1 to 6 to confirm that the data generated from the testing works is from appropriate locations, that analytical testing is undertaken for the identified CoPC, in appropriate quantities and of acceptable quality to confirm that the objectives of the testing works have been achieved.

2.8 Data Quality Indicators

The following describes the components of the Quality Assurance and Control Plan that will be adopted to assess the achievement of the DQOs set out in the SAQP by consideration of the DQIs (precision, accuracy, reproducibility, completeness and comparability).

The project DQIs have been established to set acceptance limits on field and laboratory data collected at the PPP.

The DQIs are described in **Table 4**.

Table 4 Data Quality Indicators

DQI	Field	Laboratory	Acceptability Limits
Completeness	All critical locations sampled. All samples collected (from grid and depth). Standard Operating Procedures (SOPs) appropriate and complied with. Experienced sampler. Documentation correct.	All critical samples analysed and all analytes analysed according to SOPs. Appropriate methods. Appropriate PQLs. Sample documentation complete. Sample holding times complied with.	As per NEPC (1999) < nominated criteria As per NEPC (1999)
Comparability	Sample SOPs used on each occasion. Experienced sampler. Climatic conditions recorded. Same types of samples collected.	Same analytical methods used (including clean-up). Sample PQLs (justify/quantify if different). Same laboratories (NATA accredited). Same units.	As per NEPC (1999) < nominated criteria
Representativeness	Appropriate media sampled according to SOP. All relevant media sampled.	All samples analysed according to SOP.	
Precision	SOPs appropriate and complied with. Collection of intra-laboratory and inter-laboratory duplicate samples. Analysis of laboratory duplicate samples.	Analysis of: Intra-laboratory duplicate samples (1 in 10 samples). Inter-laboratory duplicate samples (1 in 20 samples). Laboratory duplicate samples.	Acceptable duplicate limits are described in **Section 7.2.3**.

DQI	Field	Laboratory	Acceptability Limits
Accuracy	SOPs appropriate and complied with. Collection of rinsate blanks.	Analysis of: Method blanks. Matrix spikes. Matrix spike duplicates. Surrogate spikes. Laboratory control samples. Laboratory prepared spikes. Reagent blanks. Reference materials.	Non-detect for CoC 70 to 130%. RPD of <30%. 70 to 130%. 70 to 130%. 70 to 130%.

Non-compliances with acceptance limits will be documented and discussed in the relevant report. All reporting will be undertaken in accordance with NSW EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites,* as applicable.

3.0 Summary of Contamination Issues

3.1 Previous Investigations

This SAQP is based on the findings of the following previous investigation reports related to the PPP:

- Coffey Environments Australia Pty Ltd (2011). *Contamination Investigation: Sydney International Convention and Entertainment Centre* (23 August 2011);
- Coffey Geotechnics (2012a). *Stage 2 – Detailed Site Investigation: SICEEP, Darling Harbour* (1 June 2012); and
- Coffey Geotechnics (2012b). *Stage 1 – Preliminary Environmental Investigation: SICEEP, Darling Harbour* (8 June 2012);
- Coffey Geotechnics (2012c). *Supplementary Environmental Investigation: SICEEP, Darling Harbour* (17 August 2012);
- Coffey Geotechnics (2013a). *Supplementary Site Investigation: Factual Report, SICEEP, Darling Harbour* (30 January 2013);
- AECOM (2013a). *Human Health and Ecological Risk Assessment (HHERA), SICEEP, Darling Harbour* (February 2013);
- AECOM (2013b). *Remedial Works Plan (RWP), SICEEP, Darling Harbour* (February 2013); and
- AECOM (2013c). *Acid Sulfate Soil Management Plan (ASSMP), SICEEP, Darling Harbour* (February 2013).

A summary of the Coffey site investigations (Coffey 2011, 2012a to 2012c and 2013a) and the history of land uses at the PPP are provided in the HHERA (AECOM, 2013a).

3.2 Summary of Site History

Reclamation of Darling Harbour occurred throughout the late 19th Century with material sourced from unknown areas of Sydney Harbour. Material within Sydney Harbour is considered to have a high probability of ASS occurrence.

Historical aerial photography indicates the PPP was developed with extensive railway and port related infrastructure including railway sidings, wharves, sheds and associated buildings. Contaminants typically associated with such land uses comprise heavy metals, asbestos, fuels and lubrication oils.

The former Ultimo Power Station is located adjacent the western boundary of the PPP and may represent a potential source of contamination including TPH, PCBs, PAHs, heavy metals and asbestos.

It should be noted that historically the PPP was predominantly covered by goods sheds which were demolished to accommodate the construction of the current Convention Centre, Exhibition Centre and Tumbalong Park. As part of the redevelopment, a partial basement car park was constructed beneath the Exhibition Centre, and therefore it is reasonable to assume that much of the historic fill in this area was likely removed at that time. In summary, the presence of the goods sheds and the likely removal of bulk fill has resulted in less impact at the PPP then the nearby PDA.

3.3 Contaminants of Potential Concern

As detailed in the RWP (AECOM, 2013b) and based on the findings of the HHERA (AECOM, 2013a), the following chemicals of potential concern (CoPC) have been identified at the PPP:

- Soil: TPH and PAHs; and
- Groundwater: heavy metals (namely Cu and Zn) and PAHs (fluoranthene and pyrene).

Notwithstanding, and in consideration of the relatively low sampling density achieved for soil and groundwater across the PPP, soil and groundwater testing proposed herein will include the following analytical suite:

- heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc);
- TPH and BTEX; and

- PAHs.

3.4 Contamination Issues

The fill and natural soils were assessed in the RWP (AECOM, 2013b) for the proposed commercial and recreational areas.

3.4.1 Intended Commercial Areas

One contamination hotspot was identified by Coffey in the fill material in the central part of the PPP, beneath the current Exhibition Centre (refer to **Figure 3** in **Appendix A**). The contamination comprises Benzo-a-Pyrene (BaP) concentration of 6.5 mg/kg at a depth of 0.5 metres m bgs at sampling location NBH10. Additional delineation works were undertaken in this area by Coffey (Coffey, 2012c) (i.e. boreholes CBH1 to CBH4), and indicated that PAH and TPH impacts were also present at a depth of 3.5-3.6 m bgs at nearby CBH2B (refer to **Figure 3** in **Appendix A**). Coffey (2013a) also identified additional TPH impacts (1,100 to 2,300 mg/kg) from 0.25 to 1.0 m bgs in the fill materials in the central part of the PPP (at BH117), beneath the current Exhibition Centre. It is noted that the current slabs presently located in this area will remain intact, therefore restricting access to the contaminated soils in this area.

3.4.2 Intended Recreational Areas

A contamination hotspot was identified at a depth of 1.5 m bgs at NBH/MW13 (located at Tumbalong Park). PAH including BaP concentrations exceeded recreational/open park space criteria at this location. Coffey (2013a) also identified additional TPH impacts (2,900 mg/kg) from 0.12 to 0.22 m bgs in the fill materials in the northern paved part of the PPP (BH104), and BaP impacts (2.2 mg/kg) from 2 to 2.1 m bgs in the fill materials south of Tumbalong Park (BH110A). Access to the impacted materials identified at Tumbalong Park will be restricted due to the depth and will remain covered by 1 m of fill material and landscaped areas following redevelopment.

The soil analytical results for the PPP indicate variability of concentrations of PAHs and TPHs within the heterogeneous fill materials. Given that the total number of soil locations across the PPP is less than those recommended by the NSW EPA in the Sampling Design Guidelines (NSW EPA, 1995), data gaps remain and must be considered during the construction works at the PPP.

3.5 Acid Sulfate Soils

Field analysis of field pH (pH_F) and pH after oxidation (pH_{FOX}) have been conducted on samples collected from across the PPP during the previous Coffey investigations (2012a and 2012c) and the results have indicated the presence of potential acid sulfate soils (PASS) and actual acid sulfate soils (AASS) within the natural alluvial soils beneath the PPP.

Based on the geology of the PPP, the reclamation history and the laboratory analysis conducted to date, it is considered very likely that PASS/AASS will be encountered during excavation at the PPP. Therefore, given that the intended redevelopment/refurbishment works will require removal of these materials at foundation/piles and lift pits, the management of PASS and AASS will be required during redevelopment.

The PASS and AASS assessment program (including sampling methodology and laboratory analytical requirements) are detailed in AECOM (2013c) and, consequently, is not discussed further herein.

4.0 Site Assessment Criteria

The soil and groundwater testing criteria for the PPP have been adopted from the following NSW EPA endorsed guidance documents:

- NSW DEC, 2006. *Guidelines for the NSW Site Auditor Scheme (2nd Edition)*;
- NSW DECC, 2008. *Waste Classification Guidelines. Part 1: Classifying Waste*;
- Australian and New Zealand Environment and Conservation Council and Agriculture and Resourced Management Council of Australia and New Zealand. (ANZECC), 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*;
- National Environment Protection Council (NEPC), 1999. *National Environment Protection (Assessment of Site Contamination) Measure (NEPM)*;
- Friebel, E. and Nadebaum, P. (2011). *CRC CARE Health Screening L for petroleum hydrocarbons in soil and groundwater;* and
- Canada-Wide Standards for Petroleum Hydrocarbons in Soil published by the Canadian Council of Ministers for the Environment, January 2008.

4.1 Soil Assessment Criteria

Given the proposed range of land uses for the PPP, a range of criteria sourced from the guidance documents listed above are required to be applied. Application of these guidelines to the soil samples to be collected and analysed from the PPP is described below.

4.1.1 Metals and PAHs

The current investigation criteria used in NSW to evaluate soil analytical results for PAHs are provided in NSW DEC (2006) guidelines which are based on guidance provided in NEPC (1999). These guidelines present a range of Health-Based Soil Investigation Levels (SILs) and Provisional Phytotoxicity-based Investigation Levels (PILs) for soils, which are considered to be appropriate for a range of land uses on urban sites in NSW, as follows:

- SIL_1 Residential with gardens and accessible soil;
- SIL_2 Residential with minimal access to soil (including high-rise apartments/flats);
- SIL_3 Parks, recreational open space, playing fields (including secondary schools); and
- SIL_4 Commercial or industrial.

The following SIL will be variably adopted for the purposes of this SAQP:

- SIL_3 - Tumbalong Park (recreational/open space areas); and
- SIL_4 - Convention Centre areas (commercial/industrial areas).

The PBILs (NSW DEC, 2006) and EILs (NEPC 1999), which are equivalent, relate to the protection of plants, and are designed to be applied as single number criteria indicative of environmental effect. Their use has significant limitations since phytotoxicity depends on soil properties and the species of plants and are intended to be applied as a screening guide only.

It is noted that the PILs assume application to sandy loams with a pH 6 to 8. Review of the Coffey logs indicates that the upper fill materials (approximately to a depth of 1-2 m depth which would likely be excavated from service trenches) are generally characterised as sandy and gravelly fill. The application of the PILs has significant limitations as phytotoxicity depends on soil and species parameters in ways that are not fully understood. Therefore PILs will not be considered further.

4.1.2 TPH and BTEX

For the assessment of petroleum hydrocarbon contamination, the Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil published by the Canadian Council of Ministers for the Environment, (January 2008) will be adopted based on the following land use scenarios:

- Residential/Parkland Land Use – Coarse Grained Soil; and

- Commercial Land Use – Coarse Grained Soil.

The CRC CARE health screening levels (HSL) values for benzene, toluene, ethylbenzene and naphthalene (BTEXN) for direct contact for both commercial/industrial and recreational/open space were adopted from Friebel, E. and Nadebaum, P. (2011) for the proposed commercial building and Tumbalong Park landscaped areas respectively.

4.1.3 Asbestos

Presently, there are no NSW EPA endorsed assessment/screening criteria for asbestos in soil. NSW DECC (2006) advised site auditors that they "*must exercise their professional judgement when assessing whether a site is suitable for a specific use in the light of evidence that asbestos may be a contaminant of concern*". On this basis, AECOM has adopted a criteria of none detects for asbestos at the PPP.

4.1.4 Waste Classification

The current criteria used in NSW to characterise waste materials for off-site disposal are provided in NSW DECC (2009) guidelines. The guidelines set different maximum total concentrations and leachable concentrations, for specific contaminants in order for waste to be classified as 'general solid waste', 'restricted solid waste' or 'hazardous waste'. This classification then affects the way in which the waste is handled and where the waste is able to be disposed.

For the purpose of characterising soil conditions at the PPP for potential off-site disposal, soil analytical results, including the TCLP analytical results during the investigation will be compared to NSW DECC (2009) guidelines.

4.2 Groundwater Assessment Criteria

The SAC for groundwater includes the following criteria:

- ANZECC (2000) guidelines. ANZECC (2000) provides 'Trigger' values for chemicals within water, which represent the best current estimates of the concentrations of chemicals that should have no significant adverse effects on the aquatic ecosystem. ANZECC (2000) indicates that an exceedance of a trigger value does not necessarily imply that there is an inherent risk, rather that further assessment and monitoring may be required prior to implementing appropriate management actions. It is noted that according to ANZECC (2000), low reliability Trigger Values are Interim Values only because "*low reliability guideline trigger values were derived, in the absence of a data set of sufficient quantity, using larger assessment factors to account for greater uncertainty*", and "*low reliability values should not be used as default guidelines*". ANZECC (2000) stipulates that the identification of the receiving environment or the likely beneficial use of the water is essential for selection of the most applicable criteria. Given the proximity of Darling Harbour to the PPP, the trigger values for marine water ecosystems have been adopted for groundwater. The waters of Darling Harbour, which in proximity to the PPP are used for commercial and recreational purposes as part of Sydney Harbour, can be further defined under ANZECC (2000) as a "*highly disturbed system*" and as such the trigger values for protection of 95% of marine water species have been adopted; and
- National Health and Medical Research Council (NHMRC, 2011). *Australian Drinking Water Guidelines.*

In the absence of further appropriate criteria endorsed by NSW EPA, the following SAC for groundwater were adopted:

- WHO (2008) *Petroleum Products in Drinking Water*;
- United States Environmental Protection Agency (USEPA) *Regional Screening Levels - for Tap Water Quality* (USEPA, 2012);
- RIVM, 2001. *Technical evaluation of the Intervention Values for Soil/sediment and Groundwater*. Human and ecotoxicological risk assessment and derivation of risk limits for soil, aquatic sediment and groundwater. RIVM Report 711701 023. National Institute of Public Health and the Environment. February 2001, were adopted for TPH, benz(a)anthracene, benzo(g,h,i)perylene, chrysene, indeno(1,2,3-c,d)pyrene and arsenic; and
- Canadian Council of Ministers of the Environment (CCME), 2007. *Canadian Water Quality Guidelines for the Protection of Aquatic Life. Part of Canadian Environmental Quality Guidelines*. The CCME guidelines were adopted for acenaphthylene. The CCME water quality guidelines are values set to protect all forms of aquatic life and all aspects of aquatic life cycles, including the most sensitive life stage of the most sensitive

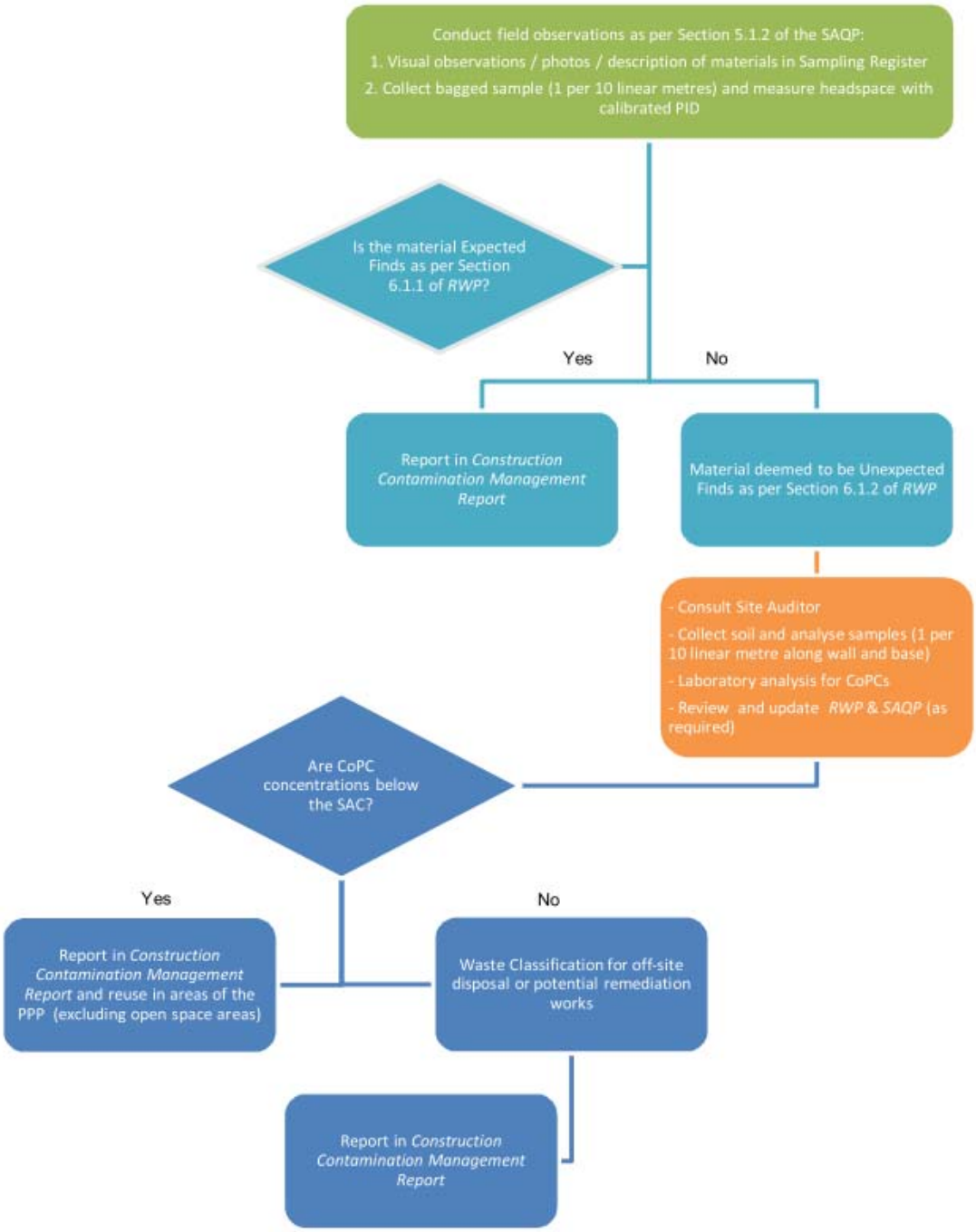
species over the long term. The CCME values were derived from a scientific Task Force that considered all components of an ecosystem (e.g. algae, macrophytes, invertebrates and fish) if the data were available. The water quality guidelines were preferentially derived from the lowest observed effect level (LOEL) from a chronic ecotoxicity study using a nonlethal endpoint for the most sensitive life stage of the most sensitive aquatic species investigated. However, guidelines were derived from acute ecotoxicity studies if such chronic toxicity data were unavailable. Further detailed information regarding the derivation of the CCME water quality guidelines is provided in CCME (2003) *Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numerical Water Quality Objectives.*

5.0 Soil and Groundwater Testing

5.1 Soil Testing

Section 5.1.1 and **5.1.2** below detail the testing requirements for excavated areas and the potential onsite reuse of these excavated areas at the PPP. These testing requirements is summarised in the following flow chart.

Table 5 Flow Chart – Soil testing of Shallow Excavations and Potential Onsite Reuse



5.1.1 Potential Onsite Reuse

The testing of materials to be potentially reused at the PPP will be conducted as follows:

- Materials generated within adjacent piling locations will be placed in stockpiles to facilitate sampling and analysis;
- Materials generated from service trenches will be progressively placed in stockpiles to facilitate sampling and analysis;
- All materials to be reused beneath concrete slabs will be sampled and analysed at a rate of one sample per 100 m^3;
- All materials to be reused at the surface (i.e. within recreational/open space areas) or within service trenches where there is potential for re excavation during future maintenance works (i.e. outside building footprint areas) will be sampled and analysed at a rate of one sample per 50 m^3. Where possible Lend Lease will endeavour to backfill these excavations with VENM; and
- As required by **Section 3.3**, soil samples will be analysed for the following CoPC:
    - Heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc);
    - TPH and BTEX; and
    - PAHs.

If the material is considered to represent an Unexpected Find (as defined in Section 6.1.2 of the RWP (AECOM, 2013c), the above analytical suite may need to be modified in consultation with the NSW EPA Accredited Site Auditor.

- The following rules will apply to the soil testing data when assessing against the soil SAC (refer to **Section 4.1**) by statistical analysis:
    - No single analyte concentration shall exceed 250% of the soil SAC for each CoPC; and
    - The standard deviation of the results must be less than 50% of the allowable maximum specified for each CoPC.

5.1.2 Excavation Areas

A suitably qualified Environmental Consultant will inspect all service trenches (i.e. as part of the installation of underground services) to assess whether the materials are:

- 'Expected Finds' as defined in Section 6.1.1 of the RWP (AECOM, 2013c). That is, the materials are similar in nature to those sampled and analysed during the previous site investigations (i.e. based on visual and olfactory observations, and the results of field screening of bagged soil samples using a PID; or
- 'Unexpected Finds' material as defined in Section 6.1.2 of the RWP (AECOM, 2013c).

The PPP inspection will be undertaken with:

- due consideration of the contaminated materials discussed in **Section 3.4**. These areas of concern will be surveyed and clearly identified prior to the commencement of any excavation works; and
- reference to the soil descriptions detailed in the previous investigations borehole logs and field screening of soil samples using a PID.

The suitably qualified Environmental Consultant will undertake the following works:

- a description of the materials observed on the base and walls of the excavation trench will be logged in a Sampling Register;
- three soil samples will be collected from the wall and base at 10 m intervals along the excavation trench. The soil samples will be placed in zip lock plastic bags and the headspace screened for VOCs using a PID. The VOC results will be included in the Sampling Register;
- If Unexpected Finds material is encountered within the excavated area, soil samples will be collected from the wall and base at 10 m intervals for laboratory analysis;

- the nearest borehole(s) (from the previous investigations) to the soil sampling location will be notated in the Sampling Register to allow comparison of material types;
- photographs of the discussed soil sampling locations will be taken; and
- based on the above field observations, a notation will be included in the Sampling Register to confirm whether the material is considered to be an Expected or Unexpected Find. If the material is an Unexpected Find, the sampling and analytical details will also be included.

The above field observations will be included in the Construction Contamination Management Report.

If 'Unexpected Finds' material is identified to be present on the excavation surfaces, soil sampling of the excavation base and walls will be conducted to confirm that CoPC (TPH and PAHs) concentrations meet the soil SAC (refer to **Section 4.1**).

If required, the soil samples will be collected as follows:

- wall samples will be collected at 10 m lineal metre intervals along the extent of excavation walls in material identified to be the most impacted (either by visual observations or field screening of samples using a PID); and
- base samples will be collected at 10 m lineal metres along the base of trenches or based on a 10 m sampling grid for wider excavation areas (if required).

All excavations will be inspected by a qualified environmental engineer/scientist to confirm that the excavation walls and bases are free of BACMs. If BACM is encountered during these works, additional soil removal and testing works will be undertaken as per **Section 5.1.6** and in accordance with the Lend Lease *CMP*.

All soil samples will be analysed for the soil CoPC detailed in **Section 3.3**.

Validated excavations will be clearly marked and identified to ensure that cross contamination of surface areas with potential impacted material is mitigated.

5.1.3 Soil testing of Landscaped/Grassed areas within Recreational/Open Space Areas

The final layout of the recreational/open spaces areas within the Public Realm is currently subject to further design and development. Consequently, it is not currently possible to determine where surface soils may be accessible to the general public and whether an appropriate sampling density of soil sampling and analysis has been achieved in these areas during previous investigations. Additional characterisation surface soil sampling and analysis may be required to ensure that the appropriate sampling density of the *NSW EPA* (1995) *Sampling Design Guidelines* or another appropriate sampling density is met. The final sampling protocol for the landscaped/grassed areas within the Public Realm will be approved by the Site Auditor.

5.1.4 Waste Classification for Offsite Disposal

Materials deemed not suitable for reuse at the PPP (based on the results obtained from **Section 0** and/or **5.1.2**) or which require excavation to accommodate the redevelopment works (i.e. foundations/pilings, etc) will be assessed for off-site disposal in accordance with the DECCW (2009) *Waste Classification Guidelines* or Part 4 of those guidelines in the case of potential acid sulfate soils (PASS) and actual acid sulfate soils (AASS). Details regarding the assessment of PASS and AASS are detailed in the ASSMP (AECOM, 2013c).

Stockpile sampling would be undertaken a frequency of one sample analysed per 500 m^3 on the basis that the sampled materials are inspected by a qualified environmental scientist and are observed to be similar in nature to those reported during the previous investigations and excavations. If the material is considered to be significantly different, then the relevant stockpile would be sampled as required by the Contingency section of the *RWP* (Section 6.2, AECOM 2013b) and in consultation with the NSW EPA Accredited Site Auditor.

Waste classification samples will be analysed at a rate of one sample per 500 m^3 (or at a rate acceptable from the landfill) for the following suite of analytes:

- Heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc);
- TPH and BTEX;
- PAHs; and
- Toxicity characteristic leaching procedure (TCLP) testing for heavy metals (arsenic, cadmium, chromium, lead, nickel and mercury) and PAHs.

5.1.5 Imported Fill

As excavations are likely to be required for the installation of underground services materials may need to be imported to the PPP for backfilling of excavated areas and for some re-levelling works in Tumbalong Park. Materials imported to the PPP will be required to meet the environmental and geotechnical requirements specified for the particular end use.

It is expected that materials imported to the PPP will generally meet the requirements of:

- Virgin Excavated Natural Material (VENM) in accordance with the DECCW (2009) *Waste Classification Guidelines*;
- Excavated Natural Material (ENM) in accordance with the Protection of the Environment Operations (Waste Regulation 2005 - General Exemption under part 6, Clause 51 and 51A, July 2008); and
- the soil SAC (refer to **Section 4.1**).

The frequency of soil sampling will be dependent on the source of the fill material. If the material is brought onto the PPP from a quarry, and the material is homogeneous, soil testing will consist of:

- a certificate warranting that the material is VENM or demonstrating the physical and chemical quality of the fill, including supporting test data; and
- visual confirmation that the material is free from contamination as it is imported to the PPP.

If the imported material (including landscaping materials such as mulch) cannot be certified as VENM or clean quarry material, the following works will occur:

- Site inspection of the source site and the reporting of these findings in the relevant reports; and
- One sample per 100m^3 will be collected and analysed or a minimum of 3 samples per source. This sampling density may be decreased depending on the quantity of material to be imported from a given source and the initial laboratory analytical results. Any change in sampling density will be determined in consultation with the NSW EPA Accredited Site Auditor; and
- Visual confirmation that the material is free from contamination as it is imported to the PPP.

Whenever possible, samples will be collected from the source location, prior to import of the material to the PPP.

All soil samples will be analysed for the following suite of potential contaminants:

- Metals (As, Cd, Cr, Cu, Ni, Pb, Zn and Hg);
- PAHs and phenols;
- TPH/BTEX;
- OPPs and OCPs;
- PCBs; and
- Asbestos.

5.1.6 Management of Bonded Asbestos Containing Materials (BACM)

In the event that BACM is encountered during the piling or excavation works, the material will be collected and disposed of in accordance with Section 4.4 of the *RWP* (AECOM, 2013b).

The BACM testing works would be undertaken as follows:

- The BACM will be suitably removed from the PPP by an Asbestos Removal Contractor (ARC);
- Airborne asbestos fibre monitoring will be undertaken around the working area during the BACM removal works to confirm that the material is being removed in an appropriately controlled manner;
- Soil samples will be collected at 10 m lineal intervals along the walls and base of any identified BACM impacted excavation areas and analysed for asbestos. Should the soils beneath the BACM be impacted with asbestos fibres, the impacted soils will be excavated for appropriate off-site disposal; and
- An ARC will conduct a visual inspection of the affected area to confirm that it is free of all visible BACM fragments. A clearance certificate will be prepared to document these works.

If BACM is encountered and removed from the PPP, any residual soils must not contain asbestos (bonded or otherwise) as determined by the following:

- A visual inspection of the excavated area to confirm the removal of all visible BACM fragments; and
- No detection of asbestos in samples collected from the residual soils and submitted for analysis.

5.1.7 Construction Contamination Management Report

Following completion of the construction works, a Construction Contamination Management Report will be prepared by the Environmental Consultant for the PPP.

The Construction Contamination Management Report will be prepared in accordance with the requirements of the NSW EPA (2011) *Guidelines for Consultants Reporting on Contaminated Sites* and will include the following information:

- An overview of the completed construction works and any related excavation works;
- Details relating to any materials considered to be 'unexpected finds' (as defined in Section 6.1.2 of the RWP [AECOM, 2013b])
- A summary of any soil testing works undertaken with reference to the soil analytical data obtained from the previous investigations;
- Surveyed figures outlining the:
  - extent of the trenching/excavation works; and
  - any required soil testing works required to assess 'unexpected finds' located within the excavated areas.
- The Sampling Register including descriptions of sampled materials (including visual and olfactory observations);
- Summary tables for soil analytical results;
- Confirmation that the project DQO's and DQIs have been appropriately met;
- NATA registered laboratory analytical certificates;
- Summary of the tracking and fate of materials including materials excavated for on-site reuse or off-site disposal;
- Landfill weighbridge dockets (if required);
- Conclusions as to the suitability of the PPP based on the proposed land uses:
- Recommendations (if required) for further works.

5.2 Soil Testing Methodology

Fieldwork will be conducted in accordance with written standard operating procedures, copies of which will be maintained in a register on-site during the construction works. This will ensure that representative samples of materials are collected and the sampling methodology remains consistent throughout the duration of the construction works.

Sample collection will be by:

- grab samples directly from the centre of an excavator bucket from the centre of stockpiles for testing of treated material (refer to **Section 0**); and
- sampling trowel from excavation bases and walls (refer to **Section 5.1.2**).

All soil testing sample points will be located using the Global Positioning System (GPS).

Materials will be described in accordance with the Unified Soil Classification System (USCS), with soil type, descriptive properties (colour, particle size, moisture content, sorting), as well as discolouration, staining, odours and other indications (if any) being noted. The information will be recorded on field logs completed for each location.

On-site screening of samples for VOCs in the field will be undertaken using a portable PID. The PID will be calibrated at least once daily (at the start of each sampling day) with a known concentration of isobutylene.

Soil samples will be placed into laboratory supplied glass jars as soon as practicable after collection. The jar size will be sufficient to meet the laboratory requirements for the requested analysis. All sample containers will be filled completely using a method such that the loss of volatile components is minimised. All sample containers will be clearly labelled with information such as sample number, sample location, depth, date collected and sampler's identification. After filling, sample containers will then be transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory. The sample preservation requirements are listed in **Table 6** below.

Table 6 Soil Sample Preservation and Storage

Analyte	Preservation	Storage
Inorganics		
Metals (General)	Unpreserved, glass jar with Teflon lined lid.	Store at <4°C, analysis within 6 months.
Metals (Chromium VI by alkali digestion)	Unpreserved, glass jar with Teflon lined lid.	Store at <4°C, extract within 28 days, analyse within 7 days.
Metals (inorganic Mercury)	Unpreserved, glass jar with Teflon lined lid.	Store at <4°C, analysis within 28 days.
Organics		
TPH C_6-C_9	Unpreserved, glass jar with Teflon lined lid.	Store at <4°C, nil headspace, analysis within 14 days.
TPH C_{10}-C_{36}	Unpreserved, glass jar with Teflon lined lid.	Store at <4°C, extraction within 14 days, analysis within 40 days.
BTEX	Unpreserved, glass jar with Teflon lined lid.	Store at <4°C, nil headspace, analysis within 14 days.
PAHs	Unpreserved, glass jar with Teflon lined lid.	Store at <4°C, extraction within 14 days, analysis within 40 days

A Sampling Register will be updated daily to manage and track the soil testing process.

5.2.1 Sampling Equipment Decontamination

Equipment decontamination will be undertaken as described below. The following equipment will be needed for the detergent wash and water rinse decontamination process:

- laboratory (phosphate-free) detergent or Decon 90;
- tap water and deionised water;
- buckets or tubs (sufficient for size of equipment to be cleaned); and
- stiff brushes for cleaning.

Equipment that cannot be thoroughly decontaminated using the detergent wash and water rinse should be steam cleaned, or if a steam cleaner is not available, not used for further sampling (and marked clearly "not decontaminated") or discarded. Equipment decontaminated using the high pressure steam cleaner will be further decontaminated as described above.

5.2.2 Quality Control samples

The following quality control (QC) samples will be collected as part of the field quality control procedures:

- Intra-Laboratory Duplicates – are identical to field samples, but both samples are sent anonymously to the primary laboratory. Blind duplicates provide an indication of the analytical precision of the main testing laboratory, but may also be affected by sampling techniques and inherent heterogeneity in the sample medium;

- Inter-Laboratory Duplicates – are identical to blind duplicates, but the duplicate sample is sent to the second (check) laboratory. Split duplicates provide an indication of the accuracy of the main testing laboratory;
- Equipment Blanks – are prepared in the field (at the sampling site) using empty bottles and the distilled water used during the final rinse of sampling equipment. After completion of the decontamination process fresh distilled water is poured over the sampling equipment and collected. The distilled water is exposed to the air for approximately the same time the sample would be exposed. The collected water is then transferred to an appropriate sample bottle and the proper preservative added, if required. Equipment blanks are a check on equipment decontamination procedures;
- Trip Blanks/Spikes – are samples of soil or water prepared by the laboratory with either zero or known anolyte concentration. Trip blanks/spikes are a check on the sample contamination originating or lost from sample transport and handling, and shipping. One Trip Blank/Spike will be analysed per sample batch; and
- Field Blanks – are similar to trip blanks except the water is transferred to sample containers on-site. Field blanks are a check on sample contamination originating from sample transport, handling, shipping, site conditions or sample containers. One Field Blank will be analysed per water sample batch.

Procedures for duplicate sampling will be identical to those used for routine sampling and duplicate samples will be despatched for analysis for the same parameters using the same methods as the routine sample. Duplicate soil samples will be collected from directly adjacent to original samples (i.e., from the adjacent area of the excavation base or wall). No homogenisation of samples will occur to reduce the loss of volatile compounds.

Duplicates and equipment blank samples will be collected as follows:

- Intra-Laboratory duplicate samples will be collected at a rate of approximately 1 in 10 soil samples and analysed for the full analyte suite. At least one blind duplicate sample will be included in each batch of samples;
- Inter-Laboratory duplicates samples will be collected at a rate of approximately 1 in 20 soil samples and analysed for the full analyte suite. At least one split duplicate sample will be included in each batch of samples; and
- One equipment blank of soil sampling equipment will be collected for every day of sampling and analysed for the full analyte suite. At least one equipment blank will be included in each batch of samples.

5.2.3 Laboratory QA/QC

The laboratories will undertake the analyses utilising their internal procedures and their test methods (for which they are NATA, or equivalent, registered) and in accordance with their quality assurance (QA) system which forms part of their registration.

Laboratory quality control procedures, which will be used during the project, will comprise the following:

- Laboratory Duplicate Samples – these are sub-samples taken from one sample submitted for analytical testing in a batch. A laboratory duplicate provides data on analytical precision. The rate of duplicate analysis will be according to the requirements of the laboratory's accreditation but will be at least one per batch;
- Matrix Spiked Samples – the purpose of the matrix spike is to monitor the performance of the analytical methods used, and to determine whether matrix interferences exist. A sample is spiked by adding an aliquot of known concentration of the target analyte(s) to the sample matrix prior to sample extraction and analysis. A spike documents the effect of the sample matrix on the extraction and analytical techniques. These will be analysed at a rate of approximately 5% of all analyses. At least one per batch will be reported;
- Laboratory Blank – this is usually an organic or aqueous solution that is as free of analyte as possible and contains all the reagents in the same volume as used in the processing of the samples. The reagent blank must be carried through the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The reagent blank is used to correct for possible contamination resulting from the preparation or processing of the sample. Blanks will be analysed at a rate of once per process batch, and typically at a rate of 5% of all analyses;

- Laboratory Control Samples – these comprise either a standard reference material or a control matrix fortified with analytes representative of the analyte class. Recovery check portions should be fortified at concentrations that are easily quantified but within the range of concentrations expected for real samples. These will be analysed at a rate of one per process batch, and typically at a rate of 5% of analyses; and
- Surrogates – surrogate spikes are known additions to each sample, blank and matrix spike or reference sample analysis, of compounds which are similar to the analytes of interest in terms of:
    - extraction;
    - recovery through clean-up procedures; and
    - response to chromatography or other determination;

    but which:
    - are not expected to be found in real samples;
    - will not interfere with quantification of any analyte of interest; and
    - may be separately and independently quantified by virtue of, for example, chromatographic separation or production of ions of different mass in a GC/MS analyser.

Surrogate spikes are added to the analysis before extraction. The purpose of surrogates is to provide a means of checking, for every analysis, that no gross errors have occurred at any stage of the procedure leading to significant analyte losses. Other internal laboratory quality control procedures, as required for NATA, or equivalent, registration, will also be performed.

Results of the QC analyses for both laboratories will be reported with each batch.

5.3 Groundwater Monitoring

5.3.1 Groundwater Monitoring Objectives

Groundwater sampling events will be conducted before and after the construction works to ensure that all onsite monitoring wells and offsite well MW08 have been sampled at least twice. The objectives of the groundwater monitoring program will be to:

- assess groundwater quality migrating from the northern and eastern PPP boundaries (adjacent to Cockle Bay) and the associated risk to aquatic ecosystems; and
- make provision for any necessary management measures (contingency measures) that may be required to respond to the monitoring results.

For the purpose of the groundwater monitoring works, the point of compliance will be considered to be the down-hydraulic boundary of the PPP (i.e. the PPP boundary north of Tumbalong Park). Existing monitoring wells will be retained for ongoing monitoring wherever possible. It is likely that the monitoring well network can be appropriately protected and retained for the monitoring works which will occur prior to the commencement of any demolition or construction works.

If Unexpected Finds material is encountered during the excavation and soil sampling works (refer to **Section 6.1**), the suitability of the groundwater monitoring well network will be reviewed in consultation with the NSW EPA Accredited Site Auditor.

5.3.2 Groundwater Monitoring Program

Groundwater monitoring will be undertaken from the groundwater monitoring well network to ensure that the wells have been sampled at least twice. If the results of the first and second round of groundwater sampling indicates that that there is significant variation in the reported CoPCs then a third sampling round will be undertaken. A third round of sampling would be conducted if:

- CoPC concentrations exceed the SAC in either the first or second sampling round; and/or
- The variation in CoPC concentrations between the first and second sampling rounds varies by greater than one order of magnitude.

Based on the limited groundwater data set and some of the recently installed Coffey wells only being sampled once (to date), all groundwater samples will be analysed for the groundwater CoPCs (heavy metals, TPH, BTEX

and PAHs) for the duration of the groundwater monitoring program. The reported groundwater results will be compared to the groundwater SAC (refer to **Section 4.2**).

The groundwater monitoring network will comprise the following 14 existing wells (refer to **Figure 3**):

- Onsite - MW05, MW06, MW11, MW13, MW16, MW20, MW104, MW105, MW106, MW107, MW109, MW110A and MW117; and
- Offsite (east) – MW08.

It is expected that some of the existing groundwater monitoring well network will be removed as part of the construction and piling works. The need to replace these wells will be determined in consultation with the NSW EPA Accredited Site Auditor.

5.3.3 Groundwater Monitoring Reporting

A groundwater monitoring report will be prepared within 8 weeks of completing each groundwater monitoring event for provision to the NSW EPA Accredited Site Auditor. The report will include the following:

- Details of groundwater monitoring methodology and scope of works;
- Construction details and logs of any new or replaced groundwater monitoring wells;
- Results of groundwater monitoring well levels, field parameters and laboratory analysis, including National Association of Testing Authorities (NATA) certified laboratory reports and chain of custody records;
- Comment on laboratory and field quality assurance / quality control program and analytical data validation;
- Interpretation of the data, including quality of groundwater with respect to the groundwater SAC and the results obtained from previous sampling rounds;
- Interpretation of groundwater elevation contours across the PPP;
- Conclusions and recommendations with respect to continuation or otherwise of the groundwater monitoring program; and
- Conclusions and recommendations on whether this SAQP needs to be updated.

5.4 Groundwater Monitoring Methodology

Groundwater sampling will be conducted in accordance with written standard operating procedures (refer **Appendix B**), copies of which will be maintained in a register for the duration of the monitoring works. This will ensure that representative groundwater samples are collected and the sampling methodology remains consistent throughout the duration of the construction works.

A summary of the groundwater monitoring methodology is provided in **Table 7** following.

Table 7 Groundwater Sampling Methodology

Activity/Item	Details
Monitoring Parameters	Monitoring should include the following: - Groundwater depth (converted to m Australian Height Datum); and - Field parameters (including temperature, electrical conductivity, pH, dissolved oxygen and redox potential). Laboratory Analysis for TPH, BTEX, PAH and heavy metals (8).
Well Gauging	Monitoring wells should be gauged using a calibrated oil/water interface probe. The probe should be decontaminated between each measurement. Water levels and non-aqueous phase liquids (NAPL) (if present) should be gauged from the surveyed point on the well casing. Given the expected tidal influence of groundwater beneath the PPP, groundwater gauging will be conducted in a single round prior to sampling wells.

Activity/Item	Details
Well Purging and Sampling Process	All groundwater monitoring wells should be purged using low flow pumps (peristaltic or narrow diameter bladder pump) in accordance with the AECOM Standard Operating Procedure (**Appendix B**). The following single use equipment should be used for purging: - dedicated low-density polyethylene (LDPE) (peristaltic and bladder pump) - hospital grade silicon tubing (peristaltic pump) - dedicated LDPE bladder (bladder pump) During purging field water parameters and groundwater level should be recorded for every 0.5 L of water purged until groundwater field quality parameters have stabilised. An appropriately experienced environmental consultant should be engaged to carry out these activities. The placement depth of tubing will be approximately 0.5 m above the base of the sampling port. The minimum purge volume for well development will be 10L and/or until reduced turbidity. The minimum purge volume for well sampling will also be based on the stabilisation of water quality parameters (generally within 10%). Thorough redevelopment of the wells prior to sampling should be undertaken to minimise the groundwater's turbidity and related issues with entrained sediment in the wells.
Sample Collection and Preservation	Following stabilisation of field parameters, samples should be placed into laboratory-supplied bottles containing appropriate preservatives for the selected analytical testing (as detailed above). Volatile samples (vials) will be collected first, followed by samples for semi-volatile analysis and then heavy metals. Samples for metal analysis will be field filtered using single use dedicated 0.45 µm filters (sterile In-line or Stericup™ filters).
Decontamination Procedure	Monitoring and sampling equipment should be decontaminated in accordance with the AECOM Standard Operating Procedure (**Appendix B**).
Disposal of Purged Groundwater	Purged groundwater should be appropriately stored for offsite disposal. If required, based on the analytical results, a licensed contractor should be engaged to dispose of the water to an appropriately licensed facility.
Analytical Laboratories	Both a primary laboratory and secondary (QC) laboratory should be used. Both laboratories should be accredited by NATA for the analyses undertaken.
Quality Assurance / Quality Control (QA/QC)	QA/QC samples collected for quality control purposes during each round of groundwater sampling will be consistent with the requirements of **Section 5.2.2**. Discussion of the laboratory and field quality assurance/quality control and analytical data validation should be included in the reporting requirements.
Sample Nomenclature	Sample nomenclature will be consistent between sampling events.

5.4.1 Laboratory Methodology

Laboratory analysis will be conducted in accordance with the requirements of NEPM (NEPC, 1999) and with referenced to USEPA and APHA methods. The analytical schedule, laboratory methods, laboratory LORs and reference methods to be applied for the groundwater monitoring are detailed in **Table 8** below.

Table 8 Groundwater analytical methods

Analysis	ALS LOR	ALS Reference method	MGT Labmark LOR	MGT Labmark Reference method
Ultra-trace dissolved metals	0.02 - 0.5 µg/L	APHA 3125 BORC/ICP/MS ORC	1-5 µg/L	USEPA 6020 ICP-MS using in-house E022.1
TPH C_6-C_9	20 µg/L	P&T/GC/MS (USEPA 5030/8260)	50 µg/L	GC-MS using in-house E004.1; E006.2; E012.1; E012.2 GC-FID and purge and trap
TPH C_{10}-C_{40}	50 µg/L	GC/FID (USEPA 3510/8015)	50 µg/L	
PAHs	0.01-0.05 µg/L	MS-SIM (USEPA 3510/8270)	0.01-0.05 µg/L	GC-MS using in-house E007.1, E007.2, E015.1, E015.2, E017.1 and E017.2

5.4.2 Sample Labelling, Storage and Transport

All groundwater samples will be clearly labelled with unique sample identification numbers consisting of the date, sample location and samplers initials. In the case of field duplicates and triplicates sample containers will be labelled so as to not reveal their purpose or sample location to the laboratory.

Samples will be either immediately be placed in an insulated container with crushed ice or placed in a refrigerator set at 4°C for storage until transit to the laboratory following collection. Samples will be sent to the NATA registered laboratory in an insulated container with crushed ice and appropriate protective packaging (e.g. bubble wrap) under chain of custody procedures.

Table 9 Groundwater Sample Preservations and Storage

Analyte	Preservation	Storage
Inorganics		
Ultra Trace Dissolved Metals (Octopole Reaction Cell [ORC])	Preserved with ultra-high purity (UHP) nitric acid, 125 mL plastic bottle with Teflon lined lid – field filtered.	Store at <4°C, analysis within 6 months.
Organics		
TPH C_6-C_9	Preserved with sulphuric acid, 2 x 40 mL glass vials with Teflon lined lid.	Store at <4°C, nil headspace, analysis within 14 days.
TPH C_{10}-C_{40}	Unpreserved, 1 x 100 mL amber glass bottle with Teflon lined lid. Note: 2 x additional 100mL amber glass bottles required for laboratory duplicates and matrix spikes	Store at <4°C, extraction within 14 days, analysis within 40 days.
PAHs	As above	Store at <4°C, extraction within 14 days, analysis within 40 days

5.4.3 Sampling Equipment Decontamination

The decontamination procedures will be performed before initial use of re-useable equipment and after each subsequent use.

All re-usable sampling equipment (water quality meters and oil/water interface probe) will be decontaminated between each sampling and measurement event, by scrubbing with a solution of Decon 90 (a phosphate-free detergent) followed by a rinse in potable water. For each day of sampling, following decontamination procedures, a rinsate blank will be completed by running laboratory prepared deionised water over the re-usable sampling equipment for collection directly into laboratory prepared sampling containers for analysis.

At each well location a new set of disposable nitrile gloves will be used during the collection of groundwater samples into the laboratory prepared glass sampling containers.

5.4.4 Quality Control Samples

Quality control (QC) samples will be collected and analysed as per **Section 5.2.2**.

5.5 Laboratory QA/QC

5.5.1 Laboratory Data Quality Objectives

Listed below are the predetermined laboratory DQOs defined for the assessment of the laboratory analytical data:

- all sample analyses to be conducted using National Association of Testing Authorities (NATA) registered methods;
- maximum acceptable sample holding time is 14 days for organic analyses and 6 months for metal analyses (28 days for mercury);
- samples will be appropriately preserved and handled;
- laboratory method blank analyses will be required to be below the laboratories limits of reporting (LORs);
- surrogate compound concentrations will be required to be spiked at similar concentration to sample results, at a rate of 1 in 20;
- all LORs must be less than the assessment criteria;
- the RPDs of replicates will be determined and compared to the following criteria for acceptability:
    - field duplicates: < 50%
    - inter-laboratory duplicates: <50%
    - laboratory duplicate where detection is less than 10 x LOR: <30%
    - laboratory duplicate where detection is greater than 10 x LOR: <20%
- RPDs for Control Spike Duplicates will be compared to an acceptable limit of 20% and undertaken at a minimum of 1 per batch;
- RPDs for Matrix Spike Duplicates will be compared to an acceptable limit of 20% and undertaken at a minimum of 1 in 20; and
- Percent recoveries of control spikes and matrix spikes will be compared to an acceptable range of 70–130%. Where this range is exceeded, reference to the laboratories internal DQO limits will be made.

5.5.2 Analytical Data Validation

Analytical data validation is the process of assessing if data are in compliance with method requirements and project specifications. The primary objectives of this process are to ensure that data of known quality are reported, and to identify if the data can be used to fulfil the overall project objectives.

Specific elements of data validation that will be checked and assessed for this project are:

- preservation and storage of samples upon collection and during transport to the laboratory;
- sample holding times;
- required limits of reporting:

- frequency of conducting quality control measurements;
- laboratory blanks;
- rinsate blank;
- field duplicates;
- laboratory duplicates;
- intra- and Inter-laboratory duplicates;
- laboratory control samples;
- matrix spike/matrix spike duplicates;
- surrogates; and
- the occurrence of apparently unusual or anomalous results, eg. laboratory results that appear to be inconsistent with field observations or measurements.

The overall reliability of the analytical data will be assessed against the Data Quality Indicators as required by NSW EPA (1997).

5.5.3 Corrective Actions

Analytical data that fail to meet the predetermined data quality objectives and acceptable limits of accuracy and precision will be managed using the following corrective actions on a case-by-case basis:

- reanalyse suspect samples, provided sample or extract is within holding time;
- evaluate and amend sampling and/or analytical procedures;
- accept the data as an estimate with an acknowledged level of bias and imprecision; and
- discard the data; or
- re-sampling and reanalysis.

In the event that data of questionable reliability are used, restrictions and limitations associated with the use of such data will be clearly identified. Failure to meet the DQOs will be reported and the significance to the outcome of the validation program will be addressed.

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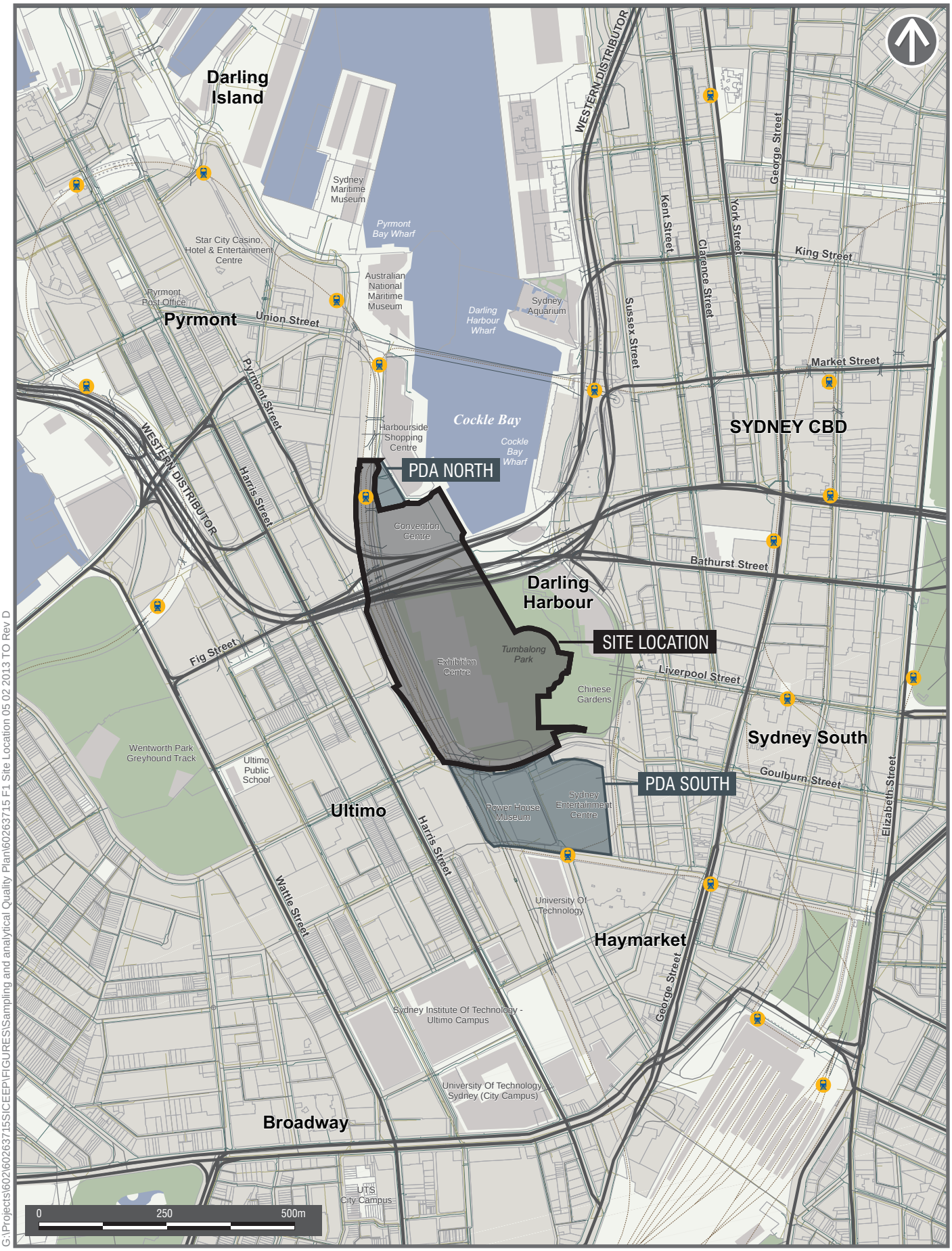
Appendix A

Site Figures



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AECOM

SITE LOCATION

Sampling and Analytical Quality Plan
Public Private Partnership Area, Sydney International Convention, Exhibition and Entertainment Precinct
Darling Harbour, New South Wales

FIGURE 1