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By email
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Ms Emma Bradbeer
Environmental Services Senior Project Manager, Group Property
Sydney Water
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Dear Emma,

Stage 1 Preliminary Site Investigation and Sampling, Analysis and Quality Plan - Sydney Water Ashfield Reservoir, 165-169 Holden Street, Ashbury, NSW

1. Introduction

Parsons Brinckerhoff Australia Pty Ltd (Parsons Brinckerhoff) was commissioned by Sydney Water Corporation (Sydney Water) to undertake a Stage 1 preliminary site investigation (PSI) and prepare this sampling, analysis and quality plan (SAQP). The SAQP is required for a Stage 2 detailed site investigation (DSI) to be undertaken for surplus land ('the site') associated with the Sydney Water-owned Ashfield Reservoir property located at 165-169 Holden Street, Ashbury, NSW ('the Sydney Water property'). The location of the Sydney Water property and the site are shown on Figure 1 in Attachment A.

1.1 Objectives

Parsons Brinckerhoff understands that Sydney Water has identified the site as being surplus to their requirements and that they wish to assess the requirements for divestment. As such, the objectives of the Stage 2 DSI works are to:

- assess the current contamination status of the site
- assess the potential risks associated with contamination at the site (if identified), with respect to the current land use (as a former depot/workshop) and potential future land uses (which could potentially include rezoning of the site for low to medium density residential land use)
- provide inputs to assist with preparation of the following documents (if necessary, dependent on the results of the Stage 2 DSI):
  - a remediation cost estimate, including estimated volumes of contaminated soil exceeding the adopted site assessment criteria that will require removal to render the site suitable for the proposed future use

- an in situ waste classification for soil exceeding the adopted site assessment criteria to be excavated from the site during any remedial works likely to take place and disposed of to a licenced off-site waste facility.

1.2 Purpose and scope of the SAQP

The purpose of this SAQP is to summarise the Stage 1 desktop review and present the methodologies and protocols to be followed during the Stage 2 DSI to meet the stated objectives. The scope of the SAQP comprises:

- a Stage 1 PSI desktop review of current and historical background information pertaining to the site in order to establish whether there are any known environmental concerns associated with the site or surrounding area
- identification of potential areas of concern and potential contaminants of concern associated with the site or surrounding area
- an outline of the proposed Stage 2 DSI scope of work and analytical sampling plan
- the adopted assessment criteria to be used to interpret field data
- the quality assurance and quality control (QA/QC) procedures and field screening methods to be adopted during field works.

2. Site location and setting

2.1 Site location and identification

The general site identification details are provided in Table 1.

Table 1 Summary of general site information

Site address	165-169 Holden Street, Ashbury, NSW 2193
Site identification	The Sydney Water property comprises Lot 1 in Deposited Plan (DP) 115504, Lot 1 in DP 911478, and Lot 1 in DP 711077. The portion of the property comprising the site to be assessed comprises part of Lot 1 in DP 115504 and part of Lot 1 in DP 911478.
Site area	The Sydney Water property comprises an area of approximately 8,280 m^2. The portion of the property comprising the site to be assessed is an area of approximately 2,708 m^2 (as defined on Figure 2 in Attachment A).
Current site use	The site is currently a disused portion of a depot, associated with the adjoining Sydney Water Ashfield Reservoir property.
Surrounding land uses	A review of current aerial photographs indicates that the areas surrounding the site generally comprise low to medium density residential properties and open space parkland (with Peace Park located immediately to the west of the site).
Local government area (LGA) and zoning	The site is located within the City of Canterbury LGA, and is zoned 'SP2 Water Supply System' under the *Canterbury Local Environmental Plan 2012* (LEP).
Proposed site use	Sydney Water have indicated that they intend to subdivide the Sydney Water property to facilitate rezoning and divestment of the site for low to medium density residential land use.

2.2 Topography and surface water drainage

The site is situated at approximately 40-50 metres Australian Height Datum (mAHD) and slopes down to the south and west. The nearest surface water body is the Cooks River, located approximately 1.3 km south-west of the site.

Some cutting and/or filling is apparent at the Sydney Water property, with retaining walls used on the southern and western sides of some areas. This is further discussed in the site walkover section of this report (Section 4). Surface water is expected to flow to the south and west, towards Peace Park, with the retaining wall in the south-western area of the property constructed to reduce the flow speed of surface water entering the park.

2.3 Geology

The regional geological map of the area (Department of Mineral Resources, 1983, 1:100,000 Geological Series Sheet 9130 (Edition 1)) indicates that the site is underlain by Ashfield Shale, comprising black to dark-grey shale and laminite.

The CSIRO Australian Soil Resource Information System (ASRIS) (http://www.asris.csiro.au/index_ie.html, accessed 16 April 2015) indicates that the soils in the vicinity of the site are characterised as being kurosols. Kurosols are characterised as having a strong texture contrast between A and B horizons and having unusual subsoil chemical features, typically high magnesium, sodium and aluminium.

The ASRIS also indicated that soils underlying the site are mapped as having a very low probability of occurrence of acid sulfate soils (ASS).

2.4 Hydrogeology

A review of the licensed borehole register on the NSW Government Water Information website (http://allwaterdata.water.nsw.gov.au/water.stm) indicated that there were no registered groundwater bores within a 500 m radius of the site.

Groundwater flow is likely to be to the west and south-west, based on the surrounding topography, towards the Cooks River which is located approximately 1.3 km south-west of the site at its closest point. A surface water body is also located within Canterbury Racecourse approximately 1.1 km south-west of the site, which has the potential to be partially fed by groundwater considering the elevation of that site.

Based on the elevation of the site and the local topography, it is considered likely that groundwater is present beneath the site within the underlying bedrock at depths of greater than 3-4 metres below ground level (mBGL).

3. Historical land use information

3.1 Stage 1 PSI historical searches

A Stage 1 PSI review of historical land use information pertaining to the site was undertaken to identify any known environmental concerns. A summary of the searches undertaken is provided in Table 2.

Table 2 Summary of Stage 1 PSI historical search results

Search	Results
Titles search	Historical land title information provided by Sydney Water indicated that the property has been owned by Sydney Water (as Board of Water Supply and Sewerage) since 1909. It is unknown who owned the land prior to this time. Historical title information provided by Sydney Water is provided in Attachment C.
Historical aerial photographs	Historical aerial photographs from 1930, 1951, 1961, 1970, 1978, 1986 and 1994 were requested from NSW Land and Property Information (a division of the Office of Finance and Services), and were reviewed along with the current (2014) photograph. In the 1930 aerial photograph, the Sydney Water property appeared to have been constructed, with the elevated reservoir clearly visible. Structures are visible on the property in the north-western and south-western areas of the property, and to the north of the reservoir in the north-eastern area of the property. Due to the shadow of the reservoir it was unclear whether structures were present in the south-east area of the property. The surrounding area was observed to be primarily low density residential properties to the north, south and east. The property immediately to the west of the property (now Peace Park) appears to be in use as an industrial facility. It is understood that this in use as the South Ashfield Brickworks during this period. Structures are present on the property, and a large excavation area, potentially containing water. In the 1961 aerial photograph, the Sydney Water property is clearer and it is apparent that there were at least 10 structures on the property to the north, west and south of the reservoir. The surrounding area remained generally unchanged. In the 1970 aerial photograph, the number of structures on the property had reduced. The structures remaining on the property appear to be consistent with those currently viewed during the site walkover. The surrounding area remained generally unchanged. No significant changes to the property or the surrounding area were observed in the 1986 aerial photograph. In the 1994 aerial photograph, the Sydney Water property remained the same. The brickworks to the west appeared to have been filled, levelled and grassed and was now parkland. No significant changes to the property or the surrounding area were observed in the current (2014) aerial photograph. Copies of the historical aerial photographs reviewed during the Stage 1 PSI are provided in Attachment D.
Council Section 149 certificates	Copies of the Section 149 certificates have been requested from the City of Canterbury but have not been received at the time of preparation of this report. These will be included in the Stage 2 DSI report.
NSW WorkCover Dangerous Goods records	A dangerous goods licences search was conducted by NSW WorkCover involving a search of the stored chemical information database and microfiche records held by WorkCover. Historical licence information was provided for 1995 and 1996. The information provided indicates that petroleum was kept in cabinets in the southern portion of the building located in the western area of the site, and that a diesel shed was located to the south of this building (on the portion of land to be retained by Sydney Water). The licence application indicates that up to 200 L of fuel may have been stored on the Sydney Water property. The plan included in the WorkCover information indicates that the western area of the property featured multiple demountable buildings in 1995/1996 in addition to the permanent structures that remain on the property. A total of seven demountable amenities buildings were shown on the plan on the portion of the property comprising the site to be assessed. Copies of the NSW WorkCover Dangerous Goods search results are provided in Attachment E.

Search	Results
EPA online notice records	Online searches of the NSW EPA *Protection of the Environment Operations Act 1997* public register (http://www.epa.nsw.gov.au/prpoeoapp/) and the NSW EPA contaminated land record database (http://www.epa.nsw.gov.au/prclmapp/searchregister.aspx) indicated that no licences or notices were on record for the property or other properties in the vicinity of the property.
Sydney Water records	A review of a portfolio of information held by Sydney Water in relation to the site was undertaken on 20 April 2015. Relevant information is summarised below: ■ A review of environmental factors (Australian Water Technologies Pty Ltd (AWT), 1996) was on file This had been prepared for proposed maintenance and refurbishment of the reservoir. The proposed activities were considered necessary to maintain the structural integrity of the reservoir, to protect the environment from contamination with red lead and to enable the reservoir to continue to operate. The report noted that breakdown of lead paint was apparent on the external surfaces of the reservoir and repair to the external render was proposed. ■ Historical title information was provided by Sydney Water and has been included as Attachment C. ■ Two hazardous building materials register and asbestos management plan reports have been prepared for the Sydney Water property by Parsons Brinckerhoff. These relate to the water reservoir (2014) and the tunnel shaft (2015), both of which are located on the area of the site to be retained by Sydney Water. Lead-based paint was present on both structures, with asbestos containing material (ACM) also identified on the reservoir and bonded synthetic mineral fibres (SMF) also identified on the tunnel shaft. No hazardous building materials survey is known to have been undertaken of the buildings on the western portion of the site. According to the Sydney Water online list of heritage assets (http://www.sydneywater.com.au/SW/water-the-environment/what-we-re-doing/Heritage-search/index.htm) the reservoir was built between 1912 and 1914; filling of the site is presumed to have been undertaken prior to that time.

3.2 Previous environmental investigations

No previous environmental investigations are known to have been conducted at the site.

3.3 Summary of site history

The site has been owned by Sydney Water since 1909, with ownership prior to this time unknown. A review of historical aerial photography indicated that the Sydney Water property has been in use as a reservoir and associated depot since at least 1930, with the site having been filled and levelled prior to this time. Sydney Water records indicate that the reservoir was built between 1912 and 1914. Based on the proximity of the site to the South Ashfield Brickworks at this time (neighbouring the site to the west), it is considered possible that materials from the brickworks may have been used in filling the site.

Early aerial photographs indicated that there was a greater number of buildings on the Sydney Water property for part of the site's history, which is supported by information provided by NSW WorkCover. It is considered that buildings on the site may have been a combination of permanent structures (including those remaining at the site) and temporary demountable structures.

Historical licencing information held by NSW WorkCover indicated that petroleum and diesel may have been stored on the Sydney Water property in the mid-1990s in storage sheds in the central western area of the Sydney Water property (i.e. the south-western area of the site), with up to 200 L potentially being stored on-site at any time. Other information held on file by Sydney Water indicated that lead paint had been flaking

from the external surface of the reservoir (located on the portion of the property to be retained by Sydney Water) prior to refurbishment works in the late 1990s.

Historical aerial photographs indicated that the surrounding area has remained primarily low density residential since at least 1930, although the property located immediately to the west of the site was observed to be in use as the South Ashfield Brickworks from some time prior to 1930, before being redeveloped into Peace Park public recreation area at some time between 1986 and 1994.

Records held by the City of Canterbury and the NSW EPA do not indicate any evidence of contamination or contaminating activities at the site or in the vicinity of the site.

4. Site inspection

The site was inspected on 14 April 2015 by a Parsons Brinckerhoff environmental scientist in the presence of Sydney Water personnel.

The Sydney Water property is surrounded by residential properties to the north and south, and beyond Holden Street, which borders the site to the east. Peace Park adjoins the site to the west and north-west. The property is enclosed by a chain wire fence, with the exception of where it immediately borders residential properties to the north and south where timber or colourbond fences are present. The property is accessible via two sets of gates off Holden Street, in the north-eastern and south-eastern areas of the property.

The property generally slopes down to the south and to the west, which is consistent with regional topography, although it has been levelled for construction of the reservoir and depot. This is evidenced by several retaining walls present around the property.

The following sections describe in further detail both the site and the remaining area of the property to be retained by Sydney Water. An aerial plan showing the site features is presented as Figure 2 in Attachment A, and site photographs are provided in Attachment B.

4.1 Site

The site area is primarily paved with bitumen, with some grassed areas with trees and shrubs located along the western, northern and eastern boundaries. No distressed vegetation was observed in these landscaped areas of the site.

There are three buildings on the site, including a small brick building (likely used for storage) located along the northern boundary, and two larger corrugated metal buildings located along the western site boundary. The southernmost of these buildings appears to have been used for vehicle storage/maintenance, with the northernmost building potentially being used for storage or as a workshop. The southernmost building was indicated to have previously housed petroleum in cabinets on historical licencing information provided by NSW WorkCover (see Table 2). The buildings have fallen into disrepair and are no longer in use.

Some building/construction equipment has been placed/stored in the central area of the site, comprising traffic barriers, timber pallets and beams, sections of pipe, and stockpiled gravel/bitumen.

The site is separated from the lower south-western area of the property by a retaining wall, with the areas differing by approximately 1 m at the western side of the site.

4.2 Remainder of Sydney Water property (to be retained)

The area of the property to be retained by Sydney Water features the Ashfield Reservoir which is an elevated reservoir (on a large sandstone base structure) located in the central eastern area of the property. Areas of the property to the west and south of the reservoir are lower, with retaining walls having been constructed around this area of the property.

There is a large single storey brick building located to the north of the reservoir, which at the time of the site inspection appeared to be in use for storage of telecommunications equipment. A smaller brick building is located to the north-east of the reservoir, along the eastern property boundary.

Two buildings are located to the south of the reservoir. The easternmost of these buildings is currently set up as a workshop. A concrete bunded area was present immediately to the north of this building, with evidence of previous infrastructure that has been removed. It was considered likely that this may have formerly housed electrical transformers and associated equipment, as newer electrical kiosks are present along the eastern property boundary which may have replaced these.

The south-western area of the property comprises a vacant portion of the depot, primarily paved with bitumen and with no aboveground structures or infrastructure. There is some building rubble (sections of pipe, timber pallets and beams) on the western edge of the paved area. The western boundary of this area slopes steeply down to Peace Park and is generally covered in vegetation, although it has been sealed in some areas to prevent erosion and direct surface water flow into the park. The neighbouring residential properties to the south appear to have encroached onto the Sydney Water property, with their fencelines located within the boundaries of the Sydney Water-owned property.

5. Preliminary conceptual site model

Based on the site inspection and the desktop review of site setting and historical land use information, a preliminary conceptual site model (CSM) has been prepared. This is summarised in Table 3.

Table 3 Preliminary CSM

Likely sources of impact	Likely sources of impact at the site include: ■ uncontrolled fill materials which would have historically been used to level the site (some time prior to 1912) ■ potential waste dumping at the site, including any potential waste from the demolition of former site structures ■ historical use of the site as a Sydney Water depot, including storage of equipment, fuel and vehicles ■ possible leaks/spills of oil/petrol from vehicle activity and storage on the site ■ potential asbestos containing materials (ACM) from imported materials, previously demolished site building/s, and weathering of existing site buildings ■ potential lead paint flaking from the reservoir structure prior to refurbishment ■ pesticides used historically and recently to maintain the site.

Potentially impacted media	Soil: Impacts from historical use of the site as a depot, contaminated fill or waste materials, storage of petroleum, storage and maintenance of vehicles, hazardous building materials, or from pesticides used on-site. Groundwater: Migration from soil impacts, although this is considered unlikely given the elevation of the site, and that groundwater is likely to be located within underlying bedrock. There is the potential for some discontinuous perched water to be present at shallower depths at the site.
Contaminants of concern	Contaminants of concern at the site comprise: ■ petroleum compounds including total recoverable hydrocarbons (TRH) and benzene, toluene, ethylbenzene and xylene (BTEX compounds) ■ polycyclic aromatic hydrocarbons (PAHs) ■ heavy metals (including lead) ■ organochlorine and organophosphate pesticides (OCPs/OPPs) ■ polychlorinated biphenyls (PCBs) ■ asbestos.
Migration pathways	Potential migration pathways include: ■ flaking of hazardous building materials (asbestos/lead) from structures onto the site surface ■ vertical migration of contaminants in soil from infiltration of rain water ■ migration of contaminants through underground service trenches ■ run-off of surface contaminants in rain water ■ volatilisation of hydrocarbon contamination ■ airborne migration of contamination in dust or vapour.
Potential exposure pathways	Potential exposure pathways include: ■ inhalation of dust or vapours by site users or nearby site users ■ ingestion or dermal contact with contaminated surface soils or near surface soils by current commercial/industrial, future residential site users or excavation/maintenance workers ■ ingestion or dermal contact with contaminated water downgradient of the site through extraction of groundwater via domestic bores or the use of downgradient surface water bodies for recreation (e.g. the Cooks River).
Potential sensitive receptors	Based on the site setting, sensitive receptors potentially include: ■ underlying soil and groundwater ■ current commercial/industrial users of the site ■ future residential users of the site ■ users of domestic bores in the vicinity of or downgradient of the site, although no registered bores were identified within a 500 m radius of the site ■ surface watercourses receiving groundwater from the site, possibly including surface water at Canterbury Racecourse and the Cooks River located 1.1 km and 1.3 km south-west of the site respectively ■ users of the neighbouring Peace Park recreation area ■ occupiers of residential properties surrounding and downgradient of the site ■ on-site and off-site construction or utility workers (those working within service pit trenches).

6. SAQP

6.1 Data quality objectives

Systematic planning is critical to successful implementation of an environmental assessment and is used to define the type, quantity and quality of data needed to inform decisions. The United States Environmental Protection Agency (US EPA) has defined a process for establishing data quality objectives (DQOs) (US EPA, 2000a and 2000b), which has been referenced in the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 1999* (NEPM; as amended 2013).

DQOs ensure that:

- the study objectives are set
- appropriate types of data are collected (based on contemporary land use and chemicals of concern)
- the tolerance levels are set for potential decision making errors.

The DQO process is a seven-step iterative planning approach. The outputs of the DQO process are qualitative and quantitative statements which are developed in the first six steps. They define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose and specify the performance requirements for the quality of information to be obtained from the data. The output from the first six steps is then used in the seventh step to develop the data collection design that meets all performance criteria and other design requirements and constraints. The DQO process adopted for the Stage 2 DSI works is outlined in Table 4.

Table 4 DQO process

Step	Description	Outcomes
1	State the problem	Sydney Water plans to divest the site for residential land use. The purpose of the Stage 2 DSI works is to determine the contamination status of soils beneath the site.
2	Identify the decisions/goal of the investigation	The decisions to be made based on the results of the investigation are as follows: ■ Has the soil been adequately sampled? ■ Were all the contaminants of concern analysed? ■ Is there sufficient data to prepare the Stage 2 DSI report? ■ Is there a risk to future users or occupiers of the site?
3	Identify the inputs to the decision	The inputs required to make the above decisions are as follows: ■ geological data ■ concentrations of contaminants of concern in soil ■ site assessment criteria for soil (outlined in Section 6.3) ■ observation data including presence of odours and discoloration of the soil ■ distribution of identified soil contamination.

Step	Description	Outcomes
4	Define the study boundaries/ constraints on data	The boundaries of the investigation have been identified as follows: ■ Spatial boundaries: the spatial boundary of the investigation area is defined as the geographical extent of the investigation area and the potential receptors of concern that need to be considered by the study. ■ Temporal boundaries: the date of the project inception (April 2015) to the completion of the fieldwork under the proposed investigation.
5	Develop a decision rule	The purpose of this step is to define the parameters of interest, specify the action levels and combine the outputs of the previous DQO steps into an 'if…then…' decision rule that defines the conditions that would cause the decision maker to choose alternative actions. The parameters of interest are concentrations of contaminants of concern (metals, pesticides, asbestos and hydrocarbons) in soil. An assessment of the concentrations of the contaminants of concern is to be undertaken to develop the DSI and the suitability for the proposed residential land use. Should concentrations exceed the adopted assessment criteria remedial options will be considered.
6	Specify limits on decision errors	The acceptable limits on decision errors to be applied in the investigation and the manner of addressing possible decision errors have been developed based on the data quality indicators (DQIs) of precision, accuracy, representativeness, comparability and completeness and are presented in Tables 5 and 6.
7	Optimise the design for obtaining data	The purpose of this step is to identify a resource-effective data collection design for generating data that satisfies the DQOs. This assessment has been designed considering the information and data obtained during the Stage 1 PSI and site inspection (Sections 2 to 5). The resource effective data collection design that is expected to satisfy the DQOs is described in detail in Section 6.2 (methodology). To ensure the design satisfies the DQOs, DQIs (for accuracy, comparability, completeness, precision and reproducibility) have been established to set acceptance limits on field methodologies and laboratory data collected.

DQIs for sampling techniques and laboratory analyses of collected soil samples define the acceptable level of error required for this validation assessment. The adopted field methodologies and data obtained have been assessed by reference to DQIs as follows:

- precision: a quantitative measure of the variability (or reproducibility) of data
- accuracy: a quantitative measure of the closeness of reported data to the true value
- representativeness: the confidence (expressed qualitatively) that data are representative of each media present on the site
- comparability: a qualitative parameter expressing the confidence with which one data set can be compared with another
- completeness: a measure of the amount of useable data (expressed as a percentage) from a data collection activity.

A summary of the field and laboratory DQIs for the validation assessment are provided in Tables 5 and 6.

Table 5 DQIs for field techniques

DQI
Precision
Standard operating procedures (SOPs) appropriate and complied with
Collection of inter-laboratory and intra-laboratory duplicates
Accuracy
Parsons Brinckerhoff SOPs appropriate and complied with
Collection of field and trip blanks and trip spikes
Representativeness
Appropriate media sampled
Comparability
Same SOPs used on each occasion
Experienced sampler
Climatic conditions (temperature, rainfall, wind)
Same type of samples collected
Completeness
SOPs appropriate and complied with
All required samples collected

Table 6 DQIs for laboratory

DQI	Acceptable Limits
Precision	
Analysis of laboratory duplicates for: ■ PAHs, TRH, BTEX and total metals in soil ■ PAHs, TRH, BTEX and total and dissolved metals in water	 <10% x PQL - ±30% RPD 4-10% x PQL - ±50-70% RPD <4% x PQL - ± 2 x PQL <10% x PQL - ±10-20% RPD 4-10% x PQL - ±25-40% RPD <4% x PQL - ± 2 x PQL
Analysis of laboratory prepared trip spikes (one per day per batch volatiles)	70-130%
National Association of Testing Authorities (NATA) certified laboratories	NATA accreditation for analyses performed

Accuracy	
Analysis of laboratory prepared trip blanks (one per batch)	Non-detect for contaminants analysed
Analysis of rinsate blanks (one per day)	Non-detect for contaminants analysed
Analysis of laboratory blanks	Non-detect for contaminants analysed
Analysis of laboratory matrix spikes, laboratory control samples and surrogate recoveries	70-130% inorganics/metals 60-140% organics 10-40% semi-volatile organic compounds
Analysis of laboratory duplicates for: ▪ PAHs, TRH, BTEX and total metals in soil ▪ PAHs, TRH, BTEX and total and dissolved metals in water	 <10% x PQL - ±30% RPD 4-10% x PQL - ±50 -70% RPD <4% x PQL - ± 2 x PQL <10% x PQL - ±10-20% RPD 4-10% x PQL - ±25-40% RPD <4% x PQL - ± 2 x PQL
Representativeness	
All required samples analysed	As per Section 6.2 of this SAQP
Comparability	
Sample analytical methods used (including clean-up)	As per NEPM (2013)
Same units	Justify/quantify if different
Same laboratories	Justify/quantify if different
Sample Practical quantification limits (PQL)s	Less than nominated criteria
Completeness	
All critical samples analysed	As per Section 6.2 of this SAQP
All required analytes analysed	As per Section 6.2 of this SAQP
Appropriate methods and PQLs	As per NEPM (2013)
Sample documentation complete	
Sample holding times complied with	

6.2 Sampling and analysis methodology

6.2.1 Sample design and rationale

To achieve the objectives of the investigation, sampling will be undertaken at a combination of grid-based and targeted locations across the site. Table A in the NSW EPA, 1995, *Sampling Design Guidelines* provides the minimum number of sampling points required for site characterisation based on detecting circular hot spots by using a grid-based sampling pattern. The guidelines indicate that a minimum of 9 sampling points are recommended for a 3,000 m^2 site, which would allow for detection of a hot spot of 21.5 m diameter with 95% confidence (the site covers an area of approximately 2,708 m^2).

It is proposed to adopt a slightly higher density for grid-spaced investigation at the site (10 locations) to provide a higher degree of confidence in the representativeness of the results. This is considered appropriate given the high potential for filling at the site, and the potential sources of the fill material. An additional five targeted locations are proposed to be undertaken to assess areas of concern identified during the PSI.

Proposed investigation locations are shown on Figure 2 in Attachment A. Justifications for sample locations are provided in Table 7.

Table 7 Rationale for sampling locations

Location reference	Justification
TP01 to TP10	Grid-spaced locations providing general site coverage.
TP11	Targeting fill materials in the northern area of the site in the vicinity of the small storage shed building.
TP12	Targeting fill materials in the north-western area of the site, adjacent to Peace Park.
TP13	Targeting the storage area in the central area of the site, and the historical site of demountable sheds.
TP14	Targeting fill materials immediately to the east of the south-western building. NSW WorkCover records indicated that petroleum was stored within a shed in this building near to this test pit location.
TP15	Targeting fill materials immediately to the south-west of the south-western building. NSW WorkCover records indicated that petroleum was stored within a shed in this building near to this test pit location.

A backhoe will be used to investigate soil at all 15 locations. This method has been chosen to facilitate a thorough visual inspection of subsurface materials. Test pit location TP15 is located in an area partially behind existing buildings. Attempt will be made to excavate this location as a test pit, however a hand auger and shovel will also be on hand to undertake this location manually should access not be possible.

All locations are proposed to be excavated to a maximum depth of 3.0 mBGL, or 0.5 m into natural underlying soil, whichever occurs first.

No groundwater assessment has been proposed to be undertaken as part of the works at this stage. Based on the elevation of the site and the local topography, it is considered likely that regional groundwater is present beneath the site within the underlying bedrock at depths of greater than 3-4 mBGL. The likelihood for contamination of the regional groundwater originating from the site is considered to be low. Should significant soil contamination be found at the site, groundwater investigation may be considered during any remedial phase of works proposed at the site.

If shallower perched water is observed at the site during the test pitting works, Sydney Water would be contacted to discuss the potential for collection and analysis of samples.

6.2.2 Fieldwork

Preliminaries

Prior to mobilisation, a 'Dial Before You Dig' (DBYD) search will be undertaken to assess for the presence of services (including gas, electricity, water, sewer, stormwater and telecommunications)

Field works methodology

The field works methodology is provided in Table 8.

Table 8 Investigation methodology

Task	Methodology
Service location	Proposed sampling locations will be cleared prior to the commencement of intrusive works by a suitably experienced service locater, using information and plans provided by the asset owners (via the DBYD service) and Sydney Water. In addition, a toothless bucket will be used to undertake 50 mm scrapes to a depth of 1.5 mBGL for all test pit locations prior to the use of a toothed bucket.
Excavation of test pits	A total of 15 test pit locations (TP01 to TP15) will be advanced using a backhoe to a maximum depth of 3.0 mBGL or 0.5 m into the natural soils, whichever occurs first. Test pits will also be terminated if refusal on bedrock is encountered. A hand auger and shovel will be on hand to undertake manual investigation of TP15 should excavator access not be possible.
Soil sample collection	Soil samples will be generally collected from: ■ the surface (0.0 to 0.2 mBGL) ■ depths of 0.3 to 0.5 mBGL, 1.0 mBGL and then at 1.0 m intervals to the base of each test pit ■ where changes in lithology, evidence of contamination or elevated photoionisation detector (PID) readings are noted. Samples will be collected directly from the excavator bucket and the sampling equipment will be cleaned with suitable phosphate free detergent and rinsed with distilled water between sampling episodes. Soil samples will be placed in 250 mL jars, leaving minimal headspace, and closed using Teflon-coated lids. Samples will be stored on ice in an esky and transported to the NATA accredited laboratory under chain of custody.
Logging	Stratigraphy and other relevant information during the investigation works (e.g. in situ testing and any groundwater inflow or levels) will be recorded by appropriately qualified personnel. Soils will be screened in the field with a PID to for potential volatile organic compounds (VOCs).
Surveying	A hand held GPS will be used to record the coordinates of each sampling location. In addition, a 'mud map' will be prepared showing measured distances to locations off site features (e.g. site boundaries, fences) and between locations. The coordinates will be indicated on the test pit logs in the report, and the 'mud map' will be provided for reference. Both the coordinates and the 'mud map' will be used for preparation of plans.
Waste	All excavated materials will be returned to the pits in the order removed, and re-instated to a standard to minimise hazards such as trips and falls. No excess soil waste is anticipated to be generated as a result of the works.

6.2.3 Laboratory analytical schedule

One soil sample per investigation location is proposed to be analysed for a suite of contaminants comprising TRH, BTEX compounds, PAHs, heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), pesticides (OCPs and OPPs) and PCBs. In addition, these samples will be analysed for pH.

In addition, more targeted sampling for other contaminants of concern is proposed as follows:

- analysis of an additional three targeted samples for petroleum hydrocarbon compounds (TRH and BTEX compounds), to be selected based on field screening results including PID measurements, visual and olfactory observations
- analysis of an additional 10 targeted samples for PAHs and 10 targeted samples for heavy metals, to be selected based on field observations (such as inclusions in fill material, etc.) and/or the results of the initial testing (i.e. to provide delineation of impacts)
- analysis of 20 targeted samples for asbestos using the quantitative analysis (percentage weight by weight) method, to be selected based on observations of the subsurface materials (e.g. evidence of building rubble) and to provide adequate site coverage.

In addition, one sample will be analysed for pH, cation exchange capacity (CEC) and clay content to assist in deriving site-specific ecological investigation levels (EILs).

Additional samples not scheduled for analysis will be placed on hold with the laboratory, allowing for additional analysis should this be required. Should the results from the initially scheduled analyses indicate that analysis of additional samples would be beneficial to assist with delineation of impacts, this would be discussed with Sydney Water prior to scheduling.

Table 9 outlines the laboratory analysis plan for the soil component of this project, including the QA/QC program. Our selected primary and secondary laboratories are accredited by NATA for all analyses scheduled, with the exception of asbestos quantitation.

Table 9 Laboratory sampling and analysis plan – Soil

Analyte	Primary samples	Duplicates/ Triplicates	Field blanks	Trip blanks	Trip spikes
TRH	18	2	2	1	-
BTEX compounds	18	2	2	1	1
PAHs	25	4	2	-	-
8 heavy metals	25	4	2	-	-
OCPs/OPPs	15	2	2	-	-
PCBs	15	2	2	-	-
Asbestos (quantitative)	20	-	-	-	-
pH	16	-	-	-	-
CEC	1	-	-	-	-
Clay content	1	-	-	-	-

In addition, an allowance has been made for analysis for heavy metals and PAHs in leachate using the toxicity characteristic leachate procedure (TCLP) analysis on up to two samples to facilitate in situ waste classification of materials (if required).

6.3 Soil assessment criteria

The assessment criteria for the investigation have been based on an analysis of land uses and potential receptors. Based on this, assessment criteria provided in the following guidelines have been identified as being applicable for assessing laboratory analytical data:

- NEPM, 2013
- Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) Technical Report No. 10 (Friebel & Nadebaum), 2011, *Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater, Part 2: Application Document*.

6.4 Health investigation levels and health screening levels

To assess the presence and extent of soil contamination at a site, the NSW EPA refers to the NEPM (2013), which provides health investigation levels (HILs) and health screening levels (HSLs) for the assessment of impacted soil.

HILs provide an assessment of potential risk to human health from chronic exposure to contaminants, and have been developed based on land use setting. As the purpose of this investigation is to assess the site against both the current and potential future land uses, both the 'HIL A' criteria for low density residential land use with gardens/accessible soil and the 'HIL D' criteria for commercial/industrial land use have been adopted.

HSLs have been developed for selected petroleum compounds and fractions and are applicable to assessing human health risk via the vapour intrusion and inhalation pathway. The HSLs depend on specific soil physicochemical properties and land use scenarios. They apply to different soil types and depths. For the purpose of this investigation, both the 'HSL A' criteria for low density residential land use with gardens/accessible soil and the 'HSC D' criteria for commercial/industrial land use have been adopted. A subsurface profile of sand has been assumed as a conservative approach, however, this will be revised if necessary for the Stage 2 DSI reporting should test pit logs and laboratory analysis for clay content indicate that this assumption was incorrect.

The CRC CARE Technical Report No. 10 (Friebel & Nadebaum, 2011) provides HSLs for petroleum hydrocarbons specifically for vapour inhalation for intrusive maintenance workers in shallow trenches, and for direct contact. These have also been adopted.

The soil assessment criteria for this investigation is summarised in Table 10.

	Low density residential land use						Commercial/industrial land use						Maintenanc	
	HSL A (in sand)[1] (mg/kg)				HIL A[2] (mg/kg)	Direct contact[3] (mg/kg)	HSL D (in sand)[1] (mg/kg)				HIL D[2] (mg/kg)	Direct contact[3] (mg/kg)	HSLs (in sand	
	0 to <1 m	1 to <2 m	2 to <4 m	4 m +			0 to <1 m	1 to <2 m	2 to <4 m	4 m +			0 to <2 m	2 to <4 m
TRH/BTEX compounds														
	-	-	-	-	-	4,400	-	-	-	-	-	26,000	NL	NL
F1)	45	70	110	200	-	-	260	370	630	NL	-	-	-	-
	-	-	-	-	-	3,300	-	-	-	-	-	20,000	NL	NL
thalene	110	240	440	NL	-	-	NL	NL	NL	NL	-	-	-	-
	-	-	-	-	-	4,500	-	-	-	-	-	27,000	-	-
	-	-	-	-	-	6,300	-	-	-	-	-	38,000	-	-
	0.5	0.5	0.5	0.5	-	100	3	3	3	3	-	430	77	160
	160	220	310	540	-	14,000	NL	NL	NL	NL	-	99,000	NL	NL
	55	NL	NL	NL	-	4,500	NL	NL	NL	NL	-	27,000	NL	NL
	40	60	95	170	-	12,000	230	NL	NL	NL	-	81,000	NL	NL
PAHs														
	3	NL	NL	NL	-	1,400	NL	NL	NL	NL	-	11,000	NL	NL
	-	-	-	-	300	-	-	-	-	-	4,000	-	-	-
	-	-	-	-	3	-	-	-	-	-	40	-	-	-
OCPs/OPPs														
	-	-	-	-	10	-	-	-	-	-	80	-	-	-
	-	-	-	-	6	-	-	-	-	-	50	-	-	-
	-	-	-	-	6	-	-	-	-	-	45	-	-	-
	-	-	-	-	50	-	-	-	-	-	530	-	-	-
	-	-	-	-	270	-	-	-	-	-	2,000	-	-	-
	-	-	-	-	240	-	-	-	-	-	3,600	-	-	-
	-	-	-	-	10	-	-	-	-	-	100	-	-	-
	-	-	-	-	300	-	-	-	-	-	2,500	-	-	-
	-	-	-	-	160	-	-	-	-	-	2,000	-	-	-
PCBs														

	Low density residential land use						Commercial/industrial land use						Maintenanc	
	HSL A (in sand)[1] (mg/kg)				HIL A[2] (mg/kg)	Direct contact[3] (mg/kg)	HSL D (in sand)[1] (mg/kg)				HIL D[2] (mg/kg)	Direct contact[3] (mg/kg)	HSLs (in san	
	0 to <1 m	1 to <2 m	2 to <4 m	4 m +			0 to <1 m	1 to <2 m	2 to <4 m	4 m +			0 to <2 m	2 to <4 m
Asbestos														
	0.01% w/w				-	-	0.05% w/w				-	-	-	-
stos fines	0.001% w/w				-	-	0.001% w/w				-	-	-	-
	Not visible in surface soil				-	-	Not visible in surface soil				-	-	-	-
Heavy metals														
	-	-	-	-	100	-	-	-	-	-	3,000	-	-	-
	-	-	-	-	20	-	-	-	-	-	900	-	-	-
	-	-	-	-	100[6]	-	-	-	-	-	3,600[6]	-	-	-
	-	-	-	-	6,000	-	-	-	-	-	240,000	-	-	-
	-	-	-	-	300	-	-	-	-	-	1,500	-	-	-
	-	-	-	-	40	-	-	-	-	-	730	-	-	-
	-	-	-	-	400	-	-	-	-	-	6,000	-	-	-
	-	-	-	-	7,400	-	-	-	-	-	400,000	-	-	-

1 Table 1A(3) Soil HSLs for vapour intrusion (mg/kg)
1 Table 1A(1) Health investigation levels for soil contaminants (mg/kg)
B4 Soil HSLs for direct contact (mg/kg)
B3 Soil HSLs for vapour intrusion (mg/kg)
quivalent quotient (TEQ), calculated as a sum of weighted selected PAHs. Further details available in NEPM (2013) Schedule B2
ted for total chromium as a conservative approach
vailable
num vapour concentrations being below the acceptable health risk level

6.5 Ecological screening levels and ecological investigation levels

The NEPM (2013) provides ecological screening levels (ESLs) for TRH, BTEX compounds and PAHs for use as an initial screening risk assessment to determine whether laboratory analysed concentrations of contaminants potentially pose a risk to plant growth. For the purpose of this investigation, ESLs for 'urban residential and public open space' and 'commercial and industrial' land uses with coarse-grained soil textures have been considered. These are outlined in Table 11.

Table 11 Soil assessment criteria - ESLs

Analyte	ESLs (mg/kg dry soil)	
	Urban residential and public open space	Commercial and industrial
TRH C_6-C_{10} minus BTEX (F1)	180	215
TRH >C_{10}-C_{16} minus naphthalene (F2)	120	170
TRH >C_{16}-C_{34} (F3)	300	1,700
TRH >C_{34}-C_{40} (F4)	2,800	3,300
Benzene	50	75
Toluene	85	135
Ethylbenzene	70	165
Xylene (Total)	105	180
Benzo(a)pyrene	0.7	0.7

The NEPM (2013) also provides ecological investigation levels (EILs), which were developed for metals, naphthalene and pesticides. The EILs take into consideration the physiochemical properties of soil and contaminants and the capacity of the local ecosystem to accommodate increases in the contaminant levels. The EILs are derived using the following equation:

$$EIL = added\ contaminant\ limit\ (ACL) + ambient\ background\ concentration\ (ABC)$$

The ABC is the background contaminant level and requires measurement at appropriate reference points at the site. The ACL, which is provided in the NEPM (2013) is the maximum contaminant concentration added to the naturally occurring background level, exceedances of which may result in adverse effects on plant health. EILs corresponding to urban residential land use will be applicable for this investigation and will be calculated in the Stage 2 DSI report based on laboratory analytical results.

6.6 QA/QC

A discussion on the QA/QC to be adopted for the Stage 2 DSI works is provided in Attachment F.

6.7 Stage 2 DSI reporting

The detailed Stage 2 DSI report will be prepared with reference to the requirements of the NSW EPA 1997, *Guidelines for Consultants Reporting on Contaminated Sites*, the NSW DEC 2006, *Guidelines for the NSW Site Auditor Scheme (2nd Edition)*, and other relevant guidelines. The report will include:

- a summary of information pertaining to the site that has been reviewed by Parsons Brinckerhoff
- a summary of the field works undertaken including field observations and measurements
- a photographic record of sampling locations (test pits)
- a copy of the 'mud map' prepared in the field showing the measured distances to investigation locations from site features and between locations
- test pit logs describing the nature of the material observed (including water inflows where appropriate) and including observations from each sampling location (including PID readings)
- figures showing the final sampling locations and contaminant distribution based on analytical results as appropriate using geographical information systems (GIS) mapping
- summary tables of soil analytical results
- a discussion of the results including an assessment of the site contamination and a comparison of data to the relevant criteria for the proposed residential land use (the NSW EPA low density residential land use and commercial/industrial land use criteria provided in the NEPM (2013))
- estimation of volumes of contaminated materials, including waste classification in accordance with the NSW EPA 2014, *Waste Classification Guidelines Part 1: Classifying Waste*.

7. Limitations

1. This Report has been prepared by Parsons Brinckerhoff Australia Pty Limited ("*Parsons Brinckerhoff")* for the benefit of Sydney Water Corporation ("*Sydney Water*"), the registered proprietor of the site requested to be investigated by Parsons Brinckerhoff ("Site") under its agreement with Sydney Water dated 20 April 2011 ("Agreement").

2. The nature and extent of the contamination assessment of the Site detailed in the Report reflects the scope of the Services set out in the Specification in the Agreement.

3. A potential purchaser (but not including a purchaser's successor in title) of the Site may rely on the findings contained in the Report for the purpose of assessing the level of contamination of that Site ("Permitted Purpose").

4. The findings contained in the Report are subject to the qualifications, assumptions and limitations set out in the Report or otherwise communicated to, or, by Sydney Water. To the extent of any inconsistency between this Limitation Statement and the qualifications, assumptions and limitations in the Report, this Limitation Statement shall prevail.

5. The Report may contain information provided by others. Except as otherwise stated in the Report, Parsons Brinckerhoff has not verified the accuracy or completeness of this information. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the Report ("Conclusions") are based in whole or in part on this information, those Conclusions are contingent upon

the accuracy and completeness of that information. Parsons Brinckerhoff accepts no responsibility for the reliability, accuracy, completeness or adequacy of information provided by others.

6. Parsons Brinckerhoff has prepared the Report without regard to any special or particular interest of any person (including that of a potential purchaser), other than Sydney Water when undertaking the Services or setting out its findings in the Report.

7. Matters material to a potential purchaser, may have been omitted from the Report, or may not have bene investigated because of the scope of the Services. It follows that a potential purchaser may rely only on what is expressed in the Report, including any restrictions set out in the Report.

8. The Report can only be relied upon for the Permitted Purpose and may not be relied upon for any other purpose and does not purport to recommend or induce a decision to make (or not make) any purchase, disposal, investment, divestment, financial commitment or otherwise in relation to the Site.

9. The Report has not and will not be updated for events occurring after the date of the Report or any other matter which may have a material effect on its contents which come to light after the date of the Report. Parsons Brinckerhoff will not be obliged to inform a potential purchaser of any matter arising or coming to its attention after the date of the Report, which may affect or qualify the Report.

10. Parsons Brinckerhoff is not liable to a potential purchaser in respect of errors or omissions in the Report which a potential purchaser knows of, or ought to be aware of, from:

    a. its own actual knowledge and inquiries;
    b. inquiries made by its advisers; or
    c. matters which a potential purchaser should have been aware of by making reasonable inquiry.

11. To the fullest extent permitted at law, Parsons Brinckerhoff, its related bodies corporate, its officers, employees and agents assume no liability and will not be liable to any potential purchaser for, or in relation to, any losses, damages or expresses (including any indirect, consequential or punitive losses or damages or any amounts for loss of income or profit, revenue or loss of opportunity to earn profit) of any kind (arising in contract, tort (including negligence or otherwise), suffered or incurred by a potential purchaser (or any other third party) arising out of or in connection with any matter outside the ambit of the Permitted Purpose in relation to the Report or findings expressed in the Report.

8. References

Australian Standard AS4964 2004, *Method for Qualitative Identification of Asbestos in Bulk Samples*.

AWT 1996, *Review of Environmental Factors, Ashfield Reservoir Rehabilitation*.

Canterbury Local Environmental Plan 2012.

CSIRO ASRIS, accessed 16 April 2015, <http://www.asris.csiro.au/index_ie.html#>

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

NSW DEC 2006, *Guidelines for the NSW Site Auditor Scheme (2nd Edition)*.

NSW EPA 1995, *Sampling Design Guidelines*.

NSW EPA 1997, *Guidelines for Consultants Reporting on Contaminated Sites*.

NSW EPA 2014, *Waste Classification Guidelines Part 1: Classifying Waste*.

NSW EPA Contaminated land record database <http://www.epa.nsw.gov.au/prclmapp/searchregister.aspx>

NSW EPA *Protection of the Environment Operations Act 1997* public register <http://www.epa.nsw.gov.au/prpoeoapp/>

NSW Government Water Information website, http://allwaterdata.water.nsw.gov.au/water.stm

Parsons Brinckerhoff 2014, *WS0003 – Hazardous Building Materials Register & Asbestos Management Plan* (reference: 2114652C_1000-343)

Parsons Brinckerhoff 2015, *WUCT07 – Hazardous Building Materials Register & Asbestos Management Plan* (reference: 2114652E_1000-1287)

Sydney Water index of heritage assets <http://www.sydneywater.com.au/SW/water-the-environment/what-we-re-doing/Heritage-search/index.htm>

9. Closure

If you have any questions, please do not hesitate to contact the undersigned on (02) 9272 5100.

Yours sincerely

Michael Watson
Senior Environmental Scientist

Amy Valentine
Principal Environmental Engineer

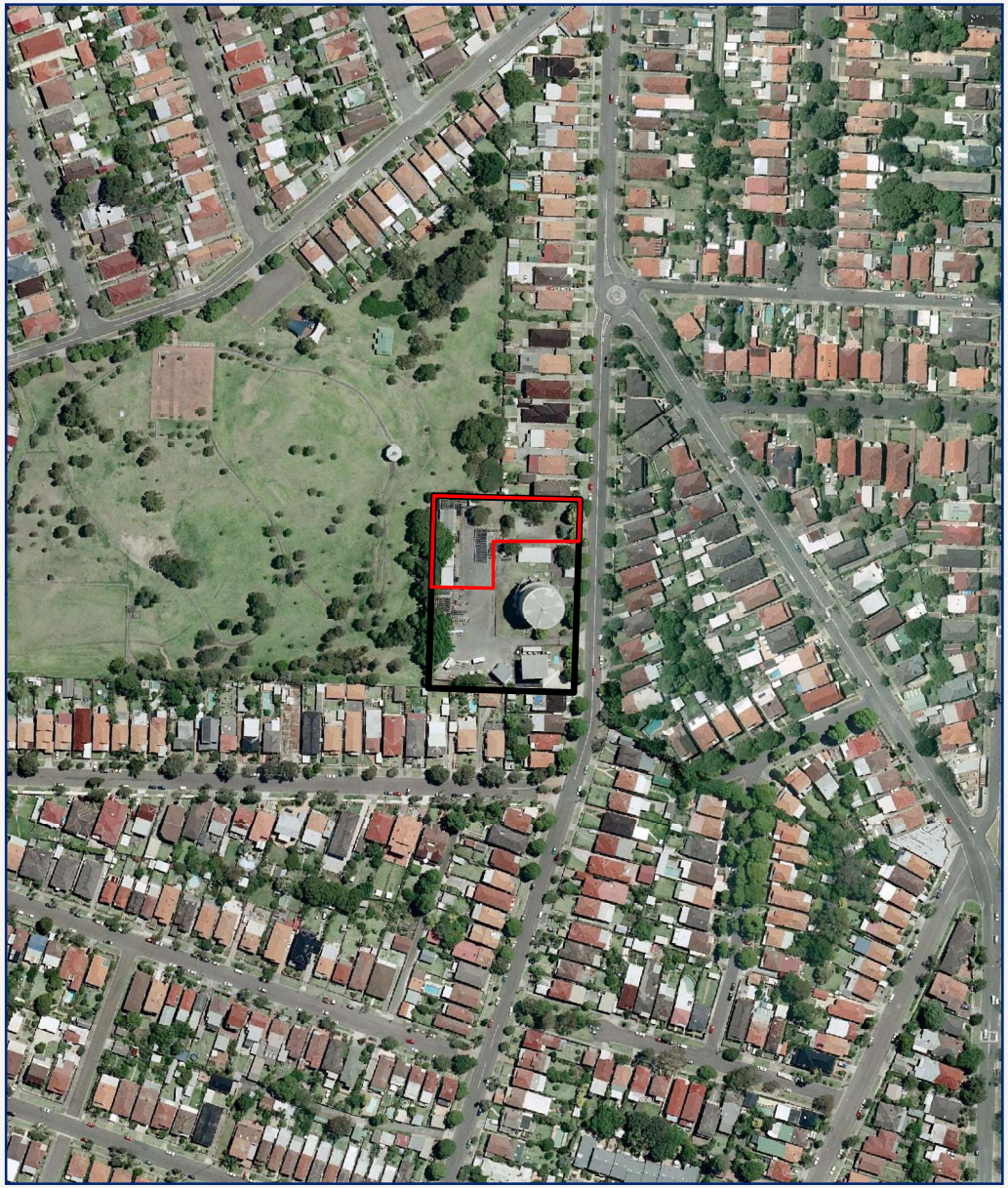
Encl.

Attachment A	Figures
Attachment B	Site photographs
Attachment C	Title search documentation
Attachment D	Historical aerial photographs
Attachment E	NSW WorkCover Dangerous Goods search results
Attachment F	QA/QC discussion

PARSONS BRINCKERHOFF

Attachment A

Figures



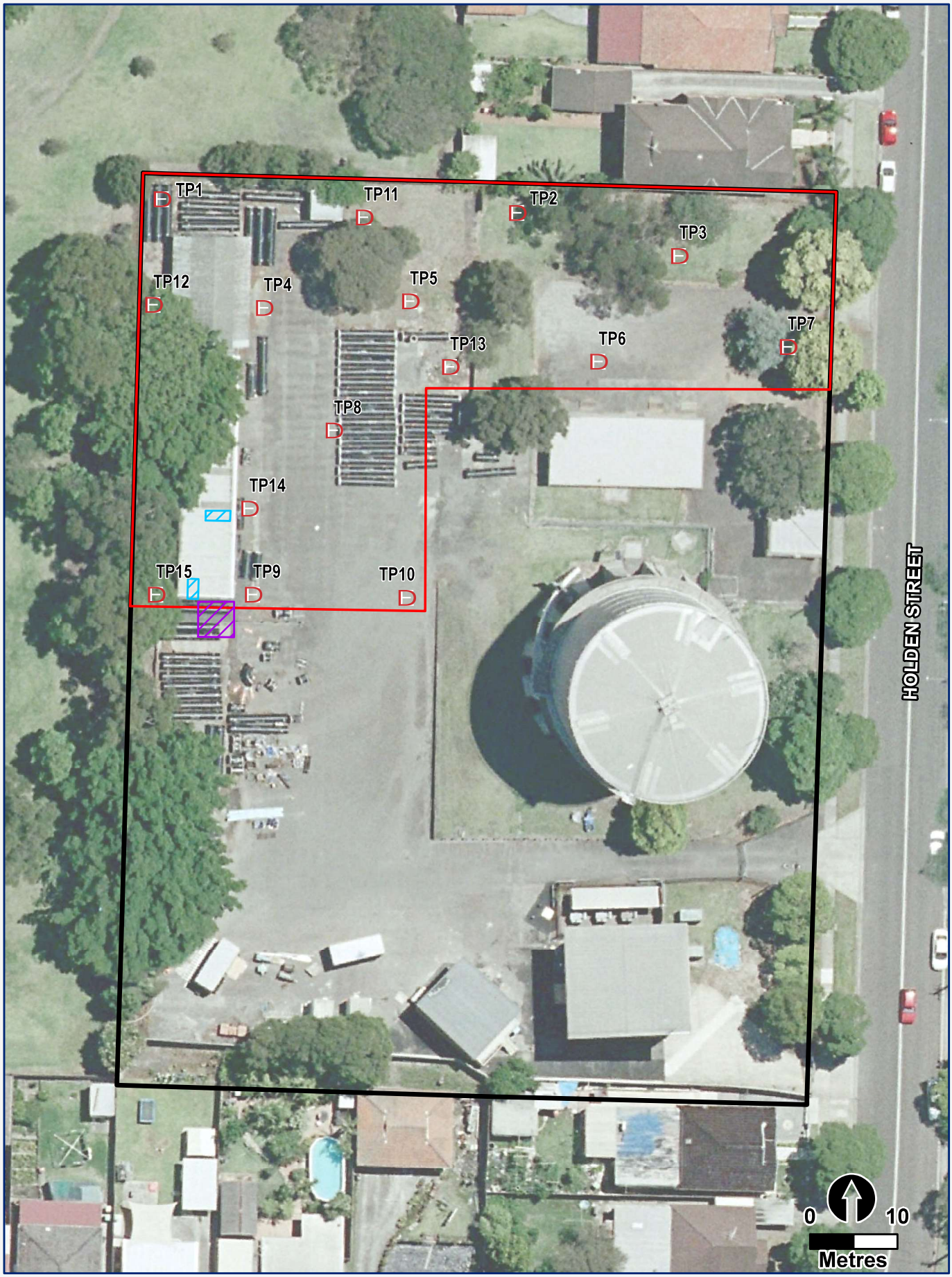
Site extent

Sydney Water property

0 100

Metres

Figure 1 Site location plan
Sydney Water Ashfield Reservoir
Holden St, Ashbury, NSW



Site extent
Sydney Water property
Approximate former location of petroleum storage in cabinets
Approximate former location of diesel shed

Figure 2 Site location plan
Sydney Water Ashfield Reservoir
Holden St, Ashbury, NSW

Aerial source: ©SKM2010 (GoogleEarth)

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Attachment B

Site photographs

Photo 1: Site entrance driveway, facing east.

Photo 2: View of north-eastern area of the site, facing west.

Photo 3: View of north-eastern area of the site, facing north-west.

Photo 4: View of retaining wall in south-western corner of site area, facing west.

Photo 5: View of western area of site and site buildings, facing north.

Photo 6: View of site buildings in western and north-western area of site, facing west.

Photo 7: View of storage area in central part of site, facing north-east.

Photo 8: View of storage shed in northern area of site, facing north.

Photo 9: View of north-western area of site, behind site building, facing south.

Photo 10: View of north-western area of site, behind site building, facing north.

Photo 11: View of the vegetated western area of the site behind buildings, facing south.

Photo 12: Storage area in southern portion of the south-western site building.

Photo 13: Storage area in northern portion of the north-western site building.

Photo 14: View of western area of the site, with the remainder of the Sydney Water property (to be retained) beyond, facing south.

Photo 15: View of Sydney Water reservoir on area of property to be retained, facing north-east.

Photo 16: View of drainage area into the neighbouring park, in south-western corner of the Sydney Water property (in area to be retained), facing south-west.