



# **Appendix K**

## **Contamination**

### **Environmental Site Assessment**

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Infrastructure NSW  
Environmental Site Assessment

Western Sydney Stadium  
O'Connell Street, Parramatta, NSW

12 July 2016  
51666/104304 (rev 1)  
JBS&G

Infrastructure NSW  
Environmental Site Assessment

Western Sydney Stadium  
O'Connell St, Parramatta NSW

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51666/104304 (rev 1)  
JBS&G

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## List of Abbreviations

A list of the common abbreviations used throughout this report is provided below.

- ACM – Asbestos Containing Material
- AEC – Area of Environmental Concern
- AF – Asbestos Fines
- bgs – Below Ground Surface
- COPC – Contaminant of Potential Concern
- CSM – Conceptual Site Model
- DECCW - NSW Department of Environment, Climate Change and Water (now OEH)
- EPA – NSW Environmental Protection Authority
- ESA – Environmental Site Assessment
- FA- Friable Asbestos
- ha - Hectare
- OEH – NSW Office of Environment and Heritage
- OCPs – Organochlorine Pesticides
- OPPs – Organophosphate Pesticides
- NoW – NSW Office of Water (formerly Department of Water and Energy, DWE)
- PAHs – Polycyclic Aromatic Hydrocarbons
- PCC – Parramatta City Council
- PCBs – Polychlorinated Biphenyls
- PAEC – Potential Area of Environmental Concern
- QA/QC - Quality Assurance/Quality Control
- RPD - Relative Percentage Difference
- SAQP – Sampling, Analytical and Quality Plan
- sVOC – Semi-volatile Organic Compounds
- TPH – Total Petroleum Hydrocarbons
- UST - Underground Storage Tank
- VOC – Volatile Organic Compounds
- WSS – Western Sydney Stadium

## Executive Summary

JBS&G Australia Pty Ltd (JBS&G) was engaged by Infrastructure NSW (iNSW, the client) to undertake a site contamination assessment for the Western Sydney Stadium (WSS) Project proposed to be developed on the site of the existing Parramatta Stadium at 11—13 O’Connell St, Parramatta, NSW (the Site). The Site is defined as the development envelope where works are proposed to be undertaken for the Project. The Site is formally identified as Lots 951, 952, 953, 954, 955, 956, 957, 958, 959, 961, 962, 963 in Deposited Plan (DP) 42643 and Crown Land Lot 80-3000 (part). The Site has a total footprint of approximately 92 887 m<sup>2</sup>. The south-east portion of the Site comprises the existing Parramatta Swimming Centre (PSC). As a result of access constraints associated with the current facilities, whilst part of the Site, the PCS has been excluded from the site investigation Study Area the subject of this assessment.

The redevelopment concept includes a proposal to construct a new 30 000 seat stadium on the site of the existing stadium and surrounds, comprising land managed by NSW Government entities including Venues NSW and the Parramatta Park Trust.

The Department of Planning and Environment (DPE) Secretary’s Environmental Assessment Requirements (SEARs) has identified the requirement to address the potential for soil and groundwater contamination at the site as part of the Proposal Environmental Impact Statement (EIS). The scope of this assessment has been developed in response to the SEARs and with consideration to relevant guidelines made or approved by the NSW Environment Protection Authority (EPA) for the assessment of site contamination.

The objective of this assessment is to characterise potential contamination within the Study Area and to draw conclusions regarding the suitability of the Study Area for the proposed use, or make recommendations to enable such conclusions.

It is a secondary objective of the works to provide information on site conditions that may require consideration during future development works in relation to worker health and safety (WHS) and waste classification guidance such that appropriate allowances may be provided for by contractors tendering for the Project works.

The scope of work completed for this assessment included the review and documentation of available previous site investigations and historical site use information to result in the development of a conceptual site contamination model (CSM); the design and implementation of a sampling, analysis and quality plan (SAQP) including soil and groundwater sampling and laboratory analysis; comparison of investigation data with adopted site assessment criteria and preparation of a site assessment report presenting the results of the assessment and drawing conclusions with regard to the contamination status of the Study Area in relation to the proposed land use.

Based on historical site use information, previous site contamination investigations and site observations, general areas of potential environmental concern and associated contaminants of potential concern (COPCs) were identified for the Study Area as outlined in the following Table.

### Areas of Potential Environmental Concern and Associated Contaminants of Potential Concern

| Area of Environmental Concern (AEC)  | Contaminants of Potential Concern (COPC)     |
|--|--|
| Potential presence of imported fill material to generate current site development levels, including modification of ground levels resulting in landscaped mounds within the Site | Heavy metals, TPH, PAHs, OCPs/PCBs, asbestos |
| Impacts associated with burial of ACM and soil impacted with ACM during previous stadium construction activities   | Asbestos                                     |
| Impacts associated with hazardous building materials from within existing and former site buildings  | Asbestos, lead, PCBs                         |
| Impacts associated with maintenance of grounds keeper plant including lawnmowers etc within maintenance areas of the site  | TPH/BTEX, PAHs, phenolics, VHCs              |

| Area of Environmental Concern (AEC)  | Contaminants of Potential Concern (COPC) |
|--|--|
| Application of pest control chemicals during site/stadium maintenance activities | OCPs/OPPs, heavy metals                  |
| Impacts associated with fire damage to former buildings/stands                   | Asbestos, PAHs, heavy metals             |

As a result of the above AECs and COPCs, potentially contaminated media requiring consideration during assessment of the Study Area were identified as fill material, natural soils and to a lesser extent, groundwater. Potential receptors of environmental impact present within the Site which will be required to be addressed with respect to the suitability of the Site for the proposed use include:

- Future site users of public open space, sports facilities and landscaped or non-paved areas whom may potentially be exposed to COPCs through direct contact with impacted soils and/or inhalation of dusts / fibres associated with impacted soils; and/or
- Excavation / construction / maintenance workers conducting activities at or in the vicinity of the Site, who may potentially be exposed to COPCs through direct contact with impacted soils and/or groundwater present within excavations and/or inhalation of dusts / fibres associated with impacted soils;
- Flora species established in the vegetated areas of the Site inclusive of large trees; and/or
- The aquatic ecosystem of Parramatta River located hydro-geologically downgradient of the site.

A site sampling and analysis plan was developed based on the CSM that comprised the systematic sampling of potentially impacted media in accessible areas of the Study Area and subsequent field assessment and laboratory analysis of collected samples for COPCs. This included the supplementation of existing contamination data collected from targeted site locations with a further 57 soil sampling locations across the Study Area in areas previously not the subject of investigation. Four groundwater monitoring wells were installed approximately evenly spaced across the Study Area to confirm groundwater table elevations and evaluate the potential groundwater contaminant conditions.

Based on the findings of this assessment and subject to the limitations in **Section 13**, the following conclusions are provided with respect to contamination conditions within the Study Area:

- The Study Area has historically been used for recreational and sporting purposes with the current stadium facilities constructed in the early to mid-1980s following a fire and subsequent demolition of the former grandstand and oval facilities.
- Development works have included significant modification of the natural topography within the Study Area resulting the presence of several areas of significant fill material, including areas to the north and south of the Stadium and within the western carpark area. Fill material has been identified within the Study Area extending to depths of between 0.1 m below current ground surface (bgs) to greater than 3 m bgs (including to 6 m in the northern fill mound at the northern site boundary). In a number of locations in the north, west and south of the Study Area, fill material below the ground surface was observed to contain visible inclusions of asbestos containing material (ACM) in friable or non-friable (bonded) form.
- In addition to observations of ACM in fill material, laboratory analysis of representative soil samples has also identified the presence of asbestos in soil at a range of locations across the Study Area, consistent with the presence of fill material. As such, the soils identified as impacted with asbestos/ACM are considered to represent a potentially unacceptable risk to future site receptors.

- Concentrations of chemical contaminants of potential concern (COPCs) in representative soils were identified to be less than the adopted health based site assessment criteria and apart from several isolated occurrences, less than the adopted ecological assessment criteria. As such, chemical contaminants are considered not to pose an unacceptable risk to identified receptors.
- Concentrations of COPCs in representative groundwater samples were generally less than the adopted site assessment criteria. Minor exceedances of a number of individual heavy metals in some samples are considered representative of typical conditions in urban environments in similar geological settings. These conditions are considered to not represent an unacceptable risk to human and/or ecological receptors within or downgradient of the site.
- No background contaminant concentrations in natural soils, chemical mixtures in soil or groundwater or significant offsite contaminant migration risks were identified during the investigation that require further consideration with respect to decisions regarding the suitability of the site for the proposed use or requirements for management such that the site may be considered suitable.
- Based on the identified asbestos in soil impacts identified within the Study Area, a site management strategy is required to manage the potential health based risks to future site workers/users. Consideration is also required to be given to management of potential worker exposure risks during site development activities and the potential for migration of airborne asbestos fibres from the Study Area.
- It is considered the site can be made suitable for the proposed land use subject to the implementation of an appropriate remediation/management strategy to address the identified asbestos impacts.

It is recommended that a remedial action plan (RAP) incorporating an asbestos management plan (AMP) be developed in accordance with the relevant regulatory requirements. The RAP will document procedures and standards to be followed in order to address the identified asbestos impact, ensuring the protection of human health and the surrounding environment, such that the asbestos impact is remediated / managed in a manner as to make the site suitable for the proposed future uses.

It is anticipated that the RAP will be prepared in conjunction with the design of the specific development scheme and subsequently included within the Stage 2 project development application such that development consent may be obtained for the remedial works.

A combined Environmental/Asbestos Management Plan (E/AMP) should be prepared in conjunction with development of the RAP, documenting environmental and occupational monitoring and management measures required to be implemented during remediation and construction related activities proposed to be undertaken at the Site. the E/AMP will be required until such time as the Site can, via remediation and subsequent validation, be considered suitable for the proposed use, potentially inclusive of ongoing management, should asbestos containing soil remain underlying suitable containment measures.

Given that demolition works may commence prior to the commencement of the detailed stadium design phase (inclusive of the RAP preparation), a standalone AMP should be prepared specific to management of asbestos risks during and following the demolition works. This AMP will be required to address the removal of asbestos within the existing structures and the management of asbestos in soil exposure risks during the demolition activities. This will primarily address the potential for dust generation from the ground surface during and following demolition activities,

but will also be required to consider the potential for exposure of workers and/or migration of impacted soil during removal of in-ground structures as may occur during the demolition works.

## 1. Introduction

### 1.1 Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by Infrastructure NSW (iNSW, the client) to undertake a site contamination assessment for the Western Sydney Stadium (WSS) Project proposed to be developed on the site of the existing Pirtek Parramatta Stadium at 11—13 O’Connell St, Parramatta, NSW (the Site), as shown in **Figure 1**. The Site is defined as the development envelope (as shown in **Figure 2**) where works are proposed to be undertaken for the Project. The Site is formally identified as Lots 951, 952, 953, 954, 955, 956, 957, 958, 959, 961, 962, 963 in Deposited Plan (DP) 42643 and Crown Land Lot 80-3000 (part). The Site has a total footprint of approximately 92 887 m<sup>2</sup>.

The redevelopment concept includes a proposal to construct a new 30 000 seat stadium on the site of the existing stadium and surrounds, comprising land managed by NSW Government entities including Venues NSW and the Parramatta Park Trust. Given the scale of the Proposal, the works are considered State Significant Development (SSD) and as such the Development Application documentation is required to include an Environmental Impact Statement (EIS).

The assessment and approvals for the Project will be undertaken in two stages under Section 83B of the *Environmental Planning and Assessment Act 1979* (EP&A Act), being:

- Initial application for staged demolition works associated with the removal of the existing stadium and Parramatta Swimming Centre (PSC) developments and approval of a Concept Plan for the WSS including parking and access facilities, ancillary infrastructure and landscaping (Stage 1); and
- A second separate application for the detailed design and subsequent construction and operation of the WSS facilities (Stage 2).

As noted in **Figure 2**, the south-east portion of the Site comprises the existing Parramatta Swimming Centre (PSC) Site. As a result of access constraints associated with the current facilities, whilst part of the Site, the PSC has been excluded from the site investigation Study Area as shown in **Figure 2**.

The Stage 1 Proposal comprises works at the Site associated with site preparation including the demolition and removal of the existing stadium infrastructure including below ground infrastructure, footpaths, roads, carparking facilities, as required to facilitate the preparation of the site for the new stadium. The Stage 1 application will also seek approval for demolition of the existing PSC site facilities, anticipated to include demolition of the above and in-ground infrastructure, removal of site trees and stabilisation of the fill mound at the south of this area.

The Department of Planning and Environment (DPE) Secretary’s Environmental Assessment Requirements (SEARs) has identified the requirement to address the potential for soil and groundwater contamination at the site as part of the Proposal Environmental Impact Statement (EIS).

The scope of this assessment has been developed in response to the SEARs and with consideration to relevant guidelines made or approved by the NSW Environment Protection Authority (EPA) for the assessment of site contamination.

### 1.2 Glossary of Terms

To ensure consistency across the EIS inclusive of the technical working papers, the following common terms have been adopted throughout this report:

- **The Site** – as defined in **Figures 1 and 2**, comprising the entire development envelope where Project works are proposed. This footprint includes the demolition and concept proposal for the stadium and associated infrastructure in addition to any ancillary features and associated infrastructure, inclusive of the Parramatta Swimming Centre site. All works the subject of the development application will be undertaken within this site boundary.
- **The Project** – the proposed Western Sydney Stadium (WSS). This comprises all works activities to be completed within Stage 1 – inclusive of the concept proposal and demolition; and Stage 2 – comprising the detailed design, construction and operation of the stadium.
- **The Study Area** – as defined in **Figures 1 and 2** for this assessment, comprises the assessment envelope for each technical discipline. This envelope may differ between the various technical working papers as some issues may require a larger assessment envelope than others, or be limited by available access constraints. For the purposes of this site contamination assessment, the Study Area has been identified as the accessible extent of the Site, excluding the Parramatta Swimming Centre footprint situated to the east of the existing stadium given that access was not available to complete intrusive investigations during the investigation period.
- **The Concept Plan** – the Concept Design prepared for the WSS, including ancillary infrastructure and landscaping, parking and access facilities. A maximum design envelope is being considered within the Concept Plan for the Stage 1 application to provide for flexibility in Stage 2.
- **Demolition Works** – The Stage 1 early works activities as listed in the SEARs, including the staged demolition and removal of the existing stadium and associated infrastructure in addition to the Parramatta Swimming Centre. This will include the carpark to the west of the existing stadium and other hardstand features including footpaths, driveways and roads.

### 1.3 Objective

The objective of this assessment is to characterise potential contamination within the Study Area and to draw conclusions regarding the suitability of the Study Area for the proposed use, or make recommendations to enable such conclusions.

It is a secondary objective of the works to provide information on site conditions that may require consideration during future development works in relation to worker health and safety (WHS) and waste classification guidance such that appropriate allowances may be provided for by contractors tendering for the Project works.

### 1.4 Scope of Works

The scope of works completed for this assessment comprised:

- A review and documentation of available historical site use information, including available heritage reports, with respect to the identification of areas of environmental concern (AECs) and associated contaminants of potential concern (COPCs);
- a detailed inspection of the Study Area and immediate surrounds to confirm the presence of potential areas of environmental concern (AECs);
- review of available previous site investigation reports including site contamination and geotechnical engineering reports associated with previous development works at the Site;
- development and documentation of a conceptual site model (CSM) based on the available information;

- development and documentation of the data quality objectives (DQOs) for the ESA in general accordance with the EPA guidelines;
- implementation of a detailed site investigation program including a program of soil and groundwater sampling and laboratory analysis program within accessible areas of the Study Area not previously the subject of site contamination investigation works;
- comparison of collected data against regulator published / endorsed assessment criteria to facilitate an assessment of land use suitability and waste classification(s);
- preparation of an ESA report in general accordance with EPA guidelines, presenting the assessment of contamination conditions and drawing conclusions regarding the potential contamination status at the Study Area with respect to the Proposal and if required, providing recommendations to enable such conclusions to be drawn.

## 2. Site Conditions and Surrounding Environment

### 2.1 Site Identification

The location and current Site and Study Area layouts are shown on **Figures 1** and **2**. Current Site features are shown on **Figure 2**. The Study Area details are summarised in **Table 2.1** below.

**Table 2.1: Summary of Site and Study Area Details**

|   |   |
|---|---|
| Lot and DP                                    | Lots 951, 953, 954, 955, 956, 958, 959, 961, 962 and 963 in DP42643 (Lot 952 DP 42643 and Part Crown Land Lot 80-3000 fall within the Site, but not the Study Area, comprising land within the PSC) |
| Address                                       | 11 – 13 O’Connell St Parramatta   |
| Approximate co-ordinates (MGA 56) of the site | 314 928E and 6 257 449N (MGA 56)  |
| Site Area                                     | 92 887 m <sup>2</sup>   |
| Study Area                                    | 72 421 m <sup>2</sup>   |
| Local Government Authority                    | Parramatta City Council   |
| Site Zoning                                   | RE2 Private Recreation (PLEP 2007 <sup>1</sup> )  |
| Previous Land Use                             | Parramatta Stadium and surrounds  |
| Current Land Use                              | Parramatta Stadium and surrounds  |
| Proposed Land Use                             | Western Sydney Stadium  |

### 2.2 Site Description

The Study Area comprises an irregular shape situated as shown in **Figures 1** and **2** bound to the west by the Parramatta River riparian zone, the Parramatta Leagues Club and associated vehicle parking facilities to the north, O’Connell St to the east, the Parramatta Swimming Centre to the east and south-east and Parramatta Park and the Old Kings Oval to the south and south-west. Reference should be made to the various report figures and also site photographs included in **Appendix A** to inform the following.

The existing Parramatta Stadium comprised a rectangular grassed playing field bound by two concrete, steel and clad spectator stands to the east and west of the field. Additional seating was present to the north and south of the field, comprising concrete terraced seating above which were higher soil based mounds for additional standing spectator areas surfaced with a combination of turf and asphalt pavements. Fixed spectator viewing screens in addition to several small caravan/portable buildings and a clad shed at the south and a brick shed at the north appeared to provide facilities including match day food and beverage outlets. Large light poles were situated at each corner of the field, beyond the extent of the seating. Security fencing screened by shrubs and asphalt paved vehicle/pedestrian access ways occupied the area beyond the stadium footprint immediately to the north and south of the stadium.

Asphalt paved vehicle parking areas were located to the north-east of the stadium, accessed by an entrance from O’Connell St at the intersection of Victoria Road. Several electrical transformers were situated at the south most extent of this site section, adjacent to the car park area to the north and the Study Area boundary with PSC to the south. Previous earthworks, potentially associated with construction of the car park were apparent, having resulted in ground levels in this area consistent with O’Connell St to the east.

An L-shaped earthen mound was located at the north-east extent of the car park and extended to the Study Area boundary with O’Connell St and the Leagues Club site to the north, including the Mud lodge building facing O’Connell St. A vertical concrete block retaining wall of up to approximately 2 m in height retained the mounded soil from the car park, whilst the mound fell

<sup>1</sup> Parramatta City Centre Local Environmental Plan 2007 (PLEP 2007)

away toward the Study Area boundaries beyond. The mound was generally grassed with a line of mature trees also planted along the crest.

Additional vegetated open space was situated to the north-west of the stadium that generally extended to the Study Area and in some instances to the river bank. Significant amendment to ground levels appeared to have resulted in the presence of a grassed mound to the north of the stadium within the Study Area. Beyond this mound to the north and to the west, ground levels fell away at the Study Area boundary sharply toward the river bank, with trees, small shrubs and mulch cover characterising the slope.

An asphalt paved car park and an adjacent to a series of weatherboard/clad single storey buildings were located within the Study Area to the west of the stadium. These buildings appeared to comprise the groundskeeper's office, workshop and equipment store. A small brick building was also located at the north-east extent of this car park where it appeared hoses and possible lawnmowers etc. may have been stored. Bulk materials bins comprising concrete block walls were situated to the south of this shed. The ground surface levels were relatively flat and approximately 0.6 m above the adjoining stadium access path ground level in this area of the site. Beyond the carpark area and the Study Area boundary, a loose gravel surfaced vehicle track accessed the Old Kings Oval. Beyond the access road, a steep embankment vegetated with mature trees, shrubs and mulch fell steeply toward the river bank.

A raised rectangular playing field/training area occupied the southern most portion of the Study Area to the south of the stadium. Large sports lighting towers were located at this field. The grass field was a levelled mound with falls at the margins down toward the Old Kings Oval to the west, river bank terraces to the south and an asphalt paved vehicle car park to the east. An asphalt paved vehicle access ramp had been cut into the eastern embankment with a timber retaining wall supporting the slope to heights of approximately 1.5 m above the ramp level.

An asphalt paved pedestrian area was situated to the east of the stadium extending to the Study Area boundary to the east, comprising the PSC fence line. Several portable shade structures, galvanised iron sheds associated with spectator facilities in addition to entrance gates to the stadium were situated in this area. Stormwater drains were apparent within the asphalt pavements.

The PSC site to the east of the Study Area, was characterised by five in-ground swimming pools with surrounding paved areas and associated infrastructure extending to the Site boundary at O'Connell St. Ground levels generally stepped down from the stadium entrance driveway to the pool level inside the PSC site boundary. Shade and spectator seating structures were located to the east and west of the two northern pools. Grassed areas further surrounded the facilities. In addition to the pools several water slides were present in this southern portion of the PSC, installed on a raised mound that was characterised by shrubs and trees and mulched ground coverings. The centre was bound by security fencing with access via the entrance building from O'Connell St and via trade vehicle from the carpark to the south and the south-west extent of the centre. A pool pump house/filter room was situated in the south-west corner of the PSC site.

### **2.3 Surrounding Landuse**

Cursory inspection of areas surrounding the Study Area identified the following land uses and/or relevant features:

- North - Leagues Leagues Club and surrounds, generally comprising a significant area of paved vehicle parking areas, historically the subject of earthworks to level the site. Several minor fill mounds were apparent at the north-west of the site, close to the Study Area boundary.

- East – O’Connell St road reserve to the north of Site entrance and the Parramatta Swimming Centre to the south of the Site entrance, including pool plant and maintenance facilities adjoining the Study Area boundary at the south-east extent. A school was located beyond O’Connell St;
- South – Parramatta Park, including the Old Kings Oval sports ground and the Parramatta River;
- West – the Parramatta River, beyond which is Parramatta Park.

## 2.4 Topography

A review of the 1:25 000 topographic maps for Parramatta (9130-3N, LPI 2002) and Prospect (9030-2N LPI, 2001) showed that the Site is located within a gently undulating regional topography with a gentle slope towards Parramatta River situated to the west and south of the Site and Study Area.

Reference to the inferred contours presented in AECOM (2016<sup>2</sup>) indicates that ground levels at the Site vary as a result of historical earthworks completed to generate the existing infrastructure and landscaped features present within the Study Area. Topographical features within the various portions of the Study Area comprise the following:

- The stadium playing surface has an average level of approximately 9 m AHD. The stadium spectator mounds at the south and north extent of the stadium have ground levels of approximately 13.5 m to 15 m AHD, respectively;
- The grassed mound to the north of the stadium has a crest elevation of approximately 17.5 m AHD, with ground levels falling to the river bank level of approximately 5 – 6 m AHD to the west of the mound, beyond the extent of the Study Area;
- The car park to the north-east of the stadium has a ground level of approximately 12.5 m AHD with the landscape mounds at the north-east extent having a crest elevation of approximately 15 m AHD.
- Ground levels to the west of the stadium in the vicinity of the groundskeeper’s office and western parking area are approximately 12.5 m AHD.
- The practice field to the south of the stadium has an elevation of approximately 14 m AHD.
- The aquatic centre pool area has ground levels of approximately 10 m AHD, whilst the crest of the water slide mound to the south-east of the Study Area has an elevation of approximately 16 m AHD.

## 2.5 Geology

A review of the 1:100 000 Geological Series “Penrith” Geological Survey of NSW Sheet 9030 (1991) indicates the site and surrounds are underlain by Ashfield Shale of the Wianamatta Group which typically comprises dark grey to black claystone-siltstone and fine sandstone-siltstone laminite. The Ashfield Shale is typically underlain by the older Hawkesbury Sandstone formation.

A review of the regional soil maps for Sydney and Penrith (DLWC 2002) indicated that soil in the vicinity of the site is likely to comprise the residual Lucas Heights Soil Landscape Group in more elevated areas with the potential for the fluvial Birrong Landscape to occur in areas along the river front.

The Lucas Heights Landscape is located in areas of gently undulating crests and ridges on plateau surfaces of the Mittagong formation with alternating bands of shale and fine grained sandstone. Local reliefs of up to 30 m occur with slopes of less than 1 %. Rock outcrops are typically absent and

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<sup>2</sup> Existing Site Topography and Drainage Flow Paths. AECOM AUSTRALIA PTY LTD, 8 June 2016 (AECOM 2016).

the Landscape has been extensively cleared of sclerophyll low forest and woodland. The soils are typically characterised as moderately deep (50 -150 cm), hardsetting yellow podzolic soils and yellow soloths with yellow earths on the outer edges of crests. The soils are noted to be stony with low soil fertility and low available water capacity.

The Birrong Soil Landscape is located in areas of level to gently undulating alluvial floodplain draining Wianamatta Group shales. Local reliefs of up to 5 m occur with slopes of less than 3 %. Broad valley flats also occur and the landscape has been extensively cleared of tall open forest and woodland. The soils are typically characterised as deep (greater than 250 cm) yellow podzolic soils and yellow solodic soils on older alluvial terraces, deep solodic soils and yellow solonetz on current floodplains. The soils are noted to be the subject of localised flooding with a high soil erosion hazard, saline subsoil, seasonal waterlogging and very low soil fertility.

It is noted that there is discussion within various circles with respect to the extent of Birrong and Lucas Heights formations in the vicinity of the Site. As discussed in the Project Aboriginal Heritage Assessment report (AECOM 2016), assessment of the extent of the “Parramatta Sand Sheet” (PSS) soil formation has indicated that this formation is likely to underlie the Site. The PSS is understood to be characterised by interbedded alluvial sand and clay profiles.

## 2.6 Hydrology

Surface water is expected to drain towards Parramatta River either to the west or south of the Study Area. In unpaved areas of the Study Area, precipitation falling on the ground surface is anticipated to infiltrate at a rate reflective of the permeability of the surface soils. In areas occupied by buildings and/or roadways, footpaths and other impermeable surfaces, precipitation is anticipated to be controlled initially by surface water drains associated with buildings and vehicle movement areas and subsequently by subsurface stormwater systems within the Study Area.

It is anticipated that once exposed soil surfaces are saturated, precipitation will migrate laterally across the ground surface toward either the local surface water drainage system or alternatively the adjoining sections of Parramatta River.

An internal underground stormwater network runs around the field, draining to the north. In addition, underground stormwater pipes to the east and west of the stadium also drain to the north. The underground stormwater pipe branches converge to the north-east of the stadium before discharge into Parramatta River.

Beyond the grassed mound to the north of the stadium an overland flow path leads to the north before confluence with stormwater from the Leagues Club and nearby roads before discharging in Parramatta River. In the eastern portion of the Study Area, overland flow paths run to the south, past the extent of the Study Area. To the west of the stadium, overland flow paths converge and discharge into the underground stormwater network as described above.

The regional stormwater network is expected to also discharge into Parramatta River.

A planning certificate previously issued for the Parramatta Stadium (**Appendix B**), indicates portions of land in the vicinity of the Site are affected by a 100 year Average Recurrence Interval Flood as indicated by the Council’s flooding information. Council has a policy covering the entire PCC to restrict development of any land by reason of the likelihood of flooding.

## 2.7 Hydrogeology

A review of registered groundwater bore information obtained from the National Resource Atlas database on 2nd September 2014 indicated the presence of five sets of groundwater bores within a 1.5 km radius of Site. Details of licensed wells and their location are included in **Appendix C** and are summarised in **Table 2.2**.

**Table 2.2 Groundwater Bore Summary Details**

| Groundwater Bore Number | Location (approx. from central portion of site) | Intended Purpose | Drilled Depth (m bgs) | Standing Water Level (m) (bgl) | Water Bearing Zones (m) (bgl)           | Geological Profile   |
|-------------------------|---|------------------|-----------------------|--------------------------------|---|--|
| GW062300                | Approx. 1200 m north of site                    | Industrial       | 100 m                 | N/R                            | 26.1-26.8 m and 63.5-63.8m              | Sandstone at 0.4 m bgl then banded shale and sandstone to 100 m bgl. |
| GW108611                | Approx. 370 m to the east of site               | Domestic         | 60.50                 | 6.20 m                         | 46.1-46.3m and 56.5-56.60 m             | Inter-bedded shale and sandstone from 3 m bgl.                       |
| GW108247                | Approx. 1400 m to the north of site             | Industrial       | 102 m                 | 10 m                           | 14.5-14.8m; 55.0-55.7 m and 80.5-83.5 m | Inter-bedded shale and sandstone from 3 m bgl.                       |
| GW110912                | Approx 1100 m east of the site                  | Monitoring Wells | 10 m                  | 7.0 m                          | 7.0 – 10.0 m                            | Clayey sand, shale from 3.5 m, sandstone from 6.5 m.                 |
| GW1108378               | Westmead Hospital (approx. 1450 m west)         | Industrial       | 282 m                 | N/R                            | 23.0-24.0 m                             | Inter-bedded shale and sandstone from 2 m bgl.                       |

Notes: N/R – Not Recorded

Based on the available geological and groundwater information reported in the license documents, it is anticipated that regional groundwater underlying the site occurs within sandstone/shale bedrock at significant depths. The groundwater is anticipated to occur within zones of relatively higher permeability associated with inconsistencies in the bedrock (faults, joints, weathered zones, etc) and this is anticipated to move, at a regional level, in sympathy with the regional topography and Parramatta River system.

Localised shallow subsoil groundwater seepage may also be expected, particularly following periods of significant wet weather. This would generally occur as a perched condition close to the soil-bedrock interface and/or within the initial highly weathered rock. In addition, perched water conditions may occur along the northern and western Site boundaries associated with the Parramatta surface water corridor. Perched/shallow groundwater is anticipated to flow in a manner consistent with localised bedrock topography, typically occurring toward the west and/or south-west and Parramatta River.

## 2.8 Acid Sulfate Soils

Review of the Acid Sulfate Soil Risk Map for Prospect/Parramatta River indicates that the Site is located within an area of 'no known occurrence of Acid Sulfate Soils'. Acid sulfate soils are not known or expected to occur in areas having this classification.

However, areas adjacent to the Parramatta River to the south of the Site within Parramatta Park are reported to have a 'high probability of Acid Sulfate Soils' in alluvial soil deposits at depths of approximately 1 m to 3 m below ground level. In addition, bottom sediments of the Parramatta River immediately to the west and south of the site are also classed as having a high probability of acid sulfate soil occurrence.

It is noted that the planning certificates included as **Appendix B**, indicate the Site is classed as Class 5 on the Parramatta City Centre LEP 2007 (now LEP 2011), Acid Sulfate Soil Map (Sheet-ASS-001). Reference to Clause 6.1 of the PCC LEP (20011) indicates that for land falling within Class 5, development consent is required for development which may result in the water table being lowered on the adjoining land classified as Class 1, 2, 3 or 4 on the acid sulfate soil map. A consent will only be given when either an acid sulfate soil management plan (ASSMP) has been prepared for

management of the works, or alternatively an assessment has identified that an ASSMP is not required for the works.

Given that the site is not anticipated to be underlain by ASS and works associated with the Site will not include dewatering within the site, or impacting groundwater levels on adjoining land, no further consideration of requirements for ASS management is required.

## **2.9 Meteorology**

A review of average climatic data for the nearest Bureau of Meteorology monitoring location (Parramatta North (Masons Drive) AMO) indicates the site is located within the following meteorological setting:

- Average minimum temperatures vary from 6.2°C in July to 17.6°C in February;
- Average maximum temperatures vary from 17.3°C in July to 28.4°C in January;
- The average annual rainfall is approximately 965 mm with rainfall greater than 1 mm occurring on an average of 90 days per year; and
- Monthly rainfall varies from 46 mm in July to 126 mm in February with the wettest periods occurring on average in January to March.

### 3. Site History

#### 3.1 Aerial Photographs

Aerial photographs from 1930, 1951, 1961, 1970, 1982, 1994, 2005 and 2011 were obtained from the Department of Land and Property Information with printed images included as **Appendix D**.

**1930** A small oval existed within the footprint of the current stadium, lined by trees, with cleared grassed land comprising the remainder of the area. Small building structures were visible along the oval boundary, and approximately 400 m south of the oval. Scattered trees and a loop walking trail were evident along the Parramatta River boundary, consistent with the present day access road to the west side of the Old Kings Oval. Scattered trees were apparent on the slope to the north-west of the oval, toward the river. A dense copse of trees was located in the vicinity of the inferred former mill dam location. An open grassed area extended to the south of the stadium footprint.

Cleared grassed land comprised the area to the east of the oval, being the current day footprint of the PSC, with a tree lined loop walking trail evident on the southern boundary

Land to the north, east, and immediate west appeared to be used for residential purposes, while some agricultural land (suspected market gardens) can be observed from approximately 700 m west of site, on either side of Parramatta River.

**1951** The oval appeared consistent with the previous photograph. The spectator stand structure at the west extent had however been renovated/extended, and additional small structures were noticeable on the boundary of the oval. Several playing fields had been marked out to the south and south-east of the stadium. Minor areas of erosion were apparent along the north-east extent of the access track to the north of the stadium, whilst additional trees were apparent to the north-west of the stadium. A structure consistent with the Ross St gate house was apparent to the north-east of the Site facing O'Connell St.

Within the PSC site, trees appeared to be larger and one of two sports fields marked out to the south of the stadium was partially located within this area of the site, whilst the balance appeared to comprise vacant grassed land.

Increased levels of residential development can be observed to the north and east of Site, and additional building structures are also visible on the cleared grassed land to the west beyond Parramatta River.

**1961** The oval and immediate surrounds appeared similar to the 1951 photograph apart from a fill mound on the eastern boundary of the oval near the PSC site. One field was apparent to the south of the stadium. The remaining areas within this section appeared similar to the 1950 photograph.

The PSC had been established, with one large pool visible in the main area. A building structure was apparent to the south-west of the pool and another to the east of the pool. A possible construction site associated with a second pool was visible to the south-east. Access roads were evident around the area, as was a possible parking area immediately south-west of the buildings. Disturbed ground was apparent in the south-eastern corner.

A large building had been constructed to the north-east of the Site, consistent

with the Parramatta Leagues club to replace two of the several smaller buildings formerly occupying this area.

- 1970** Spectator mounds appeared to have been raised at the extent of the oval, perhaps by filling. Some trees surrounding the oval had also been removed, including those to the north of the oval in the vicinity of the former mill dam. The practice field section was apparent to the south of the stadium as a clear grass area. The Leagues club building had been extended with vehicles parked informally to the south and west of the building and to the north of the oval. The PSC pool area in the south-east Site corner had been completed, as had an additional pool immediately north of the main pool visible in the previous photograph. An additional small structure was visible immediately to the south of the existing buildings. The ground surface of the south eastern corner appeared increasingly disturbed, with many small structures evident. Additional buildings were evident along the eastern boundary. The surrounding land uses appeared similar to the previous photograph, however, further development and modification of buildings in evident in areas.
- 1982** The large building on the western boundary of the oval had been demolished, while several additional small building structures were apparent around the boundary. There were no markings within the oval footprint and the oval fence also appeared to have been removed. The surrounding areas appeared similar to the 1970 photograph. The large building existing in the north-eastern corner appeared to extended toward the south-west. Additionally, the car park area appeared to have been surfaced with asphalt pavements. The PSC appeared similar to the 1970 photograph. A large car park sealed with asphalt was evident to the south of the Site. The surrounding land appeared similar to the previous photograph.
- 1994** A sports stadium approximately consistent with the current facilities layout had been constructed in the vicinity of the former oval. Large grandstand buildings had been construct to the east and west of the playing field, whilst grassed spectator terraces were located to the north and south. An asphaltic paved carpark area been constructed to the north-east of the stadium and paved access paths circled the stadium. The site area to the west bordering Parramatta River appeared altered and some vegetation appeared to have been the subject of a fire or similar. Several small buildings had also been constructed to the west of the stadium. The practice field to the south of the stadium appeared to have been raised and levelled with a paved access track also constructed linking this area to the adjoining carpark to the south-east. The Leagues club development looked similar to the previous photograph, with minor alterations to the car park. The PSC generally appeared consistent apart from the construction of a water slide feature to the south-west of the small pools. The surrounding land appeared similar to the previous photograph, with residential modifications apparent in areas. A new grandstand had been constructed facing the Old Kings Oval to the south west of the Site.
- 2005** Minor modifications were apparent to some parts of the stadium, including

installation of concrete and fixed seating in the lower areas of the terraces to the north and south of the field. Several buildings and a carpark area had also been constructed to the west of the stadium, consistent with the green keeper's facilities. The carpark facilities at the north-east extent of the Site had been modified to extend the asphalt paved area.

The PSC site appeared similar to the previous photograph, although minor modifications were apparent to features around the main pool area.

The surrounding land appeared similar to the previous photograph, with residential modifications apparent in areas.

- 2011** The stadium and surrounds area appeared similar to the previous photograph, with minor modifications apparent to parts of the stadium. The PSC buildings along the eastern Site boundary had been replaced by one large building running parallel to O'Connell Street.

### 3.2 Title Details

As per 2014 land title records presented in **Appendix E**, Parramatta Stadium Trust (now Venues NSW) is the land title holder of the majority of the Study Area, comprising Lots 951 – 959 and 961 - 963 in DP 42643. The balance of the Site, falls within land described as Crown Land Lot 80-3000. Given the heritage assessment information, as discussed in **Section 3.5**, further investigation of historical land title records was considered not to be warranted.

### 3.3 EPA Records

A search of the NSW EPA's public register maintained under the Protection of the Environment Operations Act 1997 was undertaken for the Site and surrounding properties. The results of the search are presented in **Appendix F**. The search identified that there were no current or former prevention, clean-up or prohibition notices for the site and immediate surrounds.

A search of the EPA's public register for current and historical environmental protection licence (EPL) records issued under the POEO act has not identified any documents associated with portions of the site or surrounding properties. A former license surrendered in 2000 was identified for the Parramatta Stadium Trust at O'Connell St Parramatta. Record 4864 related to the discharge of water in wet weather conditions (only). The license as presented in **Appendix F**, indicated that water collected from beneath the playing field could be discharged from the site provided minimum prescribed water quality conditions were demonstrated.

A search was also undertaken through the EPA public contaminated land register and relevant records are included in **Appendix F**. The search identified that there have been no notices issued under the Contaminated Land Management Act 1997 for the Site or any nearby surrounding properties. In addition, there are no records for the Site or adjoining nearby properties associated with NSW contaminated sites notified to the EPA under s.60 of the CLM Act (as of 14 April 2016).

### 3.4 Australian and NSW Heritage Register

A search of the Australian Heritage Trust database and the NSW Heritage Inventory was undertaken and the resulting records are included in **Appendix G**. The search indicated that there are a significant number of heritage items located within or immediately surrounding the Site that have local, NSW and/or Australian heritage significance. These include:

- Cumberland Oval, formally known as Alfred Cricket Oval.
- Stone kerb and guttering along O'Connell Streets;

- Parramatta Park and Old Government House (Item 00596), also referred to as the Parramatta Regional Park and the Former Government Farm / Dodd's Farm, situated to the south of the Study Area;
- Site of the (water) Mill and Millrace, Parramatta Park (PHALMs Archaeological management unit 3247), interpreted as being located to the north of the Study Area.

It is noted that items of state and federal heritage significance occur on properties to the north of the Study Area, including:

- The Cumberland District Hospital Group comprising parts of the site and land to the west of Parramatta River to the north;
- The Girls Training School Precinct (1 Fleet St), also listed under the Norma Parker Correctional Centre and the former Kamballa, Catholic Orphan School approximately 250 m to the north;
- Parramatta Psychiatric Centre Precinct, Fleet St approximately 500 m to the north; and
- River Terraces, Fleet St Parramatta.

Historical site use information included in the heritage inventory has been incorporated with information obtained from the various heritage assessment as discussed in **Section 3.5** following.

### **3.5 Additional Heritage and Historical Site Use Sources**

Based on information included in the NSW and Australian Inventory of Places entries in addition to information provided in AECOM (2016) *Western Sydney Stadium Technical Working Paper: Historical Heritage*, a summary of available information on historical site activities has been prepared. Reference should also be made to extracted images included in this documentation included as **Appendix H**.

#### **3.5.1 Early History**

Prior to European occupation, the river terraces adjoining the Parramatta River were occupied by woodlands dominated by Eucalypt spp. with an open grassy understorey. Mangroves may have colonised the tidal flats adjoining the river, whilst reed paperbarks and rough barked native apple would have been present on the lower terraces.

In 1788, a settlement initially called Rose Hill was established on the south bank of the Parramatta River opposite the Site. The Government Farm (also known as Dodd's Farm), including a cluster of farm buildings and a dwelling was reported to be located close to the northern river bank, comprising the far southern extent of the Site. Records of November 1790 reported approximately 200 acres (81 hectares) had been cleared of native vegetation for agricultural purposes on the river banks. Grazing cattle as well as vegetable and grain cultivation areas were operational by 1791. Records also indicate that a blacksmiths was located within the farm complex. A bridge connected the farm to the settlement on the south side of the river.

Records indicate this site was used until approximately 1801 when farming on the northern River bank ceased and much of the infrastructure was demolished. The farm dwelling, known as Dodd's house stood for another decade, being occupied by visiting naturalist George Caley. Following his departure, the site appears to have been abandoned.

To the north of the Site, construction works associated with a grain mill commenced c.1799, interpreted to be situated in an area near the present day pedestrian crossing bridge across the upper Parramatta River. Construction of the mill required the digging of mill races and formation of a dam to supply water to turn the mill. The dam was identified as formerly being situated within the Parramatta Leagues Club carpark to the north of the Site. The dam was backfilled sometime

between 1920 and 1943 when historical aerial photographs indicated that the dam had been filled and the area was occupied by a dense stand of trees.

Governor King granted 105 acres to the south of the mill to the incoming Governor Bligh in 1806. This land comprised much of the Study Area and land to the south and west to the Parramatta River banks. It was reported that Bligh did not improve the already cleared land or use the pasture, but simply maintained his right to ownership.

Survey information of 1816 indicates the Study Area to be occupied by a cricket oval adjacent to O'Connell St. The 1816 and other later plans show the presence of a water course consistent with the former mill race, cut into the surrounding terrace profile and discharging into the River to the north-west of the Site.

Bligh's land grant was cancelled in 1819, however Bligh and then his executors contested the cancellation until 1841 when the grant was finally surrendered. Governor Macquarie reincorporated Bligh's grant into the Government Domain and from approximately 1823 a road and small timber bridge was built connecting the Domain portion of the west of the river with the Ross St gate house situated to the north-east of the Site facing O'Connell St.

A stone gate house was constructed in the south-east corner of this section c.1830s - 1840s, known as Mud Lodge, located opposite the commencement of Ross Street. The Ross Street or Mud Lodge served as the gate house for the race course for approximately 40 years from 1847 (see below).

In 1857, the *Parramatta Domain Act No. 20 Vic No 35* made provision for the divestment of the Parramatta Domain provided that no less than 200 acres be set aside for a recreational park for the Parramatta Community. By 1887 the northern Domain, including the Study Area and the Old Kings Oval site to the south-west had been re-lain as a park incorporating a series of sports ovals, grassed areas and ornamental tree plantings.

A plan dated 1858 showed that a horse race course approximately ovoid in shape extended from approximately the intersection of Pennant and O'Connell St at the east extent of the Site to the riverbank in the vicinity of the Old Kings Oval at the south-west. It is reported that this racecourse was constructed in 1847 by the Cumberland Turf Club in this area, known at the time as Fox's Paddock or Mud Lodge Paddock. The racecourse was reported to have been constructed on a cleared level area in the Domain. The racecourse moved to Rose Hill in 1885, however it is reported horses were still trained here until 1893.

In 1863 a 'New Cricket Ground' opened at Parramatta, sharing the northern section of the Domain with the racecourse. It is interpreted that the cricket oval was located within the race course circle.

The Ebsworth Crown Plan of 1887 indicated that the Study Area was occupied by two ovals/sports grounds. These comprised a cricket oval facing O'Connell Street to the south of Ross Street. An 'enclosure for Athletic Sports and Games' was shown as a larger oval in the approximate footprint of the current Parramatta Stadium. The eastern portion of the Site was noted to comprise a grassy slope extending to O'Connell St at the east and the river bank at the south. An access track ran from the O'Connell and Ross St intersection, across northern extent of the Site to a causeway over the Parramatta River, crossing the mill race above the dam.

In 1883 Kings School Parramatta leased the southern sports ground and it is anticipated that the cricket oval was subsequently constructed inside the circle of ornamental trees in the area to the south of the Study Area as shown in the 1943 historical aerial photograph.

In 1939, the athletics oval was redeveloped for rugby league use, enlarging the former athletics footprint such that the cricket oval adjacent to O'Connell St was removed with this area became vacant grassed open space. A small grandstand was constructed at the west of the oval. The remaining surrounds comprised earth embankments surrounding the sunken ovoid field.

The Parramatta Swimming Centre facilities were constructed within the park during the period 1958 to 1966.

The Cumberland Oval grandstand at the west extent of the former oval site was burnt down following the 1981 rugby league grand final. The current Parramatta Stadium was subsequently built, officially opening in 1986.

Comparison of survey drawings from the 1800s with the current topography to the north-west of the Stadium indicated significantly different landforms to those previously recorded. The heritage study indicated that it is likely the prominent mounds located to the north of the stadium were created in the 1980s during construction of the current stadium, resulting in this significant modification to the previous topography.

### 3.6 Council Information

Planning records held by the Parramatta City Council (PCC) are discussed in the following sections for representative portions of the Site. Given the limited timeframe available for this assessment, no review of council held development records was undertaken during preparation of this report.

#### 3.6.1 Planning Certificates

A PCC s.149 planning certificate obtained in 2014 is included in **Appendix B** for Lots 951-965 DP42643 relating to the existing Parramatta Stadium property. Relevant information noted in the certificate comprised:

- Parramatta City Centre LEP 2007 applied to the land (at the time of the s.149 certificate preparation) and was affected by a planning proposal seeking to consolidate PLEP 2011 and PCCLEP 2007 (as subsequently completed in December 2015). In addition, the planning proposal also sought to rezone parts of the subject land to RE1 (Public Recreation) under PLEP 2011 and W1 (Natural Waterways) under PLEP2011.
- The land is zoned RE2 Private Recreation zone;
- The land is not affected by any of the matters contained in Clause 59(2) as amended in the Contaminated Land Management Act 1997 as listed:
  - That the land to which the certificate relates is significantly contaminated land;
  - That the land to which the certificate relates is subject to a management order;
  - That the land to which the certificate relates is the subject of an approved voluntary management proposal;
  - That the land to which the certificate relates is subject to an ongoing maintenance order; and
  - That the land to which the certificate relates is the subject of a site audit statement.
- The land is subject to Section 5.4 Preservation of Trees or Vegetation in Parramatta Development Control Plan (PDCP) 2011.
- The land is not identified as being affected by implementation of the Coastal Protection Act 1979 or proclaimed to be within a mine subsidence district within the meaning of Section 15 of the Mine Subsidence Compensation Act 1961.
- The land is not affected by a policy adopted by council to restrict the development of the land by reason of the likelihood of projected sea level rise (coastal protection), tidal inundation, subsidence or any other risk.
- The land is not bushfire prone land.

- The land is affected by a planning proposal seeking to include the land within Schedule 5 Environmental Heritage of PLEP 2011.
- The land is identified as containing a Heritage Item in PCCLEP 2007.
- The land is not located within a heritage conservation zone.
- Land within the site falls within Acid Sulfate Soil Class 5 for the purposes of PCCLEP 2007. As such development consent is required for carrying out of works described in the Table clause 33B of the PCCLEP 2007;
- The land is affected by a 100 year Average Recurrence Interval flood.

### **3.7 Integrity Assessment**

The information obtained from formal published sources noted above has been found to be in general agreement regarding the history of the site.

Based on the range of sources and the general consistency of the historical information, it is considered that the historical assessment has an acceptable level of accuracy with respect to the potentially contaminating activities historically occurring at the Site.

## 4. Previous Site Contamination Investigation Information

As part of this assessment, a number of previous site investigation reports completed within the Site have been identified, including:

- *Report on Site Investigation Cumberland Oval Redevelopment, Parramatta*. D.J Douglas and Partners Pty Ltd, 31 July 1984, SSI/8502 (DP 1984);
- *Additional Soil Investigations at Parramatta Stadium Carpark*. WSP Australia, 3 May 2007 (WSP 2007)
- *Report to Venues NSW on Preliminary Contamination Screening for Proposed Stadium Upgrade at Parramatta Stadium, O'Connell Street, Parramatta*. Environmental Investigation Services (EIS), ref: E27070KHrpt dated 20 January 2014 (EIS 2014a);
- *Report to Venues NSW on Preliminary Contamination Screening for Proposed Stadium Upgrade at Parramatta Stadium, O'Connell Street, Parramatta*. Environmental Investigation Services (EIS), ref: E27070KH2rpt dated 6 February 2014 (EIS 2014b); and
- *Report to Venues NSW on Additional Asbestos Screening for Proposed Stadium Upgrade at Parramatta Stadium, O'Connell Street, Parramatta*. Environmental Investigation Services (EIS), ref: E27070KH2rpt2 dated 10 April 2014 (EIS 2014c).
- *Pirtek Stadium Parramatta Proposed North and South Stand Upgrade Works, Excavation Envelope Material Characterisation Assessment Summary*. JBS&G Australia Pty Ltd, 22 April 2015 (JBS&G 2015a).
- *Pirtek Stadium Parramatta Proposed North and South Stand Upgrade Works, High Voltage Cable (HVC) Route Fill Material Characterisation Assessment*. JBS&G Australia Pty Ltd, 21 April 2015 (JBS&G 2015b).
- *Pirtek Stadium Parramatta Proposed North and South Stand Upgrade Works, Additional Fill Material Characterisation Assessment – South Stand Excavation Zone*. JBS&G Australia Pty Ltd, 18 May 2015 (JBS&G 2015c).
- *Pirtek Stadium Parramatta - West Carpark, Asbestos in Soil Preliminary Assessment*. JBS&G Australia Pty Ltd, 18 May 2015 (JBS&G 2015d).
- *Pirtek Stadium Parramatta – Management of Subsurface Asbestos Impacts, Former Practice Field Area South of the Stadium*. JBS&G Australia Pty Ltd, 21 May 2015 (JBS&G 2015e).

The scope and identified outcomes of the previous geotechnical and site contamination activities are summarised following.

### 4.1 Cumberland Oval Redevelopment Geotechnical Investigation (DP 1984)

NSW Public Works engaged DP to complete a geotechnical investigation of subsurface conditions prior to construction of the current Parramatta Stadium infrastructure to provide information on excavation and foundation conditions for a proposed grandstand. At the time of the investigation, the Site was described as comprising an existing oval surrounded by grassed banks approximately 2 – 3 m in height.

The investigation included 14 boreholes within the proposed stadium and playing field footprint and 6 boreholes to the east, north and west of the proposed stadium for the purposes of pavement design. At the time of the investigation, the playing field surface was reported to have an RL of approximately 12.5 to 13 m and ground levels on the surrounding spectator mounds in the range of RL 12.4 m to RL 15.7 m.

The stadium footprint investigation locations identified that prior to commencement of construction the presence of fill material, generally dark brown and red brown sand and clayey sand of likely localised origin extended to RLs of approximately 9.3 to 11.7 m at the east of the stadium and underlying the playing field. Underlying the proposed western stand and further to the west, the base of fill material was reported at elevations of approximately RL 7.5 to 11.3 m.

Underlying the fill material at the site natural soils were identified as red brown sand to sandy clay, consistent with apparently alluvial river terrace deposits extending to depths of 7.3 m to 12.8 m bgs (RL 1.0 to RL 5.5 m). Bedrock was noted to comprise a highly weathered shale profile approximately 1 – 3 m thick overlying sandstone at elevations in the range of approximately RL – 0.6 to RL 4.8. Groundwater was noted at elevations of approximately RL 7 to RL 8 at the time of the investigation.

#### **4.2 Additional Soil Investigations Parramatta Stadium Carpark (WSP 2007)**

As part of proposed extensions to the Parramatta Stadium Carpark, comprising works proposed at the north-east extent of the Site, WSP was engaged to assess material within an existing landscaped mound and also at one location to the north of the Parramatta Swimming Centre where asbestos in soil had been identified during previous works (report unsighted).

The report documented the completion of sampling and subsequent laboratory analysis results from 5 locations in the north-east extent of the Site and 4 locations to the north of the aquatic centre. Laboratory analysis for contaminants of potential concern including heavy metals, PAHs, TRH, BTEX, OCPs and PCBs identified contaminant concentrations were less than the adopted site assessment criteria (NEPC 1999 HIL E) as summarised in **Tables A and B**.

It was reported that during the initial investigation works (report unsighted), asbestos in soil results for representative samples collected from near surface fill material in the landscaped mound at the north-east of the site did not identify the presence of asbestos at the laboratory limit of reporting.

Prior to the reported investigation, asbestos in soil was reported to have been identified at one sample location (B8, 0.5 m bgs) to the north of the Parramatta Swimming Centre as shown in **Figure 3**. The sampled material comprised fill material with building rubble (plaster and brick) inclusions. The WSP (2007) investigation included four additional sampling locations with sampling in topsoil at a depth of approximately 0.1 m bgs. No asbestos was reported to have been identified by field staff during sampling or by the laboratory in these delineation samples. JBS&G note it is unclear as to the justification for delineation of contaminated material at a depth of 0.5 m in fill via collection of topsoil samples at 0.1 m bgs.

WSP recommended that the 'delineated' extent of asbestos in soil at the nominated location be excavated and removed from the site to a licensed landfill, or alternatively discussions be held with Council regarding potential opportunities to maintain this material on site under management.

JBS&G note that based on the provided information it is unclear as to whether the identified asbestos impacted material and also the mound material subsequently excavated was reused on site or removed off-site to a landfill facility.

#### **4.3 Preliminary Contamination Screening EIS (2014a)**

The report identified that EIS was engaged by Venues NSW to complete a preliminary assessment of potential contamination conditions in three limited areas within the Study Area comprising the north and south terraces of the stadium and the man-made hill (mound) immediately to the north of the stadium. Detailed assessment plans and borehole logs are included in **Appendix I** and the laboratory analysis results from this investigation are summarised in **Tables A and B**.

Information provided to EIS indicated that the former Cumberland Oval grandstand was destroyed by fire and subsequently demolished in 1981. The current stadium was then constructed, including lowering the playing field level and construction of the mounds comprising the terraces etc. No

information was provided as to the source of the fill material used to construct the existing features.

The objective of the assessment was to identify the potential risk for widespread soil contamination within the two terrace areas and assess the potential suitability of fill material within the mound for re-use during upgrade of the stadium. The scope of work was limited to a review of information provided to EIS, preparation and implementation of a field and laboratory sampling plan, comparison of the data with adopted site assessment criteria and preparation of an assessment report.

Potential areas of concern (AECs) and associated contaminants of potential concern (COPC) at the site were identified by EIS:

- Fill material of unknown origin used to form existing site levels: heavy metals, total petroleum hydrocarbons (TPH), monocyclic aromatic hydrocarbons (BTEX), organochlorine pesticides (OCPs), organophosphate pesticides (OPPs), polychlorinated biphenyls (PCBs) and asbestos; and
- Potential use of Hazardous Building Materials (HBM) associated with the former stadium: asbestos, lead and PCBs.

The adopted site assessment criteria were based on commercial/industrial land use exposure scenarios as presented in NEPC (2013).

The site investigation activities included the completion of boreholes on an approximately systematic sampling grid as follows:

- Three borehole locations in the southern terrace footprint;
- Three borehole locations in the northern terrace footprint; and
- Five borehole locations in the man-made fill mound to the north of the stadium.

The boreholes completed at locations as shown in **Figure 3**, identified the following strata in the three investigation areas:

- Stadium South Terrace: Clayey sand, sandy silty clay and sand fill material with anthropogenic inclusions extended to depths of up to approximately 3.8 m below ground surface (m bgs). No suspected ACM was reported to have been identified in the fill material. The fill material was underlain by natural silty clay and sandy clay/clayey sand soils to depths of approximately 10.7 m to 14.5 m bgs. Sandstone bedrock was confirmed underlying the natural soil. Groundwater was identified during drilling at depths of approximately 7.7 m to 10.1 m bgs.
- Stadium North Terrace: Clayey sand, sandy silty clay and sand fill material with anthropogenic inclusions extended to depths of up to approximately 3.7 m bgs. No suspected ACM was reported to have been identified in the fill material. The fill material was underlain by natural silty clay and sandy clay/clayey sand soils to depths of approximately 11 m to 16 m bgs. Sandstone bedrock was confirmed underlying the natural soil. Groundwater was identified during drilling at depths of approximately 7.5 m to 15 m bgs.
- Fill Mound North of the Stadium: Four of the five boreholes were terminated in fill material at depths of up to approximately 6 m bgs as a result of encountering suspected fibrous ACM. The fill material typically consisted of silty clay, clayey sandy silt and silty sand with anthropogenic inclusions. ACM fragments were identified within the soil fill material matrix, generally at depths of greater than 0.4 m bgs.

A total of 14 fill material samples were selected for laboratory analysis for the full range of potential contaminants of concern identified above. One natural soil sample was analysed for chemical contaminants (excluding asbestos). In addition, five suspected ACM fragments were analysed for the presence of asbestos.

As summarised in **Tables A** and **B**, all chemical contaminant concentrations in analysed fill material and natural soil samples were reported at levels less than the adopted site assessment except for B(a)P within BH2 2.8\_2.3, with a concentration of 1.1 mg/kg, which slightly exceeds the public open space ESL of 0.7 mg/kg.

Representative soil samples screened for asbestos from the south and north terrace areas were reported to have asbestos in soil concentrations less than the laboratory limit of reporting (LOR).

Asbestos was identified in representative samples of fibre cement and fibrous material debris encountered within the soil fill material matrix within the fill mound to the north of the stadium. Several boreholes encountered material considered likely to comprise friable asbestos. Samples of silty clay and silty sand fill material encountered as near surface material in the mound, overlying the asbestos impacted material, were reported to have asbestos in soil, although present at trace concentrations, less than the laboratory LOR.

The report concluded that the asbestos impacts were likely to be limited to the extent of fill material in these areas, however the extent of the fill material was not fully assessed due to the risks associated with the suspected friable asbestos at a number of sampling locations.

It was recommended that an environmental management plan (EMP) be prepared to address management of the ongoing containment of asbestos within the man-made mound to the north of the stadium.

#### **4.4 Preliminary Contamination Screening EIS (2014b)**

The report identified that EIS were engaged by Venues NSW to complete a preliminary assessment of potential contamination conditions in two limited portions of the Study Area comprising the eastern grandstand and terrace of the existing stadium and the practice field to the south of the stadium. At the time of the investigation the practice field comprised a grassed open space. Detailed assessment plans and borehole logs are included in **Appendix J** and the laboratory analysis results from this investigation are summarised in **Tables A** and **B**.

The objective of the assessment was to identify the potential risk of widespread soil contamination within the two terrace areas and assess the potential suitability of fill material within the mound for re-use during upgrade of the stadium. The scope of work was limited to a review of information provided to EIS, preparation and implementation of a field and laboratory sampling plan, comparison of the data with adopted site assessment criteria and preparation of an assessment report.

Potential areas of concern (AECs) and associated contaminants of potential concern (COPC) at the site were identified by EIS:

- Fill material of unknown origin used to form existing site levels: heavy metals, total petroleum hydrocarbons (TPH), monocyclic aromatic hydrocarbons (BTEX), organochlorine pesticides (OCPs), organophosphate pesticides (OPPs), polychlorinated biphenyls (PCBs) and asbestos; and
- Potential use of Hazardous Building Materials (HBM) associated with the former stadium: asbestos, lead and PCBs.

The adopted site assessment criteria were based on commercial/industrial land use exposure scenarios as presented in NEPC (2013).

The site investigation activities included the completion of boreholes on an approximately systematic sampling grid as follows:

- Three borehole locations in the eastern grandstand footprint; and
- Eight borehole locations in the practice field footprint.

The boreholes located as shown in **Figure 3** identified the following strata in the two investigation areas:

- East Grandstand: fill material comprising gravelly sandy, sandy clay, clayey sand and sandy silt were encountered at all three sampling locations to depths of 0.2 m to 0.65 m bgs. The fill material contained inclusions of various gravels, ash and root fibres. Natural soils including silty clay and sandy clay were encountered beneath the fill material, with interbedded sandstone and sandy clay encountered at depth.
- Southern Practice Field: Silty clay, sandy clay, clayey sand and sand fill material with inclusions of various rock gravels, ash and root fibres were encountered to depths of between 1 m and 2.6 m below ground surface. Natural soil comprising silty clay, silty sandy clay, sandy clay, sand and sandy silt were encountered underlying the fill material. Groundwater was identified as standing water following completion of drilling at depths of approximately 7.5 m to 12.5 m bgs.

No suspected asbestos containing material fragments were reported to have been identified during these sampling activities. A total of 17 fill material and 7 natural soil samples were selected for laboratory analysis for the full range of potential contaminants of concern identified above.

As summarised in **Tables A** and **B**, all chemical contaminant concentrations in analysed fill material and natural soil samples were reported at levels less than the adopted site assessment criteria. Representative soil samples screened for asbestos from the east grandstand were reported to have asbestos in soil concentrations less than the laboratory limit of reporting (LOR). Laboratory analysis of a sample collected from the south-east of the practice field (BH101, 2.6 m) identified the sample to contain chrysotile asbestos fibres, whilst asbestos concentrations in all other samples from this area were reported to not have asbestos in soil above the laboratory LOR.

EIS considered the source of the asbestos contamination was likely associated with low levels of demolition rubble within fill material underlying the practice field. The report concluded that the asbestos impacts were likely to be limited to the extent of fill material in these areas, however the extent of the fill material was not fully assessed due to the risks associated with the suspected friable asbestos at a number of sampling locations. It was recommended that further investigation as to the potential extent of asbestos contamination was required within the practice field area and subsequent to this a remedial/management strategy be developed to manage the identified contamination risks such that the site could be rendered suitable for the proposed land use.

#### **4.5 Preliminary Contamination Screening EIS (2014c)**

The report identified that EIS were engaged by Venues NSW to undertake an additional assessment of potential assessment of potential contamination conditions in the practice field to the south of the Stadium. The objective of this assessment was to better characterise the potential for widespread asbestos in soil impact within the practice field portion of the stadium surrounds.

The scope of work was limited to a review of information provided to EIS, preparation and implementation of a field and laboratory sampling plan, comparison of the data with adopted site assessment criteria and preparation of an assessment report.

The additional site investigation activities comprised installation of an additional thirteen boreholes, resulting in a systematic grid spacing with approximately 20 m between sampling

locations at locations as shown in **Figure 3**. Detailed assessment plans and borehole logs are included in **Appendix K**.

The boreholes identified fill material underlying the site at depths of 1.7 m to 2.8 m bgs. The fill material typically consisted of silty clay, sandy clay, clayey sand and silty sand with variable inclusions. Suspected ACM fibre cement fragments were identified during drilling in 6 of the additional 13 boreholes. Natural silty clay soils were encountered beneath the fill at all boreholes.

A total of 21 suspected ACM fragments collected during the investigation were confirmed by the laboratory to contain asbestos fibres. Thirty three fill and 2 natural soil samples were screened for asbestos with the results summarised in **Tables A** and **B**. Asbestos in soil was reported above the laboratory LOR in four samples located as presented in **Figure 5**, with one sample reporting the presence of asbestos fibres at concentrations below the LOR. Fibre cement bundles (asbestos fines) were reported in three of the samples collected from depth intervals of approximately 0.5-0.95 m bgs.

The assessment indicated that the asbestos impacts, comprising non-friable ACM and asbestos fines were distributed randomly throughout the placed fill material, considered to comprise the source of the contamination.

EIS considered that as a result of the depth and immobile nature of the asbestos contamination, it represented a low risk to human receptors provided the site remained in the condition at the time of the investigation. However, should fill material be disturbed, the risk would increase. It was recommended that such risks could be addressed via implementation of an appropriate management strategy during future site works.

#### **4.6 North and South Stand Excavation Envelope Characterisation Assessment (JBS&G 2015a)**

JBS&G was engaged by Venues NSW to complete material characterisation assessment works for soils proposed to be excavated during construction activities associated with upgrade of the north and south stands. The initial objective had been to confirm the suitability of material for beneficial reuse either on-site or at an alternative off-site location. As a result of the identification of asbestos in soil during the initial sampling and laboratory analysis program, additional investigation activities, including increased sampling density and laboratory analysis was incorporated into the scope of work to facilitate an informed discussion of potential management options during the proposed construction works.

This letter provided an overview of the completed investigation works as completed at the time of preparation for consideration of Venues NSW, including the installation of 14 test pits on an approximately even spacing and subsequent analysis of representative samples for contaminants of potential concern including heavy metals, PAHs, TRH, BTEX and asbestos in addition to tests required to assess the material under a beneficial reuse exemption. Material was evaluated against waste classification criteria.

Six locations within the northern stand and 8 locations in the southern stand as shown in **Figure 3**, identified the presence of gravelly sand fill material with inclusions of igneous and sandstone gravel, concrete, river pebbles, glass and terracotta fragments. No visible ACM fragments, odours or staining were observed during the field investigation. Where encountered, the natural soil comprised yellow sand. Field investigation details are provided in **Appendix L**.

Laboratory analysis results as summarised in **Tables A** and **B**, identified asbestos fibre cement debris and/or loose fibre bundles in fill material at depth at 2 locations in the north stand and four locations in the southern stand as shown in **Figure 5**. The asbestos in soil impacts were considered, under WorkSafe NSW definitions to comprise friable asbestos. Chemical contaminants were noted at concentrations falling within the General Solid Waste category for off-site disposal to landfill.

Alternatively, it was considered, should a suitable location be identified, that the material could potentially be retained on site within a containment cell, subject to ongoing management.

#### **4.7 HVC Route Characterisation Assessment (JBS&G 2015b)**

Subsequent to completion of the material characterisation works as outlined above, Venues NSW requested that an investigation be completed of subsurface conditions within the proposed trench alignment for installation of a new HVC service such that appropriate management measures could be addressed should additional asbestos impacts be identified.

The scope of works included installation of 5 test pits along with the proposed route to enable representative samples to be collected and submitted for laboratory analysis. The route and associated sample locations as shown in **Figure 3**, was situated within the current public domain to the north of the northern stand in the north of the Study Area.

The sampling locations encountered pavements and/or grass/landscaping overlying clay/sandy clay or silty sand fill material with inclusions of igneous gravel and roots and in some instances demolition rubble. The fill material varied in depth from 0.4 m bgs to greater than 2.0 m bgs. As summarised in **Tables A and B**, seven fill samples were analysed for contaminants of potential concern. Loose asbestos fibre bundles or fibre cement debris were identified during laboratory analysis in 3 of the 7 samples. Other chemical contaminants were not identified at concentrations that were considered to be of concern and all fell within the GSW thresholds.

It was recommended that fill material disturbance activities should be undertaken under friable asbestos management conditions.

#### **4.8 South Stand Excavation Zone Additional Characterisation Assessment (JBS&G 2015c)**

JBS&G was requested to complete additional investigation works in the east portion of the southern stand excavation zone with the objective of better characterising the potential presence of asbestos in soil contamination in this area of the site. The scope of work comprised the installation of three additional test pit locations and subsequent laboratory analysis of representative samples. It is noted that existing underground irrigation pipework and other below ground services in this area constrained opportunities for investigation locations.

The 3 additional sampling locations are shown on **Figure 3** and the resulting analysis results are presented in **Tables A and B**, supporting investigation documentation is provided in **Appendix L**. Fill material comprising red brown sandy clay fill initially with few inclusions and then at depths of greater than approximately 1m with inclusions of gravel, concrete and terracotta fragments and igneous gravel was encountered to the termination depth of TP01-S and TP02-S in fill at approximately 1.5 m and 2 m respectively. No visible ACM was identified in the test pit spoil during the field investigation. Six representative samples were analysed for asbestos in soil with concentrations of asbestos detected in one sample TP03-S (0.3-0.4 m) comprising loose fibre bundles as shown in **Figure 5**. Chemical contaminant levels were reported to be less than the GSW thresholds.

#### **4.9 West Carpark Preliminary Investigation (JBS&G 2015d)**

Following identification of asbestos impacted soil within the proposed north and south stand upgrade areas, JBS&G completed limited investigation works to assess conditions underlying the western carpark with the objective of evaluating the potential for on-site containment of excavated asbestos impacted material. The scope of work comprised the installation of 5 test pits in accessible areas of the carpark as shown in **Figure 3** and subsequent laboratory analysis of representative soil samples. The laboratory analysis results for the selected samples are summarised in **Tables A and B**.

Fill material of variable composition was encountered underlying the pavements to depths of between 0.3 m bgs and greater than 2.5 m bgs, generally being greatest at the northern extent of the area. Whilst a portion of the fill material was noted to comprise building rubble, no suspected ACM was noted during the sampling activities.

Laboratory analysis for the presence of asbestos in soil identified asbestos fragments and/or loose fibre bundles in samples from TP02-W (0.2-0.3) and TP03-W (0.1-0.3) as presented in **Figure 5**. Chemical contaminant levels were reported to be less than the GSW thresholds.

#### **4.10 Asbestos Assessment Former Practice Field Area South of Stadium (JBS&G 2015e)**

JBS&G were requested by Venues NSW to complete an assessment of potential asbestos management requirements associated with the southern area of the Site, known as the former Practice Field Area. As discussed above, a number of site investigation activities had been completed in this portion of the Site that had identified the presence of asbestos in soil. As a result of the findings, Venues NSW was evaluating potential alternative site development/upgrade options to that considered at the time of the initial assessment reports.

JBS&G personnel completed an inspection of the practice field to assess whether conditions remained as noted at the time of the initial assessment works and reviewed in detail the existing site investigation data.

Based on the inspection and previous investigation data, JBS&G considered that the presence of a grassed discrete non-asbestos impacted stratum of approximately 0.1 m to 0.15 m overlying the impacted asbestos and the vegetation cover, the site was considered suitable for ongoing recreational/public use, subject to maintenance of the ground condition.

Protocols as outlined in a site asbestos management plan (AMP) were recommended for any site activities that may result in disturbance of the ground surface and/or discrete non-asbestos impacted topsoil profile such that no unacceptable exposure risks to site workers, users and/or visitors may occur.

## 5. Conceptual Site Model

### 5.1 Potential Areas of Environmental Concern

Based on the history review and field observations from the site, general areas of environmental concern have been categorised and are presented in (Table 5.1).

**Table 5.1 Areas of Environmental Concern and Associated Contaminants of Potential Concern**

| Area of Environmental Concern (AEC)  | Contaminants of Potential Concern (COPC)     |
|--|--|
| Potential presence of imported fill material to generate current site development levels, including modification of ground levels resulting in landscaped mounds within the Site | Heavy metals, TPH, PAHs, OCPs/PCBs, asbestos |
| Impacts associated with burial of ACM and soil impacted with ACM during previous stadium construction activities   | Asbestos                                     |
| Impacts associated with hazardous building materials from within existing and former site buildings  | Asbestos, lead, PCBs                         |
| Impacts associated with maintenance of grounds keeper plant including lawnmowers etc within maintenance areas of the site  | TPH/BTEX, PAHs, phenolics, VHCs              |
| Application of pest control chemicals during site/stadium maintenance activities   | OCPs/OPPs, heavy metals                      |
| Impacts associated with fire damage to former buildings/stands   | Asbestos, PAHs, heavy metals                 |
| Potential impacts associated with electrical transformers situated in the northern portion of the site.  | TRH, PCBs                                    |

### 5.2 Potentially Contaminated Media

Based on the available historical and current site use information, fill material in the various portions of the site is considered to be a potentially contaminated media based upon:

- The potential for fill material at the Site to contain waste materials associated with historical site activities, including demolition waste which may include lead and/or asbestos, particularly in the vicinity of the former Cumberland Oval stadium;
- The presence of fill material as surface soils in areas where previous buildings containing HBM including asbestos and/or lead paint may have been demolished without appropriate controls to minimise the potential for contamination of surface soils with material debris; and
- Fill material as surface soils in areas where chemicals have been applied in site maintenance activities including pesticides and herbicides.

Natural soils underlying the Site are considered to be potentially impacted media based upon:

- The potential for natural soils to occur at or in the vicinity of the ground surface in areas of the site where chemicals may have been applied during maintenance activities;
- The potential for natural soils to occur at, or in the vicinity of the ground surface underlying former buildings with the potential to have been impacted as a result of debris from buildings that contained HBMs including asbestos and/or lead paint; and
- the potential leachability of the identified contaminants and the disturbed/filled nature of various portions of the site, which have potentially been impacted by historical site activities.

Given the deep levels of groundwater anticipated to occur across the majority of the Site and the relatively low probability of mobile contaminants in fill material and/or natural soils, it is considered that there is a low probability that groundwater will have been significantly impacted as a result of site conditions. However, as the potential for contamination of groundwater will depend upon the actual nature, occurrence and characteristics of contamination within the overlying fill

material and potentially natural soils, of the potential for contamination of groundwater at the Site has been further considered.

### 5.3 Potential For Migration

Contaminants generally migrate from site via a combination of windblown dusts, rainwater infiltration, groundwater migration and surface water runoff. The potential for contaminants to migrate is a combination of:

- the nature of the contaminants (solid/liquid and mobility characteristics);
- the extent of the contaminants (isolated or widespread);
- the location of the contaminants (surface soils or at depth); and
- the Site topography, geology, hydrology and hydrogeology.

The potential contaminants identified as part of the site history review and previous investigations are generally in either a solid form (e.g. heavy metals, asbestos, etc.) and liquid form (e.g. fuel, pesticides, etc.), however, dependent upon concentrations, there is the potential for TRH/VOC impacts to occur in a vapour form also in soils underlying the site as noted above.

Given the variety of ground surface treatments at the site, varying from permanent pavements, overgrown vegetative cover, to mulch and areas of exposed soil, the potential for migration of solid contaminants via wind blown dust is considered variable. In areas of permanent pavement or dense vegetative cover, the potential for migration of dust including asbestos fibres, lead, ash, etc. will be low. However, in areas with poor ground cover, the risk is much greater.

The potential for surface water migration of such contaminants and also infiltration of groundwater and migration through the soil profile is similarly variable. In vegetated areas prone to water logging, or where there is an elevated potential for infiltration of surface water via leakage of subsurface stormwater infrastructure as a result, the potential for infiltration of dissolved contaminants is considered comparably elevated. Such conditions have the potential to result in the migration of contaminants from the soil to the groundwater system underlying the site.

### 5.4 Potential Exposure Pathways

Based on the contaminants of potential concern identified in various media as discussed above, existing site uses and with consideration of future potential site development activities, the exposure pathways considered to be potentially complete for the Site currently, during and following development works include:

- Potential dermal and oral contact to impacted soils as present at the ground surface by future site occupants, casual users and/or workers and at shallow depths as may be accessible to site workers in service excavations across the extent of the Site;
- Potential contaminant uptake by vegetation established in the various vegetated areas of the Site, potentially including large street tree plantings and landscaped areas; and
- Potential dermal, inhalation and oral contact to impacted soils and/or groundwater during future infrastructure and/or foundation excavation works as may be required during Site development works.

At this stage, it is not anticipated that any groundwater extraction will occur over the area of the Site in the future. However, short term dewatering may occur to facilitate installation of services at depth, where required.

## 5.5 Receptors

Potential receptors of environmental impact present within the Site which will require to be addressed with respect to the suitability of the Site for the proposed use include:

- Future site users of public open space, sports facilities and landscaped or non-paved areas whom may potentially be exposed to COPCs through direct contact with impacted soils and/or inhalation of dusts / fibres associated with impacted soils; and/or
- Excavation / construction / maintenance workers conducting activities at or in the vicinity of the Site, who may potentially be exposed to COPCs through direct contact with impacted soils and/or groundwater present within excavations and/or inhalation of dusts / fibres associated with impacted soils;
- Flora species established in the vegetated areas of the Site inclusive of large trees; and/or
- The aquatic ecosystem of Parramatta River located hydro-geologically downgradient of the site.

Where petroleum or other volatile hydrocarbon compound impact is identified, potential inhalation exposure to vapours will also require to be considered.

## 5.6 Preferential Pathways

For the purpose of this assessment, preferential pathways have been identified as natural and/or man-made pathways that result in the preferential migration of COPCs as either liquids or gases.

Man-made preferential pathways are present throughout the Site, generally associated with historical and/or current underground services infrastructure and in areas of fill material in various areas of the site. Fill materials are anticipated to have a higher permeability than the underlying natural soil and/or bedrock.

Sub-surface services are also present throughout the Site at near surface depths. Preferential pathways can be formed by the generally higher permeability backfill used to re-instate these trenches.

Preferential pathways are also important in the assessment of potential off-site sources of COPCs. Preferential pathways are potentially present in the adjoining road network, as associated with service easements.

## 6. Sampling Analysis and Quality Plan

### 6.1 Data Quality Objectives

DQOs are statements that define the confidence required in conclusions drawn for data produced for a project, and which must be set to realistically define and measure the quality of data needed.

DQOs were developed for the investigation, as discussed in the following sections.

#### 6.1.1 State the Problem

Previous assessment of ground conditions including site contamination assessment activities has identified the presence of fill material to variable depths underlying the Site. Targeted investigation in areas of previously proposed development works has in some instances identified the presence of asbestos impacted soil, that will require management prior to or during future redevelopment of the Site.

A review of the nature and extent of contamination conditions at the Site has identified the absence of available site contamination characterisation information within portions of the Site, particularly within the current playing field footprint and to the east of the current stadium.

In order to appropriately characterise conditions within the Study Area (comprising currently accessible portions of the Site) such that decisions may be made with respect to the extent of site management/ remediation required, a program of systematic and targeted soil and groundwater sampling and analysis is needed.

Information on potential Site contamination conditions presented in earlier sections of this report resulted in the conceptual Site contamination information presented in **Section 5** of this report, which together form a CSM.

#### 6.1.2 Identify the Decisions

Based on the decision making process for assessing urban redevelopment sites detailed in DEC (2006<sup>3</sup>), modified to meet the specific project objectives, the following decisions must be made:

- Are there any unacceptable risks to likely future on-site receptors from impacted soils during development?
- Are there any issues relating to local area background soil concentrations that exceed the appropriate soil criteria?
- Are there any impacts of chemical mixtures?
- Are there any aesthetic concerns in fill soils present at the site?
- Is there any evidence of, or potential for, migration of contaminants off-site?
- Is a site management strategy required?

In addition to the aforementioned, where soil and/or groundwater contamination is identified, data needs to be obtained to facilitate the preparation of appropriate advice regarding potential remedial / management strategy(ies) applicable during the proposed demolition and future redevelopment works project stages.

#### 6.1.3 Identify the Inputs to the Decision

Inputs to the decisions included:

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<sup>3</sup> *Contaminated Sites – Guidelines for the NSW Site Auditor Scheme (2nd Edition)*. NSW Department of Environment and Conservation 2006 (DEC 2006)

- Information presented in previous site investigation report(s) as discussed in **Section 4**;
- Detailed Site inspection;
- Desktop assessment and historical Site use review;
- Identified AECs and associated COPC;
- Advancement of fifty-seven soil bores and conversion of four sample locations into groundwater monitoring wells;
- Collection of soil and groundwater samples;
- Identification of appropriate assessment criteria for assessment of field and analytical results;
- Laboratory analysis of samples of potentially contaminated media for COPC; and
- Confirmation that data generated by sample analysis are of an acceptable quality to allow reliable comparison to assessment criteria by assessment of quality assurance / quality control (QA/QC) as per the data quality indicators established in **Section 6.7**.
- Specifically, sufficient data need to be collected from each of the identified potentially impacted media (e.g. fill material, natural soils and groundwater) in the identified AECs for the associated COPC (**Table 5.1**).

#### 6.1.4 Define the Study Boundaries

The Site comprises an irregularly shaped parcel of land situated west of O’Connell Street, Parramatta, NSW as shown in **Figures 1** and **2**. As a result of access limitations, the Study Area has been defined as the portion of the Site excluding the current PSC land as shown in **Figure 2**. The Study Area is legally defined as Lots 951, 953, 954, 955, 956, 958, 959, 961, 962 and 963 in Deposited Plan (DP) 42643 and occupies an area of approximately 72 421 m<sup>2</sup>. The lateral study boundary is defined as the Site shown in **Figure 2**.

The maximum vertical extent of the soil investigation generally comprised a minimum of 0.5 m into natural soil, or where groundwater monitoring wells were installed, a minimum of 2 m below groundwater seepage. On this basis, the maximum vertical extent of investigation was 11.2 m bgs.

Due to the project objectives, seasonality was not assessed as part of this investigation. Data was therefore representative of the timing and duration of the current investigation.

#### 6.1.5 Develop a Decision Rule

The decision rules are outlined as follows.

Site investigation analytical data was assessed against EPA endorsed human health and ecological based criteria (as appropriate) provided in the *National Environment Protection (Assessment of Site Contamination) Measure*, National Environment Protection Council, 2013 (NEPC 2013).

The decision rules adopted to answer the decisions identified in **Section 6.1.2** are summarised in **Table 6.1**.

**Table 6.1: Summary of Decision Rules**

| Decision Required to be Made  | Decision Rule  |
|---|--|
| 1. Are there any unacceptable risks to on-site future receptors from soils? | Soil analytical data was compared against EPA endorsed criteria including NEPC (2013) contaminant thresholds.<br>If one or more concentrations of contaminants at one or more sampling locations were reported above the adopted EPA endorsed criteria, the answer was Yes.<br>If all concentrations of contaminants were reported to be below the adopted EPA endorsed criteria, the answer was No. |

| Decision Required to be Made  | Decision Rule  |
|---|--|
|   | <p><u>Use of statistical methods:</u></p> <p>For the characterisation of sample sets, statistical analysis of the data was undertaken as appropriate and in accordance with relevant guidance documents, to facilitate the decisions. The following statistical criteria was adopted with respect to soils, where appropriate:</p> <p>Either the reported contaminant concentrations were all below the Site criteria, or the average Site concentration for each analyte was below the adopted Site criterion, no single analyte concentration exceeded 250% of the adopted Site criterion, and the standard deviation of the results was less than 50% of the Site criterion.</p> <p>If the resulting 95% upper confidence limit (UCL) of the average concentration for each analyte was below the adopted Site criterion, the answer to the decision was No.</p> <p>If the statistical criteria were not satisfied, the answer to the decision was Yes.</p> |
| <p>2. Are there any unacceptable risks to likely future receptors from impacted groundwater?</p>                                | <p>Groundwater analytical data was compared against appropriate criteria to evaluate the following occurrences:</p> <p>The concentration of the contaminant in groundwater was, or will foreseeably be, above the appropriate criteria and will remain that way;</p> <p>OR, there is separate-phase contamination of groundwater.</p> <p>If the criteria stated above were satisfied, the answer to the decision was Yes.</p> <p>If the criteria were not satisfied, the answer to the decision was No.</p>  |
| <p>3. Are there any issues relating to local area background soil concentrations that exceed the appropriate soil criteria?</p> | <p>Analytical data in natural soil samples were compared to the background levels for urban areas of NSW as described in NEPC (2013). Where concentrations were less than the background levels, the answer to the decision was No.</p> <p>Otherwise the answer to the decision was Yes.</p>   |
| <p>4. Are there any chemical mixtures?</p>  | <p>Were there more than one group of contaminants present which increase the risk of harm?</p> <p>If there was, the answer to the decision was Yes.</p> <p>Otherwise, the answer to the decision was No.</p>   |
| <p>5. Are there any aesthetic issues associated with potentially impacted media at the Site?</p>                                | <p>If there were any unacceptable odours, soil discolouration or other aesthetic aspect, the answer to the decision was Yes.</p> <p>Otherwise, the answer to the decision was No.</p>  |
| <p>6. Is there any potential for contaminant migration from the Site?</p>   | <p>A qualitative assessment of contaminant sources, migration pathways and receptors was completed during assessment of available investigation data.</p> <p>Where the assessment identified the potential for unacceptable risks to off-Site receptors as a result of site contamination conditions, the answer to the decision was Yes.</p> <p>Otherwise the answer to the decision was No.</p>  |
| <p>7. Is a Site management strategy required?</p>   | <p>Was the answer to any of the above decisions Yes?</p> <p>If so, further characterisation and / or remedial works will be required to evaluate the requirements for management/remediation so as to render the Site suitable for the proposed land use.</p> <p>Otherwise, the answer to the decision was No.</p>   |

### 6.1.6 Specify Limits on the Decision Error

This step is to establish the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data. Data generated during this project must be appropriate to allow decisions to be made with confidence.

Specific limits for this project have been adopted from the NSW OEH (2011<sup>4</sup>), NEPC (2013), ANZECC/ARMCANZ (2000<sup>5</sup>), DEC (2007<sup>6</sup>), EPA (1995<sup>7</sup>) and modified to meet the project objectives.

To assess the usability of the data prior to making decisions, the data will be assessed against pre-determined Data Quality Indicators (DQIs). The pre-determined DQIs established for the project are discussed below in relation to precision, accuracy, representativeness, comparability, completeness and sensitivity (PARCCS parameters), and are shown in **Table 6.2**.

- Precision - measures the reproducibility of measurements under a given set of conditions. The precision of the laboratory data and sampling techniques is assessed by calculating the Relative Percent Difference (RPD) of duplicate samples.
- Accuracy - measures the bias in a measurement system. The accuracy of the laboratory data that are generated during this study is a measure of the closeness of the analytical results obtained by a method to the 'true' value. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards.
- Representativeness – expresses the degree which sample data accurately and precisely represent a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples on a representative basis across the site, and by using an adequate number of sample locations to characterise the site to the required accuracy.
- Comparability - expresses the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples; ensuring analysing laboratories use consistent analysis techniques and reporting methods.
- Completeness – is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study.
- Sensitivity – expresses the appropriateness of the chosen laboratory methods, including the limits of reporting, in producing reliable data in relation to the adopted site assessment criteria.

**Table 6.2: Summary of Quality Assurance / Quality Control (QA/QC) Program**

| Data Quality Indicator              | Frequency           | Data Quality Criteria |
|-------------------------------------|---------------------|-----------------------|
| <b>Precision</b>                    |                     |                       |
| Blind duplicates (intra laboratory) | 1 / 20 samples      | <50% RPD <sup>1</sup> |
| Laboratory duplicates               | 1 / 20 samples      | <50% RPD <sup>1</sup> |
| <b>Accuracy</b>                     |                     |                       |
| Surrogate spikes                    | All organic samples | 70-130%               |
| Laboratory control samples          | 1 per lab batch     | 70-130%               |

<sup>4</sup> *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*. NSW Office of Environment and Heritage, 2011 (OEH 2011)

<sup>5</sup> *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, October 2000 (ANZECC/ARMCANZ 2000)

<sup>6</sup> *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination*. NSW DEC, March 2007 (DEC 2007)

<sup>7</sup> *Contaminated Sites: Sampling Design Guidelines*. NSW Environment Protection Authority, 1995 (EPA 1995)

| Data Quality Indicator   | Frequency            | Data Quality Criteria  |
|--|----------------------|--|
| Matrix spikes  | 1 per lab batch      | 70-130%  |
| <b>Representativeness</b>  |                      |  |
| Sampling appropriate for media and analytes  | -                    | -  |
| Samples extracted and analysed within holding times.   | -                    | Soil organics (7-14 days), inorganics (6 months)<br>Water TPH/PAHs 7 days to extraction, VOCs/ vTPH – 14 days, 6 months for metals |
| Laboratory blank   | 1 per sampling batch | <LOR   |
| Trip Spike   | 1 per sampling batch | 70 – 130 % BTEX  |
| Storage Blank  | 1 per sampling batch | < LOR BTEX   |
| Rinsate blank  | 1 per sampling batch | <LOR   |
| <b>Comparability</b>   |                      |  |
| Standard operating procedures for sample collection & handling                                       | All samples          | All samples  |
| Standard analytical methods used for all analyses  | All samples          | All samples  |
| Consistent field conditions, sampling staff and laboratory analysis                                  | All samples          | All samples  |
| Limits of reporting appropriate and consistent   | All samples          | All samples  |
| <b>Completeness</b>  |                      |  |
| Sample description and chain of custody completed and appropriate                                    | All samples          | All samples  |
| Appropriate documentation  | All samples          | All samples  |
| Satisfactory frequency and result for QC samples   | All QA/QC samples    | -  |
| Data from critical samples is considered valid   | -                    | Critical samples valid   |
| <b>Sensitivity</b>   |                      |  |
| Analytical methods and limits of recovery appropriate for media and adopted Site assessment criteria | All Samples          | LOR<= Site assessment criteria   |

1 Relative percent difference

If any of the DQIs are not met, further assessment was necessary to determine whether the non-conformance will significantly affect the usefulness of the data. Corrective actions may include requesting further information from samplers and / or analytical laboratories, downgrading of the quality of the data or alternatively, re-collection of the data.

### 6.1.7 Optimise the Design for Obtaining Data

Various strategies for developing a statistically based sampling plan are identified in EPA (1995), including judgemental, random, systematic and stratified sampling patterns. Given the Site history information, in areas not previously the subject of investigations at appropriate densities, sampling on a systematic grid basis supplemented with targeted sample locations in accessible areas of the Study Area was considered the most appropriate methodology for identification of contamination conditions which may require management with respect to the proposed ongoing commercial / and public open space land use and / or represent a commercial or work health and safety risk for workers involved in demolition of the existing infrastructure and construction of the proposed new stadium facilities.

In accordance with the requirements outlined in the NEPC (2013) and NSW EPA (1995), the minimum number of sampling points needed for characterisation of a Site of this size (9.25 ha) is 57 evenly spaced locations.

As discussed in **Section 4**, 58 former site investigation locations have historically been advanced in targeted areas, typically in the central north and central south of the Study Area for assessment of soil conditions. To supplement the existing Site data, JBS&G completed subsurface investigation locations as shown in **Figure 4**, comprising the following:

- Forty-two boreholes (BH01 to BH20, BH36 to BH53 and MW01 to MW04) were advanced across the Study Area in areas external to the current stadium facilities on an approximately systematic spacing. Four sample locations were converted into groundwater monitoring wells (MW01, MW02, MW03 and BH47/MW04a). It is noted that MW04 was not converted in a groundwater well as a result of drilling refusal prior to groundwater; and
- Fifteen boreholes (BH21 to BH35) were advanced within the existing playing field footprint.

Based upon the objectives of the investigation and the available Site use information, the density of the investigation undertaken is considered appropriate to adequately characterise the presence of contamination conditions that may impact upon the suitability of the site for future commercial and public open space use and identify potential commercial/work health and safety risks to a suitable level.

## 6.2 Soil Sampling Methodology

Soil samples were collected during Site investigation works utilising a drill rig fitted with solid flight augur and push tube attachments given the potential for volatiles.

All sampling locations were either grass or asphalt covered. On the playing field, the playing surface comprising 0.02 m including the grass, and the underlying sand and gravel, was removed and kept separately prior to the commencement of drilling at each location to enable ground staff to make efficient repairs to the playing surface.

Soil samples were generally collected from the ground surface (0-0.1 m) or directly underneath the pavements/playing surface profile (approximately 0.1 m), at 0.3, 0.5 m and then at 0.5 m intervals to a maximum depth of 3 m or 0.5 m into natural materials (or prior refusal), whichever was the shallower. Additional samples were collected on observation of any potentially impacted fill horizons, odorous and/or discoloured soils such that potentially contaminated profiles could be adequately characterised.

During the collection of soil samples, features such as seepage, discolouration, staining, odours and other indications of contamination were noted on field logs (**Appendix M**).

Collected samples were immediately transferred to laboratory supplied sample jars or 500 mL plastic bags (for asbestos analysis). The sample jars / bags were then transferred to a chilled ice box for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form was completed and forwarded with the samples to the testing laboratory.

### 6.2.1 Asbestos Quantification Methodology

Asbestos quantification was completed at each sampling location using the following methodology in general accordance with that outlined in NEPC (2013)/WA DOH (2009).

At each sampling location, at least 10 litres of material from each 1 m increment (or discrete soil type) was collected from the 150 mm diameter auger head and placed on a separate plastic sheet that was distinctly different to the soil colour. The soil was subsequently spread thinly on the plastic for inspection. Any obvious ACM fragments were placed in a dedicated laboratory supplied polyethylene ziplock sample bag labelled with the sampling location, depth increment, sampler's

initials and sampling dat. For coarse grained material (sand, gravel, etc), the material was then passed through a 7 mm field sieve. The material captured in the sieve was then hand sorted and any further ACM fragments identified were placed in the sample bag. For clayey samples, clods were broken down by hand to a suitable size such that any ACM greater than 7 mm in size was able to be identified and collected.

A representative 500 mL volume sample of sieved material was then collected and placed in a separate dedicated laboratory supplied polyethylene ziplock sample bag that was subsequently labelled as a soil sample for analysis. The soil samples were then submitted under chain-of-custody procedures for laboratory analysis to assess the presence of free asbestos fibres/asbestos fines within the soil in accordance with WA DoH (2009).

The collected >7 mm ACM fragments from each sampling location/interval were weighed in-house by JBS&G staff using an externally calibrated scale with an accuracy of 1 g and the resulting mass of ACM fragments in each increment sample recorded.

The enHealth (2005<sup>8</sup>) guideline outlines an approach whereby the concentration of asbestos in soil attributable to ACM contamination may be identified. Given that the adopted site specific criterion is for ACM and not asbestos, the enHealth asbestos calculation formula has been revised for the purposes of this assessment to:

$$\% \text{ Soil ACM} = \frac{\text{ACM (kg)}}{\text{Soil volume (m}^3\text{)} \times \text{Soil density (kg/m}^3\text{)}}$$

The soil volume was calculated via field measurement of the borehole dimensions and recorded to verify each sample is based on a sample of approximately 10 L. Reference was made to WA DoH (2009) to derive a suitable average density based on the predominant soil type for each sample such that volumes may be calculated (eg. 1.65 g/cm<sup>3</sup> for sand). The ACM (kg) is the addition of the weight of ACM fragments > 7 mm in diameter plus the concentration of asbestos fibres/asbestos fines reported by the laboratory following analysis of the soil samples.

### 6.2.2 Duplicate Sampling

Duplicate samples were collected for QA / QC purposes and placed directly into using the method for primary samples above and placement directly into sample jars/bags. Samples were not mixed prior to placement into the jars to minimise the potential for loss of volatiles. Similarly, where 500 mL samples were required for duplicate asbestos analysis no mixing of material was undertaken prior to placement into plastic bags to prevent the loss of free fibres. It is noted that this methodology may result in the calculation of poor RPDs but this is considered acceptable given that the loss of volatiles / fibres that may occur if samples are mixed would result in the reporting of lower contaminant concentrations than actually present.

### 6.2.3 Field PID Screening

Soil samples collected during the sampling program were screened on site during works using a photo-ionisation detector (PID) to assess the potential presence of VOCs including petroleum hydrocarbons. Samples obtained for PID screening were placed in a sealed plastic bag for a period of approximately 5 minutes to equilibrate, prior to a PID being attached to the bag. Readings were then monitored for a period of approximately 1 minute or until values stabilised and the stabilised / highest reading was recorded on the field logs (**Appendix M**).

PID calibration records are provided in **Appendix N**.

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<sup>8</sup> *Management of Asbestos in the Non-Occupational Environment*. Department of Health and Ageing, 2005 (enHealth 2005).

#### 6.2.4 Decontamination Procedures

The following procedure was used to clean non-disposable equipment prior to the collection of each sample:

- Scrubbing with a wire brush to remove gross contamination;
- Pressure spray with Decon 90 detergent and potable water mix;
- Pressure spray rinse with potable water; and
- Air drying.

A rinsate sample was obtained during the field decontamination procedures between sampling locations. The rinsate sample was obtained by rinsing non-disposal sampling equipment with laboratory grade demineralised water following the decontamination procedure. The water sample was appropriately preserved and stored with the site soil samples prior to transport to the laboratory for chemical analysis.

Decontamination records are provided in **Appendix N**.

#### 6.2.5 Sample Preservation and Transport

Soil samples destined for laboratory chemical analysis were immediately transferred to laboratory supplied sample jars and sealed with Telfon-lined screw closures or 500 mL plastic bags (for asbestos analysis). The sample containers were then placed in a chilled esky for sample preservation prior to and during shipment to the testing laboratory. Asbestos in soil samples were placed in new disposable ziplock plastic bags and subsequently sealed. Preservation of the primary soil and QA/QC samples obtained during this investigation was completed in accordance with recognised protocols (NEPC 2013).

The samples were transported under standard chain-of-custody protocols to a laboratory with National Association of Testing Authority (NATA) accreditation for the required analyses. Not all soil samples collected were analysed. Soil samples were analysed in accordance with the sampling and analytical program (**Table 6.3**). All samples will remain at the primary laboratory for a period of two months for possible future analysis (subject to holding times) if required.

### 6.3 Groundwater Assessment Methodology

#### 6.3.1 Well Installation

The JBS&G investigation activities included conversion of four boreholes into groundwater monitoring wells (MW01, MW02, MW03 and BH47/MW04a) spaced approximately evenly across the site in lieu of specific point sources of suspected groundwater contamination.

The wells were constructed of 50 mm diameter Class 18 unplasticised polyvinyl chloride (uPVC) screen and casing, with appropriate gravel packs, bentonite seals, and lockable caps to complete the wells. The wells were advanced to a maximum depth of 10.5 m bgs. Details of each well construction are included on the field logs presented in **Appendix M**.

The wells were developed on the same day as installation with a stainless steel bailer in order to remove the sediment introduced during the well installation and to ensure an appropriate connection to the surrounding soil strata. During development the wells were rapidly purged and then allowed to recharge with a minimum of 3 well volumes removed at each location or until the well yielded improved turbidity.

Subsequent to completion of the well installation activities the relative levels of three of the four monitoring well, as measured to the top of the casing were measured by a registered surveyor such that standing groundwater elevations at each monitoring well location could be approximated. The surveyors report is presented in **Appendix N**.

### 6.3.2 Monitoring Well Sampling

Following a minimum of five days following development, groundwater samples were collected at each location using the following procedure:

- Groundwater levels were gauged with an interface probe to assess standing groundwater levels (SWLs) and assess the potential presence of light non-aqueous phase liquid (LNAPL);
- A low flow peristaltic pump (equipped with new disposable silicone tubing and disposable low density polyethylene (LDPE) tubing for each location) was then used for purging / sampling at each monitoring well. The LDPE tubing was lowered to a maximum depth of two-thirds of the wetted screen length of the monitoring well prior to the commencement of purging;
- Purging of groundwater was undertaken at a flow rate of approximately 0.2 L / minute while ensuring to minimise the drawdown as measured by interface probe. It is noted that low hydraulic conductivity in the subterranean media surrounding MW01 and MW02 limited the groundwater available to recharge the well during sampling, as such, significant drawdown was observed during purging activities. As a result of the limited recharge water available to MW01 and MW02 stable groundwater conditions were not achieved prior to sampling;
- Measurement of field parameters including pH, conductivity, redox potential, dissolved oxygen and temperature was completed at a regular frequency during purging using a multi-parameter probe/meter and a flow cell;
- During the purging and sampling, features such as discolouration, odours and other indications of contamination were noted on field sheets (**Appendix N**);
- Groundwater samples were obtained using the low-flow peristaltic pump when three consecutive readings of field parameters met the following criteria: pH  $\pm$  0.5; dissolved oxygen  $\pm$  10% or 0.1mg/l; electrical conductivity  $\pm$  3%; and redox potential  $\pm$  10mV (Vic EPA 2000);
- Collected groundwater samples were immediately transferred to sample containers of appropriate composition, which had been pre-treated in a manner appropriate for the laboratory analysis. Groundwater samples were obtained in a manner that ensured no headspace remained in the bottles, and where appropriate were filtered in the field prior to preservation;
- Each of the sample bottles were labelled with the project ID, date, sampler's initials and unique monitoring well ID (or QC sample name), using permanent ink marker on labels affixed to the sides of the bottles by the laboratory. In addition, the sample ID (i.e., the monitoring well ID) was also replicated on the lid of the bottles / vials in the event that the labels became detached from the bottles during transport;
- All bottles were then placed directly into a pre-chilled ice chest, for transport to the analytical laboratories; and
- Chain of custody documentation was completed for each batch of samples relinquished to the laboratory and included: sample ID; number of bottles/vials/ media type (i.e. water); project ID; name; and date of sampling and relinquishment.

Field notes documenting the sampling event are included in **Appendix N**.

## 6.4 Laboratory Analysis

JBS&G contracted Eurofins as the primary laboratory for the required chemical analyses. Eurofins was NATA registered for the required analyses. In addition, the laboratories were required to meet JBS&G's internal QA/QC requirements. The completed analysis schedule is summarised in **Table 6.3**.

**Table 6.3 Sampling and Analysis Program**

| Sample Type | No. of Sampling Locations                                | Analyses  |
|-------------|--|---|
| Soil        | 15 on field locations                                    | Asbestos (500mL) – 16 primary samples<br>Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) - 20 primary samples<br>PAH - 20 primary samples<br>TPH/BTEX – 10 primary samples<br>OCPs/OPPs/Herbicides – 15 primary samples<br>PCBs – 10 primary samples<br>ASLP/TCLP (metals/PAHs) – 4 primary samples |
| Soil        | 42 locations within the broader proposed works footprint | Asbestos (500mL) – 54 primary samples<br>Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) - 42 primary samples<br>PAH - 42 primary samples<br>TPH/BTEX – 25 primary samples<br>OCPs/OPPs/PCBs – 25 primary samples<br>ASLP/TCLP (metals/PAHs) – 8 primary samples<br>pH/EC/CEC – 2 primary samples   |

As discussed in **Section 6.1.6**, for QA / QC purposes duplicate and triplicate samples were collected at a minimum rate of 1 per 20 primary samples for both soil and groundwater samples. Rinsate samples were also obtained from non-disposable sampling equipment and accompanied sampling events. Trip spike and storage blank samples were carried during all field sampling works and submitted for laboratory analysis with each batch of samples.

## 7. Assessment Criteria

### 7.1 Regulatory and Technical Guidance

The investigation was undertaken with consideration to aspects of the following guidelines and technical documents, as relevant:

- Contaminated Sites: Sampling Design Guidelines. NSW Environment Protection Authority, 1995 (EPA 1995).
- Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites. NSW Office of Environment and Heritage, 2011 (OEH 2011).
- Contaminated Sites: Guidelines for the NSW Site Auditor Scheme, 2nd Edition. NSW Environment Protection Authority, 2006 (DEC 2006).
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013). National Environment Protection Council (NEPC 2013).
- Contaminated Sites: Guidelines on Duty to Report Contamination under the Contaminated Land Management Act 1997 (as amended 2015). NSW Environment Protection Authority (EPA 2015).
- Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination. NSW DEC, March 2007 (DEC 2007).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, October 2000 (ANZECC / ARMCANZ 2000).
- Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council (NHMRC) 2011 (NHMRC 2011).
- Guideline for the Assessment and Management of Sites Impacted by Hazardous Ground Gases. NSW EPA 2012 (EPA 2012).
- Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards. Department of Health and Ageing and EnHealth Council, Commonwealth of Australia, June 2002 (EnHealth 2002).
- Waste Classification Guidelines Part 1: Classifying Waste. NSW EPA, November 2014 (EPA 2014).
- Guidelines for Managing Risks in Recreational Water. National Health and Medical Research Council 2008 (NHMRC 2008).

### 7.2 Soil Criteria

In accordance with NEPC (2013) a fine grained soil texture was adopted given the occurrence of predominately silty sandy clay fill materials / natural soils.

Based on the proposed land use and in accordance with the decision process for assessment of urban redevelopment sites (DEC 2006), concentrations in the soil were compared against published levels as presented in **Appendix O** sourced from the following:

- NEPC (2013) Health based Investigation Levels (HILs) for Commercial / Industrial (D) land use (HIL-D);
- NEPC (2013) Health based Investigation Levels (HILs) for Recreational (C) land use (HIL-C);

- NEPC (2013) Health Screening Levels (HSLs) for petroleum hydrocarbons considering potential for vapour intrusion, fine grained soil for Commercial / Industrial land use at 0.0-1.0 m depth;
- NEPC (2013) Health Screening Levels (HSLs) for petroleum hydrocarbons considering potential for vapour intrusion, fine grained soil for Recreational / Open Space use at 0.0-1.0 m depth;
- Site specific ecological investigation levels (EILs) were derived through the added contaminant limits for Commercial and Industrial, and Public Open Space land uses;
- NEPC (2013) Management Limits for TRH, fine grained soils for Commercial / Industrial land use;
- NEPC (2013) Ecological Screening Levels (ESLs) fine grained soil for Commercial / Industrial land use;
- NEPC (2013) Ecological Screening Levels (ESLs) fine grained soil for Public Open space land use;
- CRC Care (2011) HSL D for Direct Contact;
- CRC Care (2011) HSL C for Direct Contact; and
- Where there are no NSW EPA endorsed thresholds, including for specific VOC compounds in soil, the laboratory limit of reporting (LOR) has been adopted as an initial screening value for the purposes of this assessment in lieu of site specific risk assessment derived criteria.

The results of asbestos observations and analysis were assessed in general accordance with NEPC (2013) and WA DOH (2009<sup>9</sup>) guidance.

### 7.3 Groundwater Criteria

As noted in EPA endorsed guidelines (DEC 2007), the EPA regards protection of aquatic ecosystems and drinking water as default environmental values in all preliminary assessments of groundwater contamination. Subsequent, more detailed assessments, may demonstrate that these environmental values do not apply.

Given that the closest receiving water body (Parramatta River) to the west of the site is a freshwater environment, threshold values for freshwater environments have been adopted for this assessment.

Given the site's fresh water receptor, being the upper Parramatta River, consideration was subsequently given to hardness modified ecological trigger levels as per ANZECC/ARMCANZ (2000), calculated based upon the average hardness value of groundwater at the site (91 mg/L).

Where existing default groundwater assessment criteria are exceeded and there is a potential for current or future exposure to the contaminant, further investigation, remediation or management may be required. Where the most sensitive criterion for an individual contaminant of concern is less than the LOR or background levels (if known), then the LOR or the background level (if known) can be used as the adopted groundwater assessment criteria.

Concentrations in the groundwater were compared against published levels as presented in **Appendix O** sourced from the following:

- NEPC (2013) HSLs for petroleum hydrocarbons considering potential for vapour intrusion, fine grained soil for Commercial / Industrial land use at 2 m to <4m and 4 m to < 8 m depth;

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<sup>9</sup> *Guidelines for the Assessment Remediation and Management of Asbestos-Contaminated Sites in Western Australia*. WA Department of Health 2009 (DOH 2009)

- NEPC (2013) Groundwater Investigation Levels (GILs) for freshwater ecosystems;
- NEPC (2013) GILs Drinking Water Criteria;
- Guidelines for Managing Risks in Recreational Water. National Health and Medical Research Council 2008 (as amended December 2014) (NHMRC 2016) (Factor 10) for Aesthetics and Health; and
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, October 2000 (ANZECC / ARMCANZ 2000).

## 8. Quality Control / Quality Assurance

### 8.1 QA/QC Results

The QA/QC result for soil samples collected at the Site are summarised in **Table 8.1** and discussed in **Section 8.2**. Detailed QA/QC results are included **Appendix K**.

**Table 8.1: QA/QC Results Summary**

| Data Quality Indicator                               | Results   | DQI Met?             |
|--|---|----------------------|
| <b>Precision</b>                                     |   |                      |
| Blind duplicates (intra laboratory) (soil)           | Sampling rate greater than 1 in 20.<br>RPDs = 0-169%  | Partial <sup>1</sup> |
| Blind triplicates (inter laboratory) (soil)          | Sampling rate greater than 1 in 20.<br>RPDs = 0-<109%   | Partial <sup>1</sup> |
| Blind duplicates (intra laboratory) (water)          | Sampling rate greater than 1 in 20.<br>RPDs = 0-<50%  | Yes                  |
| Blind triplicates (inter laboratory) (water)         | Sampling rate greater than 1 in 20.<br>RPDs = 0-<50%  | Yes                  |
| <b>Accuracy</b>                                      |   |                      |
| Surrogate spikes (Soil)                              | 26 - 199%<br>Surrogate spikes were completed for all organic samples                          | Partial <sup>1</sup> |
| Laboratory control samples (Soil)                    | 70- 130%<br>Laboratory control samples completed for each batch                               | Yes                  |
| Matrix spikes (Soil)                                 | 70 - 130%.<br>One matrix spike was completed for each batch                                   | Yes                  |
| Surrogate spikes (Water)                             | 70 - 130%<br>Surrogate spikes were completed for all organic samples                          | Yes                  |
| Laboratory control samples (Water)                   | 70 - 130%<br>Laboratory control samples completed for each batch                              | Yes                  |
| Matrix spikes (Water)                                | 70 - 130%.<br>One matrix spike was completed for each batch                                   | Yes                  |
| <b>Representativeness</b>                            |   |                      |
| Sampling appropriate for media and analytes          | All sampling was conducted in accordance with JBS&G procedures                                | Yes                  |
| Samples extracted and analysed within holding times. | All samples were extracted and analysed within holding times                                  | Yes                  |
| Trip spike (Soil)                                    | 85-95%<br>One per sampling event when sampling for volatile or semi-volatile COPC             | Yes                  |
| Trip blank (Soil)                                    | <LOR<br>One per sampling event when sampling for volatile or semi-volatile COPC               | Yes                  |
| Rinsate blank  | <LOR except for Alkali metals (Mg, K, Na).<br>One per sampling event with reusable equipment. | Partial <sup>1</sup> |

|  |  |     |
|--|--|-----|
| Laboratory Blanks (Soil)   | <LOR<br>One per laboratory method  | Yes |
| Trip spike (Water)   | 89-105%<br>One per sampling event when sampling for volatile or semi-volatile COPC   | Yes |
| Trip blank (Water)   | <LOR<br>One per sampling event when sampling for volatile or semi-volatile COPC  | Yes |
| Laboratory Blanks (Water)  | <LOR<br>One per laboratory method  | Yes |
| <b>Comparability</b>   |  |     |
| Standard operating procedures for sample collection & handling   | Field staff used same standard operating procedures throughout works   | Yes |
| Standard analytical methods used for all analyses  | Standard analytical methods were used  | Yes |
| Consistent field conditions, sampling staff and laboratory analysis  | Sampling was conducted using standard operating procedures in the same conditions throughout the works. The laboratory remained consistent throughout the investigation.                   | Yes |
| Limits of reporting appropriate and consistent   | Limits of reporting were consistent and appropriate  | Yes |
| <b>Completeness</b>  |  |     |
| Sample description and COCs completed and appropriate  | All borehole logs, groundwater sampling sheets and COCs were completed appropriately.  | Yes |
| Appropriate documentation  | Field documentation was appropriately completed.   | Yes |
| Satisfactory frequency and result for QC samples   | All frequency and results for QA/QC were satisfactory  | Yes |
| Data from critical samples is considered valid   | Data from critical samples is considered valid.  | Yes |
| <b>Sensitivity</b>   |  |     |
| Field and analytical methods and limits of recovery appropriate for media and adopted site assessment criteria | Appropriate laboratory analysis methods and detection limits were considered to have been achieved to the extent practicable during the field and laboratory phases of this investigation. | Yes |

Notes: 1 See discussion of DQI exceedances

## 8.2 QA/QC Discussion

### 8.2.1 Precision

#### Soil Blind Duplicates (intra laboratory)

Soil field blind (intra-laboratory) duplicates were analysed at a rate greater than 1 per 20 primary samples being the required DQI frequency.

Soil blind duplicate RPDs were reported within the acceptable limits with the following exceptions:

- Metals (arsenic, chromium, copper, lead, nickel and zinc) with exceedance RPDs ranging between 52% to 123%; and
- TRH fraction exceedance RPDs ranging between 62% and 169%.

The RPDs are attributed to the heterogeneity of the material analysed. Additionally, a number of analyses were reported near the laboratory LOR resulting in disproportionately elevated RPDs

when compared to the results are similar. As such, the outliers are considered not to adversely impact the ability to rely upon the data for making decisions in relation to site suitability. Detailed RPD results are provided in **Attachment P**.

#### Soil Blind Triplicates (inter laboratory)

Soil field blind (inter-laboratory) triplicates were analysed at a rate greater than 1 per 20 primary samples which is required 1/20 DQI frequency.

Soil blind triplicate RPDs were reported within the acceptable limits with the following exceptions:

- TRH fractions exceedance RPDs ranging between 82% and 109%; and
- PAH (Benzo(a)pyrene TEQ (upper bound)) RPDs of 82%.

The RPDs are attributed to the heterogeneity of the material analysed. Additionally, the LOR between the primary and secondary laboratories differed resulting in the elevated RPD for PAHs. As such, the outliers are considered not to adversely impact the ability to rely upon the data for making decisions in relation to site suitability. Detailed RPD results are provided in **Attachment P**.

#### Water Blind Duplicates (intra laboratory)

Water blind duplicate analyses were completed at a suitable frequency and reported RPDs were reported within the acceptable limits.

#### Water Blind Triplicates (inter laboratory)

Water blind triplicate analyses were completed at a suitable frequency and reported RPDs were reported within the acceptable limits RPDs were reported within the acceptable limits.

### **8.2.2 Accuracy**

#### Surrogate Spikes (Soil)

Surrogate spikes sample analysis results have been reported for analysis of all organic constituents for soils and water. Forty-one spike samples reported were >30% variation ranging from 26% to 199%. Given that most organic COPCs were reported below the LOR and all volatile COPCs were reported below the site assessment criteria, this is considered not to adversely influence the outcomes of the investigation. Additionally, the recovery percentages were generally within the NATA accredited lab method acceptance range for surrogate spike recoveries, which are 50-150%.

#### Laboratory Control Samples (Soil)

Soil laboratory control samples were conducted for each laboratory batch submitted and were all within the investigation DQI criteria of 70-130%. The data set is therefore considered reliable.

#### Matrix Spikes (Soil)

Soil matrix spike samples were conducted for each laboratory batch submitted and were all within the investigation DQI criteria of 70-130%. The data set is therefore considered reliable.

#### Surrogate Spikes (Water)

Water surrogate spike samples were conducted for each laboratory batch submitted and were all within JBS&G's acceptance criteria of 70-130%. The data set is therefore considered reliable.

#### Laboratory Control Samples (Water)

Water laboratory control samples were conducted for each laboratory batch submitted and were all within JBS&G's acceptance criteria of 70-130%. The data set is therefore considered reliable.

### Matrix Spikes (Water)

Water matrix spike samples were conducted for each laboratory batch submitted and were all within JBS&G's acceptance criteria of 70-130%. The data set is therefore considered reliable.

### **8.2.3 Representativeness**

#### Sampling appropriate for media and analytes

All soil and groundwater sampling works completed during the investigation were conducted in accordance with JBS&G standard operating procedures. Push tubes were used to collect undisturbed samples for chemical analysis to enable assessment of volatile COPCs. In addition, solid flight augers with 175mm diameter were advanced for the purposes of visual inspection of fill conditions and the collection of 500mL asbestos soil samples following asbestos quantification, which is considered appropriate for the assessment of asbestos in soil.

Groundwater was sampled using low flow techniques, considered appropriate for the potential site contaminants including volatile compounds.

All samples were collected wearing a new pair of disposable nitrile gloves. Where possible, disturbance of the sample was minimised during placement into the laboratory supplied sample container and during shipment.

#### Samples extracted and analysed within holding times

All analyses have been undertaken within holding times.

#### Trip spikes (Soil)

Trip spike recoveries were within the JBS&G acceptable limit of 70-130 %, with a reported range of 85 to 95 % for individual BTEX compounds.

#### Trip blanks (Soil)

There were no reported concentrations of BTEX compounds above the laboratory LOR.

#### Rinsate Samples

Rinsate samples were submitted with the soil and groundwater samples collected during the assessment. Reported concentrations of all COPCs were <LOR demonstrating compliance with decontamination objectives. Alkali metals concentrations reported in rinsate samples were considered representative of rinse water properties rather than indicative of potential cross contamination.

#### Laboratory Blanks (Soil)

Reported concentrations of all analytes were <LOR in laboratory blank samples.

#### Trip spikes (Water)

Trip spike recoveries were within the JBS&G acceptable limit of 70-130%, with a reported range of 89 to 105%.

#### Trip blanks (Water)

There were no reported concentrations of BTEX compounds above the laboratory LOR.

#### Laboratory Blanks (Water)

Reported concentrations for all COPC were <LOR in laboratory blank samples.

#### **8.2.4 Comparability**

Experienced JBS&G personnel undertook all sampling in accordance with standard JBS&G sampling methods.

All field works and sampling were undertaken by one experienced JBS&G field scientist.

The laboratory LORs are consistent and are considered appropriate.

#### **8.2.5 Completeness**

Samples were generally transported under full chain of custody (COC) documentation. The COC documentation was generally completed correctly and the selected analyses were correctly conducted.

All field documentation was completed appropriately and were correct.

The frequency of analysis and result for all QC samples are appropriate.

#### **8.2.6 Sensitivity**

The adopted analytical methods provided suitable LORs with respect to the adopted site assessment criteria.

### **8.3 QA/QC Conclusion**

The field sampling and handling procedures produced QA/QC results which indicate that the soil and groundwater data are of an acceptable quality and suitable for use in site characterisation. The NATA certified laboratory results sheets indicate that the project laboratory was generally achieving levels of performance within its recommended control limits during the period when the samples from this program were analysed.

The non-conformances described in **Section 8.2** are considered to be minor in nature and acceptable given the consistency of the data, with the majority of QA/QC results falling within the NATA accredited method acceptance range, and results significantly below the adopted site assessment criteria.

On the basis of the results of the field and laboratory QA/QC program, the soil and groundwater data are of an acceptable quality upon which to draw conclusions regarding the environmental condition of the Study Area.

## 9. Soil Results

### 9.1 Field Observations

A total of 57 sample locations were advanced as part of this site investigation. Previous soil sample locations are presented on Figure 3. Current soil sampling and asbestos quantification sample locations are presented on **Figure 4**. Borelogs are provided in **Appendix M**.

Bituminous pavements or grass (including the playing field) were generally encountered at the ground surface at sampling locations.

Fill material on the playing field generally comprised sand and gravels and was underlain by natural clay and weathered sandstone. Fill material across the portions of the site outside of the playing field included igneous gravel (road base), sands and silty clays and was underlain by natural clayey or sandy soil. No major anthropogenic inclusions were generally observed within the fill material.

Fill material was observed at depths ranging from 0.2 m bgs up to 5 m bgs.

No odours, staining or asbestos containing material (ACM) were observed within the fill material or natural soils at the site.

PID results during field screen for volatile contaminants were generally <0.5 ppm, consistent with the lack of observed odours and staining.

### 9.2 Analytical Results

Historical soil analytical results are presented in **Tables A** and **B** with current soil analytical results are presented in **Table C** and asbestos quantification summary is presented in **Table D**. Laboratory documentation is provided in **Appendix Q**. The following comments summarise the laboratory analysis results incorporating past and present data as a single set. Exceedances of the site assessment criteria are presented on **Figure 5**.

#### 9.2.1 Metals

All heavy metal concentrations in soil samples collected and selected for analysis were reported below the adopted human (HIL) and ecological (EIL) health site assessment values, with the exception of:

- Copper in BH39 0-0.1 (230 mg/kg), reported above the public open space EIL of 170 mg/kg, but equivalent to the commercial/industrial EIL; and
- Nickel in 11 sample locations, with concentrations ranging from 86 to 150 mg/kg, which exceed the public open space EIL of 85 mg/kg.

The sample nickel population was statistically assessed using methodologies described in **Section 6** to generate a 95% upper confidence level (UCL) of the arithmetic mean as shown in **Appendix R**. Statistical assessment of the results identified that no individual analyte concentrations exceeded 250% of the adopted site criterion, the standard deviation of the results was less than 50% of the site criterion and the 95% UCL value was reported at 65 mg/kg, less than the adopted EIL criterion of 85 mg/kg. On this basis, nickel concentrations as a population were considered to have met the ecological health criterion.

#### 9.2.2 PAHs

The concentrations of PAHs in the soil samples selected for analyses were all less than the human health site assessment criteria.

A single sample, BH2 2.8\_2.3, was reported above the public open space ESL of 0.7 mg/kg with a concentration of 1.1 mg/kg. This concentration is below the commercial/industrial ESL.

### 9.2.3 Asbestos

No ACM was identified in soil samples during field asbestos quantification activities completed for the current assessment. ACM (friable and/or non-friable) were identified in fill material at seventeen sample locations during previous investigations as discussed in **Section 4** and presented in **Figure 5**.

Friable asbestos in soil was detected above the adopted site assessment HSL in fill material samples collected during the previous and current field investigation at sample locations: TP02-W 0.2-0.3, CTP05; BH12, MW03 and BH16 during the current investigation; and BH101, BH210, BH211, BH212, and BH213 (EIS 2014b and 2014c), as shown in **Figure 5**. In addition, given the reported observations, it has been presumed concentrations present at EIS (2014a) BH8, BH9, BH10 and BH11 also occur above the adopted assessment criterion.

In addition, friable asbestos in soil was identified at trace concentrations below the LOR in fourteen other fill material samples collected from these areas of the Site as shown in **Figure 5**.

### 9.2.4 TRH

The concentration of TRH in the soil samples selected for analyses were all less than the site assessment criteria and generally below the LOR.

### 9.2.5 BTEX

The concentration of BTEX in the soil samples selected for analyses were all less than the site assessment criteria and below the LOR.

### 9.2.6 OCPs and OPPs

The concentration of OCPs and OPPs in the soil samples selected for analyses were all less than the site assessment criteria.

### 9.2.7 PCBs

The concentration of PCBs in the soil samples selected for analyses were all less than the site assessment criteria and generally below the LOR.

### 9.2.8 Herbicides

The concentration of herbicides in the soil samples selected for analyses were all less than the site assessment criteria and below the LOR.

## 10. Groundwater Results

Groundwater analytical data is summarised in **Table E**. Groundwater gauging and groundwater quality parameter results are summarised in **Table F**. Laboratory reports and chain of custody documentation are included in **Appendix Q**. The locations of groundwater monitoring wells are shown on **Figure 4**. Water criteria exceedances are presented on **Figure 6**.

### 10.1 Field Observations

Standing water levels at the time of the GME (8 June and 21 June 2016) were observed between 5.319 metres below top of casing (m btoc) and 8.882 m btoc in the four monitoring wells. With reference to the survey report (**Attachment N**), the calculated standing water level in m Australian Height Datum (AHD) at the monitoring wells was reported as follows:

- MW01 (south-west) = 5.684 m AHD on 8 June 2016 and 5.90 m AHD on 21 June 2016.
- MW02 (north-west) = 4.338 m AHD (8 June 2016) and 3.964 m AHD (21 June 2016).
- MW03 (north-east) = 6.704 m AHD (8 June 2016) and 6.679 m AHD (21 June 2016).
- MW04 (south-east) = 6.701 m AHD on 21 June 2016.

Based on this result and the local topographical setting, the direction of groundwater flow at the site is posited to be generally north-west, consistent with the topographical setting of the site and presence of Parramatta River. It is noted that standing water levels as measured on the 8 June 2016 were completed following an intense rainfall event during the period 4-6 June 2016 and as such, follow up standing groundwater level measurements as noted above were re-measured during the MW04 GME on 21 June 2016.

Groundwater was observed to be colourless to brown in colour and ranging from low to high turbidity. No phase separated hydrocarbons (PSH), odours or sheens were noted in the wells.

Field parameters of dissolved oxygen (DO), electrical conductivity (EC), pH, reduction-oxidation potential (redox) and temperature were recorded at the three sampled monitoring wells. Field parameters are summarised in the following:

- DO values ranged from 0.74 to 2.53 ppm;
- EC values ranged from 427.6 to 1300  $\mu\text{S}/\text{cm}$ ;
- pH ranged from 5.43 to 6.75;
- Uncorrected redox potential ranged from 90 to 186.5 mV; and
- Temperature of 18.2 to 24.3 °C.

Groundwater at the site is considered to be neutral to slightly acidic with low levels of dissolved oxygen. Uncorrected redox potential was generally low as consistent with low levels of dissolved oxygen.

### 10.2 Groundwater Analytical Results

#### 10.2.1 Heavy Metals

Assessment of the results identified the following:

- Concentrations of arsenic, cadmium, lead and mercury in all groundwater samples were reported at levels below the adopted (HMTV) assessment criteria.

- Total chromium in one sample, MW02 (0.003 mg/L) exceeded the HMTV for Chromium (III) of 0.025 mg/L by less than 1 order of magnitude, the remaining samples reported total chromium concentrations less than the LOR.
- The copper concentration in MW02 (0.023 mg/L), exceeded the HMTV of 0.0036 mg/L, by less than one order of magnitude, whilst the concentrations in the two remaining samples were close to the laboratory limit of reporting (LOR).
- Nickel concentrations in two samples, MW02 (0.013 mg/L) and MW03 (0.011mg/L) equalled or exceeded the adopted GIL of 0.011 mg/L (NEPC 2013), however all nickel concentrations in analysed samples were reported to be less than the HMTV of 0.028 mg/L.
- Zinc concentrations in primary samples exceeded the adopted GIL of 0.008 mg/L, with MW02 (0.13 mg/L), MW03 (0.049 mg/L) and MW04 (0.031 mg/L) also reported to exceed the HMTV. The values exceeded the HMTV by less than one order of magnitude. The presence of zinc in groundwater is considered likely the result of anthropogenic impact, however given the levels are less than a single order of magnitude above the adopted criterion, the exceedance is not of great significance with respect to sensitive ecological receptors with consideration to the highly urbanised environment within which the Parramatta River is situated.

#### **10.2.2 TRH**

The concentration of TRH in the groundwater samples selected for analyses were all less than the site assessment criteria and below the LOR.

#### **10.2.3 BTEX**

The concentration of BTEX in the groundwater samples selected for analyses were all less than the site assessment criteria and below the LOR.

## 11. Discussion

### 11.1 Are there any unacceptable risks to on-site future receptors from soils?

Asbestos impacts in soil, in the form of friable fibre bundles, weathered cement fragments and non-friable (bonded) ACM, have been identified in fill material within the Study Area during the previous and current investigations. The asbestos in soil impacts have the potential to represent an unacceptable risk to future site users/workers if not appropriately managed.

Sampling locations with identified concentrations of asbestos are presented on **Figure 5** and are generally associated with elevated areas of the Study Area, including the north and south spectator areas of the existing stadium; the raised former practice field to the south of the stadium; a landscaped mound at the northern extent of the Study Area; and a filled existing carparking area at the west of the Study Area. However, it is noted that asbestos in soil has also been identified at several isolated sampling locations within the carpark in the northern portion of the Study Area and also one location to the south-east of the stadium.

Based on the assessment outcomes, a preliminary plan of interpreted areas of known and potential impact has been prepared as **Figure 6**. As shown in this figure, a number of areas, including the lower stadium seating areas and several known areas of fill material at the east, south-east and west of the Study Area have been identified as locations requiring further investigation to confirm asbestos in soil conditions. In the interim, in accordance with the general strategy for management of asbestos, management of these areas should presume these areas are impacted with asbestos in soil until investigations are completed that demonstrate otherwise.

The source of the asbestos impacts in soil are considered to be a combination of contaminated imported fill material; burial of waste material in elevated areas of the Study Area; or impacts to soil associated with site structures/infrastructure formerly present at the site that were inappropriately demolished. Asbestos impacts have not been identified in undisturbed natural soil underlying pavements and fill material within the Study Area.

Assessment of fill material and natural soils at the site identified concentrations of non-asbestos COPCs in all soil samples analysed were reported below the adopted health based site assessment criteria and are considered not to pose unacceptable health based risks to future receptors.

Isolated EIL/ESL exceedances in fill material of copper and B(a)P when compared to the adopted public open space criteria are considered not to pose an unacceptable ecological risk given the copper concentrations were identified in road base gravel fill material and the PAHs were identified at sufficient depths so as to be below plant root zones. In any event it is noted in NEPC (2013) that PAHs including benzo(a)pyrene are typically of sufficiently low solubility such that the contaminants are non bio-available.

### 11.2 Are there any unacceptable risks to likely future receptors from impacted groundwater?

Laboratory analysis of groundwater samples obtained from across the Study Area identified the absence of significant potential contamination indicators. The presence of chromium, copper, nickel and zinc in groundwater samples at concentrations above the adopted ecological assessment criteria is considered typical of a built up urban environment within the Study Area geological setting.

Concentrations of heavy metals within soil samples analysed were generally low and the underlying residual clays and shale are low in permeability, thus it is unlikely significant vertical migration from metals within soils at the site would substantially contribute to the heavy metals concentrations within groundwater at the site.

To this extent, the marginal heavy metals exceedances are considered not to represent a potential unacceptable risk to future onsite receptors or onsite or offsite environmental receptors.

All other COPCs in groundwater samples analysed were reported below the site assessment criteria and/or the LOR.

Based on this, there are no unacceptable risks to future receptors from groundwater contamination at the Study Area.

**11.3 Are there any issues relating to local area background soil concentrations that exceed the appropriate soil criteria?**

Four natural soil samples were collected for laboratory analysis for COPC during the current sampling works, BH01 0.9-1.0, BH22 1.5-1.6, BH30 0.6-0.7, and BH30 1.7-1.8. Individual heavy metal concentrations were reported within background ranges as per Olszowy et al. (1995). In addition, all other COPCs were reported below the LOR. On this basis, there are considered not to be any issues relating to local area background soil concentrations that require further consideration.

**11.4 Are there any chemical mixtures?**

There were no soil or groundwater conditions identified with significant concentrations of more than one contaminant of concern and therefore no potential chemical mixtures were identified during the investigation that may pose an unacceptable contamination risk at the site with respect to future site users.

**11.5 Are there any aesthetic issues associated with potentially impacted media at the Site?**

No unacceptable odours, discolouration/staining or other aesthetic concerns were identified in soil and/or groundwater during site investigation activities. However, past investigation within a number of areas at the site has previously identified the presence of ACM cement fragments and potentially friable asbestos waste within fill material in limited portions of the Study Area. These conditions, correlating with identified areas representing areas of unacceptable health risk are considered to represent potential aesthetic based issues within portions of the Study Area.

**11.6 Is there any potential for contaminant migration from the Site?**

The potential for migration of contaminants from the site is considered to be low based upon the general absence of surface soil and/or groundwater contamination and sealed / grassed nature of the surface of the site. However, in the event that ground surface conditions are not maintained, the presence of asbestos impacted soil in landscaped and paved areas of the Study Area, migration of asbestos fibres, via airborne movement and/or surface water transport of sediment containing asbestos fibres has the potential to occur.

**11.7 Is a Site management strategy required?**

Based on the identified asbestos in soil impacts identified within the Study Area, a site management strategy is required to manage the potential health based risks to future site workers/users. Consideration is also required to be given to management of potential worker exposure risks during site development activities and the potential for migration of airborne asbestos fibres from the Study Area.

## 12. Conclusions and Recommendations

### 12.1 Conclusions

Based on the findings of this assessment and subject to the limitations in **Section 13**, the following conclusions are provided with respect to contamination conditions within the Study Area:

- The Study Area has historically been used for recreational and sporting purposes with the current stadium facilities constructed in the early to mid-1980s following a fire and subsequent demolition of the former grandstand and oval facilities.
- Development works have included significant modification of the natural topography within the Study Area resulting the presence of several areas of significant fill material, including areas to the north and south of the Stadium and within the western carpark area. Fill material has been identified within the Study Area extending to depths of between 0.1 m below current ground surface (bgs) to greater than 3 m bgs (including to 6 m in the northern fill mound at the northern site boundary). In a number of locations in the north, west and south of the Study Area, fill material below the ground surface was observed to contain visible inclusions of asbestos containing material (ACM) in friable or non-friable (bonded) form.
- In addition to observations of ACM in fill material, laboratory analysis of representative soil samples has also identified the presence of asbestos in soil at a range of locations across the Study Area, consistent with the presence of fill material. As such, the soils identified as impacted with asbestos/ACM are considered to represent a potentially unacceptable risk to future site receptors.
- Concentrations of chemical contaminants of potential concern (COPCs) in representative soils were identified to be less than the adopted health based site assessment criteria and apart from several isolated occurrences, less than the adopted ecological assessment criteria. As such, chemical contaminants are considered not to pose an unacceptable risk to identified receptors.
- Concentrations of COPCs in representative groundwater samples were generally less than the adopted site assessment criteria. Minor exceedances of a number of individual heavy metals in some samples are considered representative of typical conditions in urban environments in similar geological settings. These conditions are considered to not represent a unacceptable risk to human and/or ecological receptors within or downgradient of the site.
- No background contaminant concentrations in natural soils, chemical mixtures in soil or groundwater or significant offsite contaminant migration risks were identified during the investigation that require further consideration with respect to decisions regarding the suitability of the site for the proposed use or requirements for management such that the site may be considered suitable.
- It is considered the site can be made suitable for the proposed land use subject to the implementation of an appropriate remediation/management strategy to address the identified asbestos impacts.

### 12.2 Recommendations

It is recommended that a remedial action plan (RAP) incorporating an asbestos management plan (AMP) be developed in accordance with the relevant regulatory requirements. The RAP will document procedures and standards to be followed in order to address the identified asbestos

impact, ensuring the protection of human health and the surrounding environment, such that the asbestos impact is remediated / managed in a manner as to make the site suitable for the proposed future uses.

It is anticipated that the RAP will be prepared in conjunction with the design of the specific development scheme and subsequently included within the Stage 2 project development application such that development consent may be obtained for the remedial works.

A combined Environmental/Asbestos Management Plan (E/AMP) should be prepared in conjunction with development of the RAP, documenting environmental and occupational monitoring and management measures required to be implemented during remediation and construction related activities proposed to be undertaken at the Site. the E/AMP will be required until such time as the Site can, via remediation and subsequent validation, be considered suitable for the proposed use, potentially inclusive of ongoing management, should asbestos containing soil remain underlying suitable containment measures.

As demolition works may commence prior to the commencement of the detailed stadium design phase (inclusive of the RAP preparation), a standalone AMP should be prepared specific to management of asbestos risks during and following the demolition works. This AMP will be required to address the removal of asbestos within the existing structures and the management of asbestos in soil exposure risks during the demolition activities. This will primarily address the potential for dust generation from the ground surface during and following demolition activities, but will also be required to consider the potential for exposure of workers and/or migration of impacted soil during removal of in-ground structures as may occur during the demolition works.

Given that access was not available to the Parramatta Swimming Centre portion of the Project Site at the time of the site investigation, intrusive site contamination investigation works have not as yet been completed within this portion of the Project Site. Based upon the conceptual site contamination model as presented in this assessment, it is considered likely that contamination issues within this site portion will be consistent with those identified for the balance of the Project Site, primarily being asbestos impacts. Until such time as access is available to the swimming centre site to complete an appropriate investigation of site conditions, planning for demolition phase works should adopt a consistent site contamination/asbestos management requirements across the whole of the Project Site as outlined above. Should future site investigation works, anticipated to occur following closure of the pool to the public, identify the absence of asbestos in soil and/or other contamination concerns requiring management, the AMP and RAP documentation could be revised to reflect the additional information.

### **13. Limitations**

This advice is provided for use by the client who commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties. The advice has been prepared specifically for the client for the purposes of the commission. No warranties, express or implied, are offered to any third parties and no liability will be accepted for use or interpretation of this advice by any third party.

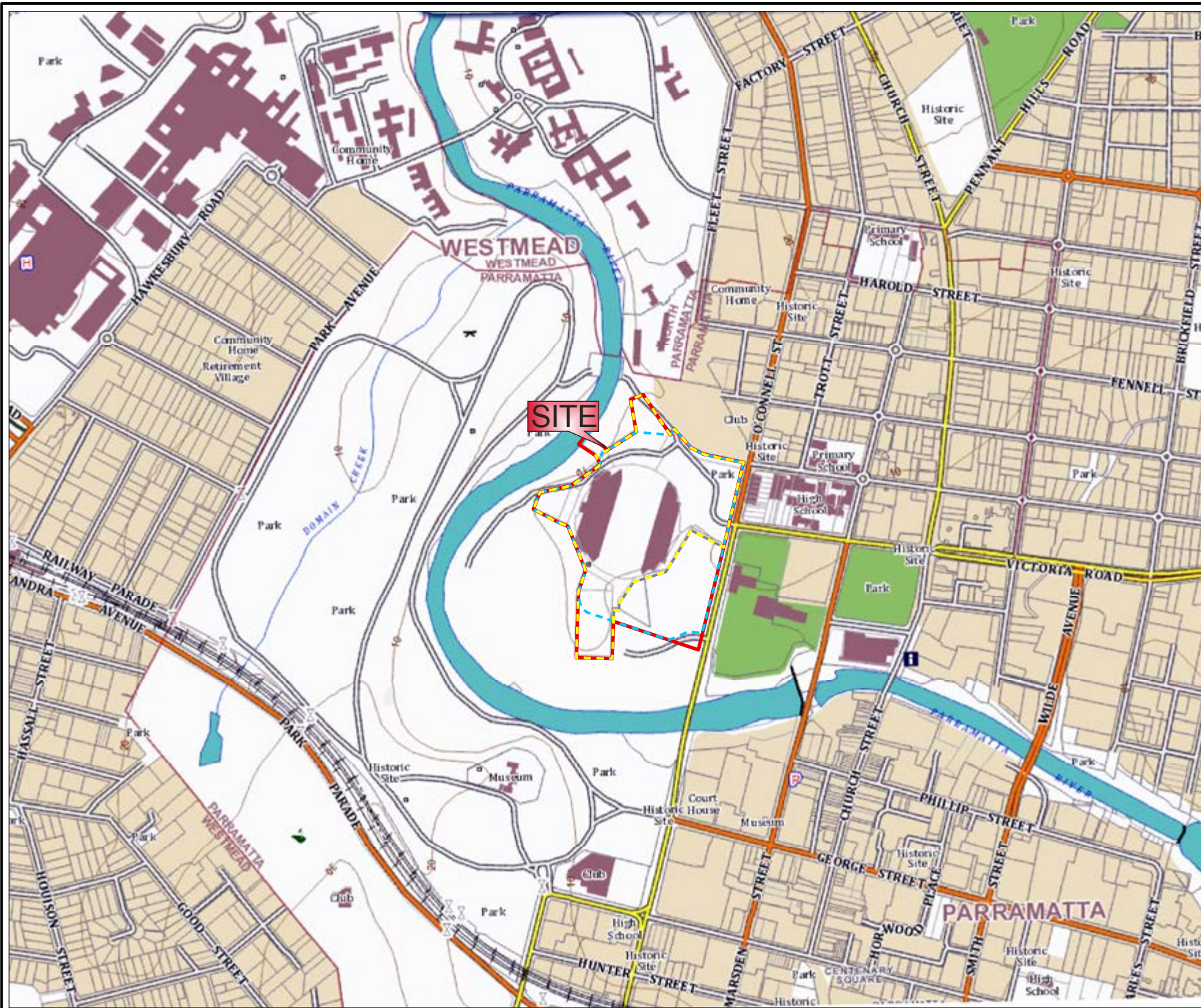
The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G.

Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, that were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the advice provided herein, through natural processes or through the intentional or accidental addition of contaminants. The advice is based on the information obtained or available at the time the advice is provided.

This advice is not a complete assessment of the status of the site, and it is limited to the scope of works commissioned. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the advice in the context of the additional information

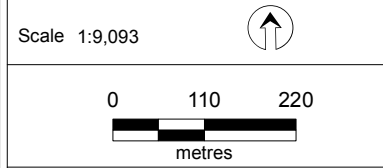
## Figures



- Legend:**
- The Site
  - The Study Area
  - Demolition Works Area



Job No: 51666  
 Client: Infrastructure NSW  
 Version: R01 Rev A    Date: 30-Jun-2016  
 Drawn By: SE    Checked By: JR

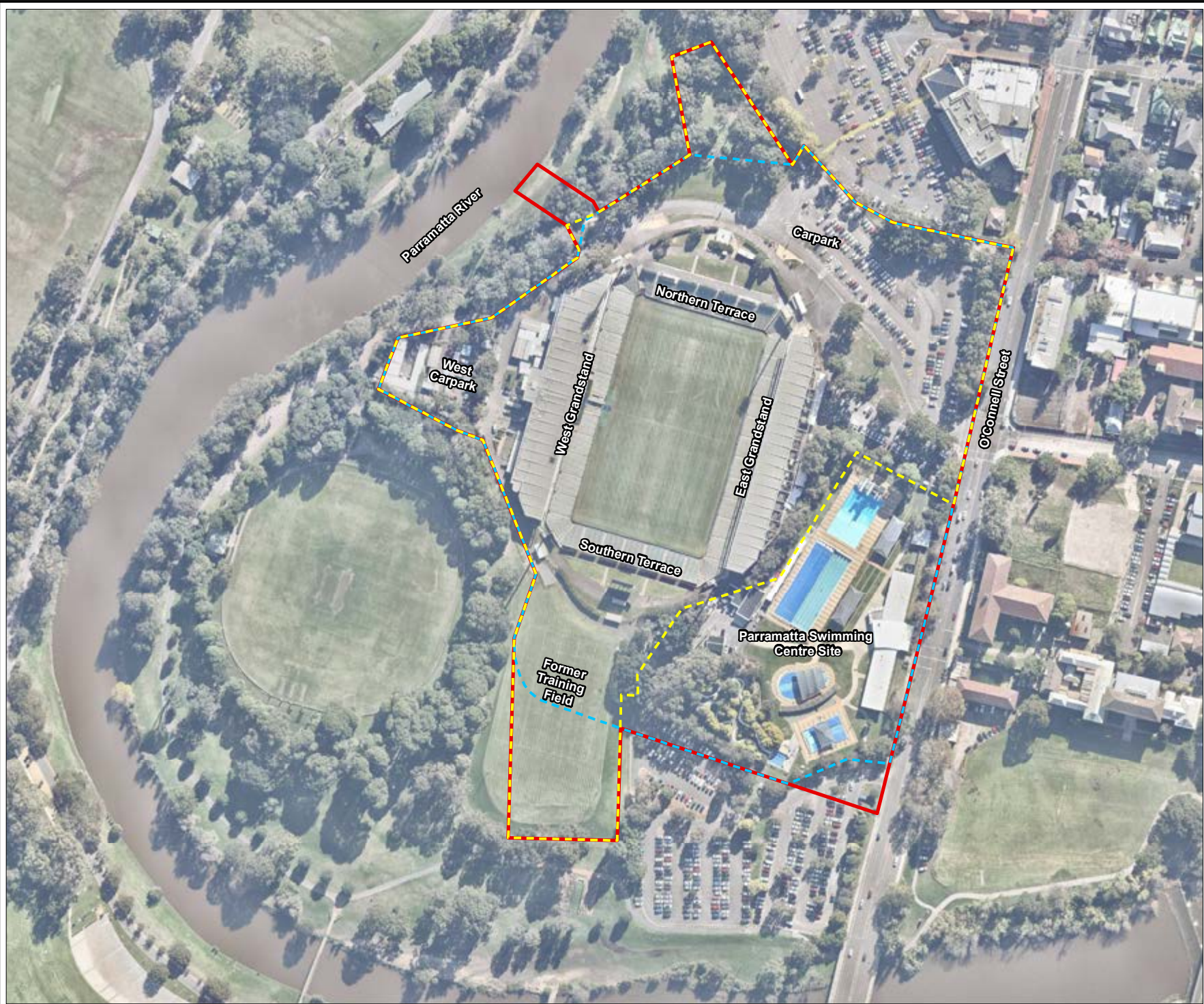


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**Parramatta Stadium  
 Parramatta, NSW**

**SITE LOCATION**

**FIGURE 1**



- Legend:**
- The Site
  - The Study Area
  - Demolition Works Area



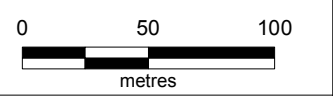
Job No: 51666

Client: Infrastructure NSW

Version: R01 Rev A      Date: 30-Jun-2016

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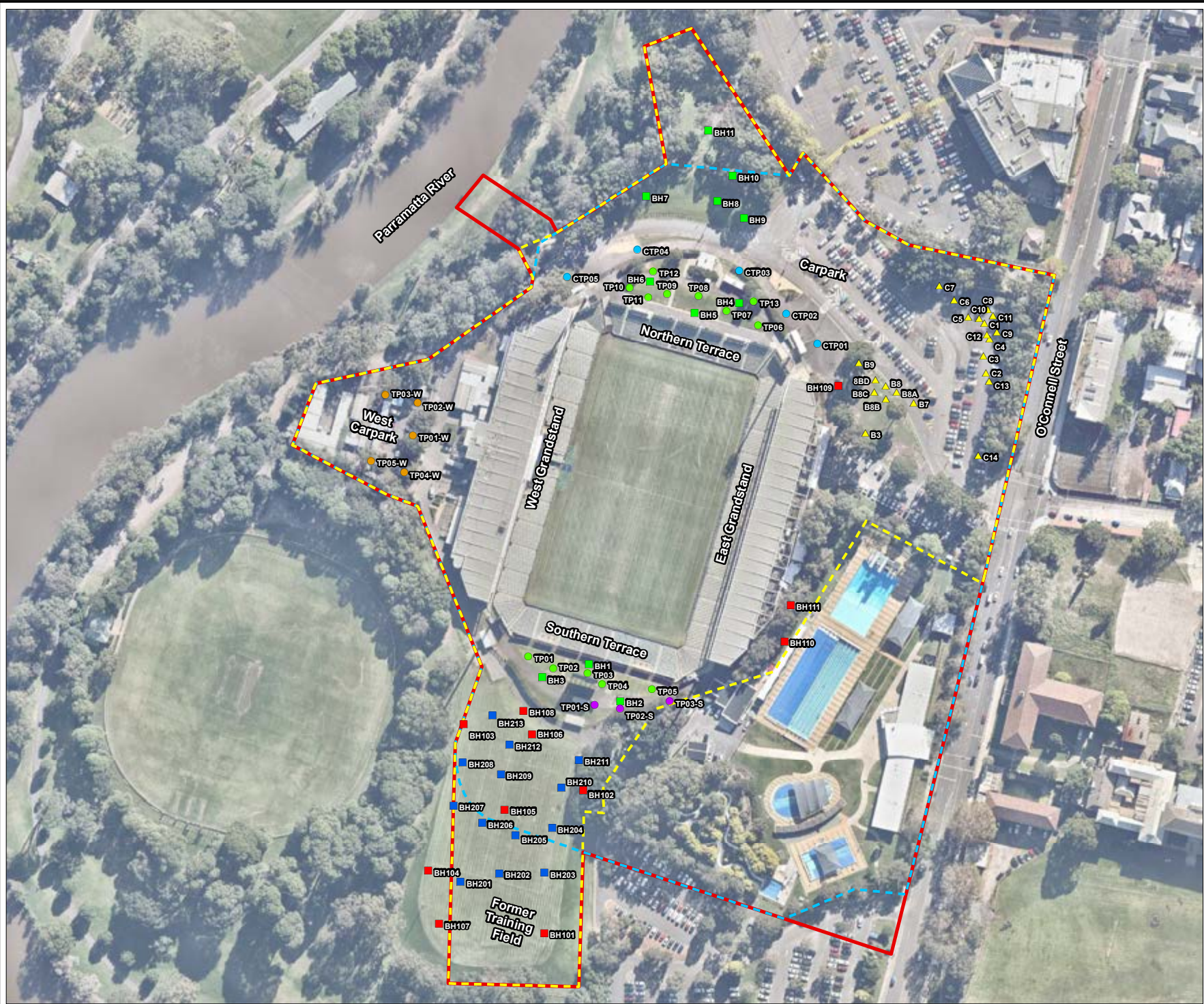


Coor. Sys. GDA 1994 MGA Zone 56

**Parramatta Stadium  
Parramatta, NSW**

**SITE LAYOUT**

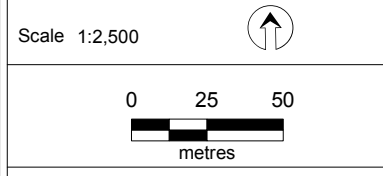
**FIGURE 2**



- Legend:**
- The Site
  - The Study Area
  - Demolition Works Area
- Historical Sample Location**
- EIS 2014a
  - EIS 2014b
  - EIS 2014c
  - JBS&G 2015a
  - JBS&G 2015b
  - JBS&G 2015c
  - JBS&G 2015d
  - ▲ WSP 2007



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**Parramatta Stadium  
 Parramatta, NSW**

**PREVIOUS SITE INVESTIGATION  
 LOCATIONS**

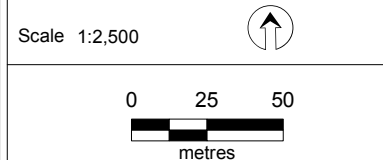
**FIGURE 3**



- Legend:**
- The Site
  - The Study Area
  - Demolition Works Area
  - Borehole Location
  - Groundwater Monitoring Well Location



Job No: 51666  
 Client: Infrastructure NSW  
 Version: R01 Rev A      Date: 30-Jun-2016  
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**Parramatta Stadium  
 Parramatta, NSW**

**ADDITIONAL SITE INVESTIGATION  
 LOCATION PLAN**

**FIGURE 4**

|             |         |               |
|-------------|---------|---------------|
| <b>BH11</b> | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| FA & AF     | 4.5     | Present       |

|             |         |               |
|-------------|---------|---------------|
| <b>BH10</b> | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| ACM in Soil | 0.4-0.5 | Present       |
| ACM in Soil | 4.4-4.5 | Present       |
| FA & AF     | 4.5     | Present       |

|             |         |               |
|-------------|---------|---------------|
| <b>BH8</b>  | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| ACM in Soil | 3.6-3.7 | Present       |
| ACM in Soil | 5.2-5.4 | Present       |
| ACM in Soil | 5.9-6.0 | Present       |
| FA & AF     | 6       | Present       |

|             |         |               |
|-------------|---------|---------------|
| <b>BH12</b> | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| FA & AF     | 10-2.0  | 0.0022 %w/w   |

|              |         |               |
|--------------|---------|---------------|
| <b>CTP05</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| FA & AF      | 0.2-0.3 | 0.0225 %w/w   |

|             |         |               |
|-------------|---------|---------------|
| <b>TP10</b> | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| ACM in Soil | 0.3-0.5 | Present       |

|               |         |               |
|---------------|---------|---------------|
| <b>TP02-W</b> | Depth   | Concentration |
| Analyte       | (m BGS) |               |
| ACM in Soil   | 0.2-0.3 | 0.0467 %w/w   |
| FA & AF       | 0.2-0.3 | 0.0044 %w/w   |

|              |         |               |
|--------------|---------|---------------|
| <b>BH213</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| FA & AF      | 0.3-0.5 | 0.0225 %w/w   |

|              |          |               |
|--------------|----------|---------------|
| <b>BH212</b> | Depth    | Concentration |
| Analyte      | (m BGS)  |               |
| FA & AF      | 0.5-0.95 | 0.15 %w/w     |
| ACM in Soil  | 2.0-5.0  | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH209</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| ACM in Soil  | 14      | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH210</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| FA & AF      | 10-15   | 0.11 %w/w     |
| ACM in Soil  | 14      | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH207</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| ACM in Soil  | 13      | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH201</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| ACM in Soil  | 13      | Present       |
| ACM in Soil  | 19      | Present       |

|             |          |               |
|-------------|----------|---------------|
| <b>BH9</b>  | Depth    | Concentration |
| Analyte     | (m BGS)  |               |
| ACM in Soil | 2.95-3.0 | Present       |
| FA & AF     | 3        | Present       |

|             |         |               |
|-------------|---------|---------------|
| <b>BH39</b> | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| Copper      | 0.0-0.1 | 230 mg/kg     |

|             |         |               |
|-------------|---------|---------------|
| <b>BH14</b> | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| FA & AF     | 10-2.0  | 0.007 %w/w    |

|             |         |               |
|-------------|---------|---------------|
| <b>MW03</b> | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| FA & AF     | 0.2-0.3 | 0.0041 %w/w   |

|             |         |               |
|-------------|---------|---------------|
| <b>B8</b>   | Depth   | Concentration |
| Analyte     | (m BGS) |               |
| ACM in Soil | 0.5     | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH211</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| FA & AF      | 10-15   | 0.15 %w/w     |
| FA & AF      | 15-195  | 0.02 %w/w     |
| ACM in Soil  | 12-2.2  | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH204</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| ACM in Soil  | 13-2.4  | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH205</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| ACM in Soil  | 13-2.5  | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH203</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| ACM in Soil  | 2.4     | Present       |

|              |         |               |
|--------------|---------|---------------|
| <b>BH101</b> | Depth   | Concentration |
| Analyte      | (m BGS) |               |
| ACM in Soil  | 0.4-0.5 | Present       |
| FA & AF      | 19-2.0  | 0.011 %w/w    |

- Legend:**
- The Site
  - The Study Area
  - Demolition Works Area
  - Asbestos Present At Less Than Guideline Criteria
  - Asbestos Exceedances (Known / presumed)
  - Borehole Location
  - Groundwater Monitoring Well Location
- Historical Sample Location**
- EIS 2014a
  - EIS 2014b
  - EIS 2014c
  - JBS&G 2015a
  - JBS&G 2015b
  - JBS&G 2015c
  - JBS&G 2015d
  - ▲ WSP 2007



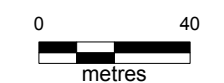
Job No: 51666

Client: Infrastructure NSW

Version: R01 Rev A Date: 30-Jun-2016

Drawn By: SE Checked By: JR

Scale 1:2,000

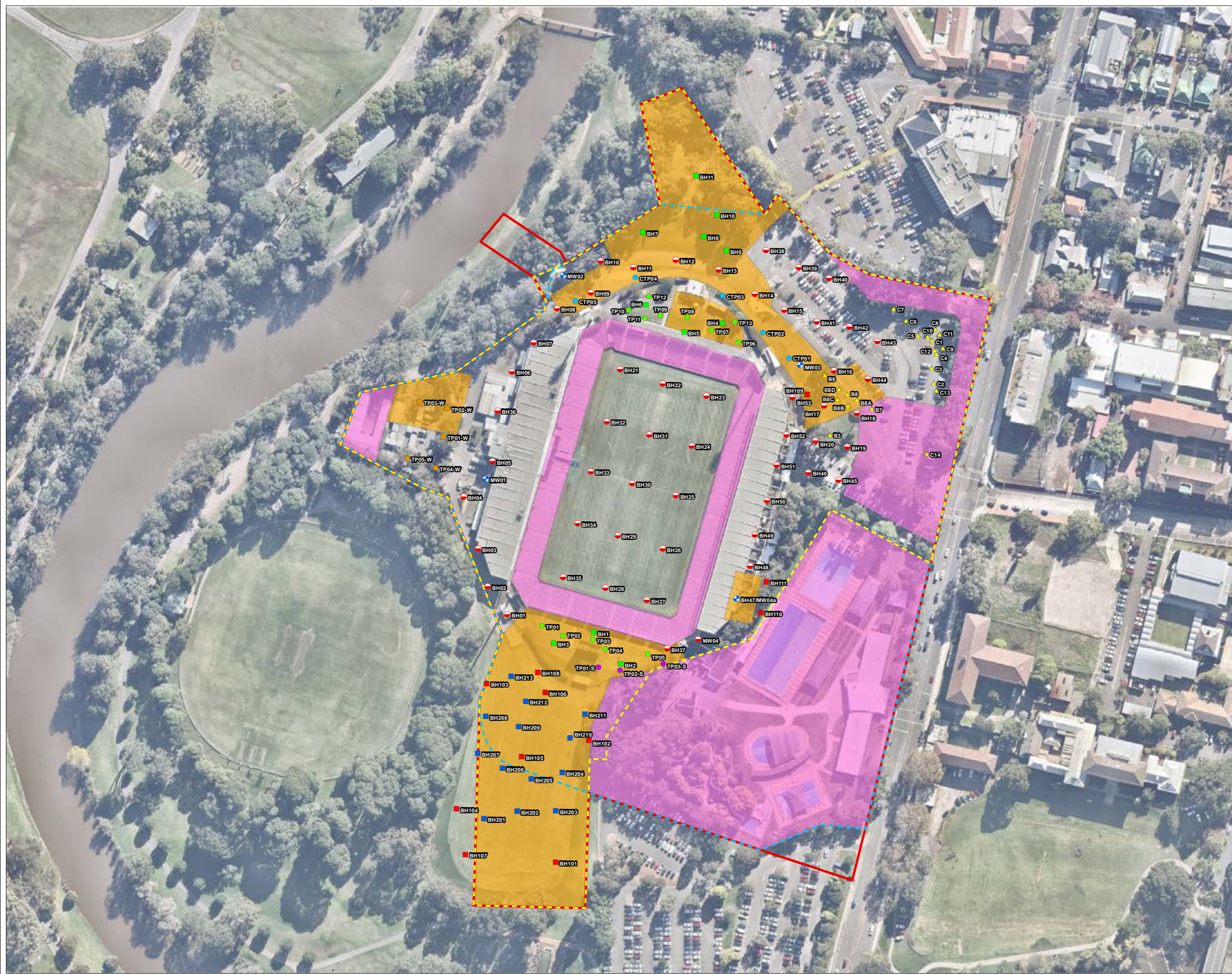


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**SOIL EXCEEDANCES**

**FIGURE 5**



- Legend:**
- The Site
  - The Study
  - Demolition Works
  - Known / Interpreted Asbestos In Soil Impact Extent
  - Area Requiring Further Assessment To Establish Management Requirements
  - Borehole Location
  - Groundwater Monitoring Well Location
- Historical Sample Location**
- EIS 2014a
  - EIS 2014b
  - EIS 2014c
  - JBS&G 2015a
  - JBS&G 2015b
  - JBS&G 2015c
  - JBS&G 2015d
  - ▲ WSP 2007



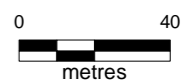
Job No: 51666

Client: Infrastructure NSW

Version: R01 Rev A      Date: 13-Jul-2016

Drawn By: SE      Checked By: JR

Scale 1:2,000



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Parramatta, NSW**

**AREAS REQUIRING  
IMPLEMENTATION OF ASBESTOS  
IN SOIL MANAGEMENT CONTROLS**

**FIGURE 6**