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LEND LEASE (MILLERS POINT) PTY LTD

Barangaroo Hickson Road Remediation Area

Soil and Water Impact Assessment Report (Ex-situ Method)

to accompany the

Remediation Works Development Application (SSD 6617–2014)

301015-03532-EN-REP-003 – Rev 2

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SYNOPSIS

This Soil and Water Assessment Report has been prepared for Lend Lease Millers Point to accompany a Development Application for Remediation of part of **Hickson Road** at Millers Point (SSD 6617-2014). It is to be submitted to the Minister for Planning for approval pursuant to Part 4 of the *Environmental Planning and Assessment Act, 1979*. The area of Hickson Road to be remediated is the subject of NSW EPA Remediation Site declaration 21122.

Confidentiality

PROJECT 301015-03532 - BARANGAROO HICKSON ROAD REMEDIATION AREA SOIL AND WATER IMPACT ASSESSMENT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE
A	Draft for Client Review	AJD A Dunphy	TIM T Michel		9-Oct-2014
B	Final Draft	AJD A Dunphy	CRT C Thomas		17-Nov-2014
0	Final	AJD A Dunphy	CRT C Thomas	CRT C Thomas	9-Mar-2015
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2	Updated Final 2	A Dunphy A Dunphy	CRT C Thomas	C Thomas C Thomas	8-Apr-2015

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GLOSSARY OF TERMS

AHD	Australian Height Datum
ARI	Average Recurrence Interval
BDA	Barangaroo Delivery Authority
BGL	Below Ground Level
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes (Monocyclic Aromatic Hydrocarbon)
Block 4 Remediation Area	Portion of the Declaration Area situated within Barangaroo South
Block 5 Remediation Area	Portion of the Declaration Area situated within Barangaroo Central (including remediation of some land adjacent to the Declaration Area on the west)
CBD	Central Business District
COPC	Contaminants of Potential Concern
DECCW	NSW Department of Environment, Climate Change and Water
EIL	Ecological Investigation Levels
EPA	Environment Protection Authority
EPA Declaration Area	Remediation Site Declaration 21122. Refer to **Appendix 1** and **Appendix 2**.
EPL	Environment Protection Licence
Ex-situ Remediation Methodology	Excavation of contamination and off-site disposal (with off-site treatment, where required)
Hickson Road Remediation Area	Portion of Hickson Road that requires remediation to facilitate removal pf the EPA Remediation Site Declaration 21122.
In-situ Remediation Methodology	Remediation using in-situ chemical oxidation and/or extraction (product recovery).
Lend Lease	Lend Lease (Millers Point)
OEH	NSW Office of Environment and Heritage
OCP	Organochlorine Pesticide
OPP	Organophosphate Pesticide
PAH	Polycyclic Aromatic Hydrocarbons

PCB	Polychlorinated Biphenols
PPT	Parts per Thousand
RAP	Remedial Action Plan
RL	Reduced Level
RWP	Remedial Works Plan
SEARs	Secretary's Environmental Assessment Requirements
Site	Area required for the purpose of the Hickson Road Remediation Development Application identified as: • Hickson Road Remediation Area • Any other areas of Barangaroo or Hickson Road required for staging and undertaking the remediation works.
Site Remediation Area	The Hickson Road Remediation Area
SROH	Significant risk of harm
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
VMP	Voluntary Management Proposal
WTP	Water Treatment Plant

1. INTRODUCTION

1.1 Background

WorleyParsons has been engaged by Lend Lease Millers Point (Lend Lease) to prepare a Soil and Water Impact Assessment report to accompany Development Application (DA) SSD 6617-2014 for the Ex-situ Method of remediation of part of Hickson Road at Millers Point. The DA is to be submitted to the Minister for Planning for approval pursuant to Part 4 of the *Environmental Planning and Assessment Act, 1979*. The area of Hickson Road to be remediated is the subject of NSW EPA Remediation Site declaration 21122.

1.2 Scope of this Report

This report has been prepared to respond to the Department of Planning and Environment's *Secretary's Environmental Assessment Requirements* (SEARs) issued in respect of DA *SSD 6617-2014 Remediation works including part of Hickson Road within the EPA Declaration Area, Barangaroo Central* dated 18 August 2014. The SEARs are outlined as follows. This report is related to the Ex-situ Method option only proposed in the DA.

5. Soil and Water

- *Assess impacts on water quality of Sydney Harbour and surface and groundwater hydrology and quality including proposed management, mitigation and monitoring measures;*
- *Details of water supply including consideration of alternative water supply arrangements and water conservation measures;*
- *Erosion, sediment and stormwater management and controls during construction and remediation; and*
- *Consideration of any impacts on Groundwater Dependent Ecosystems.*

In addition to assessing the relevant SEARs applicable for DA SSD 6617-2014 with respect to soil and water, Lend Lease also engaged WorleyParsons to address in this Soil and Water Impact Assessment, as relevant, the items of DECCW's (now EPA) letter of 12th August 2010 regarding MP 10 0023 Basement and Bulk Earthworks Project Application. The relevant items are as follows:

Water

a. *Water volume management;*
b. *Anticipated volumes of water generated on-site including potential volumes of groundwater and stormwater discharges;*
c. *Volumes of wastewater to be treated on-site;*
d. *Volumes for recycling/reuse; and*

e. *Volumes to be discharged to sewer.*

Water monitoring

a. *Criteria for nominating areas and different sources of site water as clean or contaminated;*

b. *Water monitoring protocols and decision criteria for whether site water will be directed to stormwater, a water treatment plant, to sewer or to a liquid waste facility;*

c. *Water discharge criteria and monitoring frequency for parameters listed in the "Water Quality Monitoring Requirements" document prepared as part of the EA;*

d. *Details of an initial more intensive monitoring program for sediment basins, stormwater discharges; reuse water and ambient waters to help determine potential water quality impacts and ongoing monitoring protocols;*

e. *Details of specific discharge and monitoring points for on-site waters including for collected groundwater seepage into excavations, sediment basins for clean or contaminated areas, discharge points to stormwater drains, and confirmation of ambient monitoring locations in Darling Harbour and Johnstons Bay;*

f. *Suitability of Johnstons Bay as a reference site based on turbidity data from Darling Harbour and Johnstons Bay or a monitoring plan to determine its suitability;*

g. *Consideration of tidal currents, circulation patterns in Darling Harbour and the position of stormwater discharge points with regard to the positioning of monitoring location(s) outside the turbidity curtain. The location may not be a fixed point so that it can account for potential plume movement under different conditions. Alternatively, more than one location may be needed; and*

h. *Consider developing criteria for wastewater discharges that would trigger a review of water management systems. These criteria can trigger operational responses that help to ensure licence limits are never exceeded.*

Stormwater and sediment controls

a. *A better description of measures for stormwater and sediment control for specific locations on the site (e.g. positioning of detention basins, silt fences, silt arrestors, filter socks and fixed hay-bales in relation to sediment sources, stockpiles and stormwater outlets); and*

b. *The proposed silt curtain in Darling Harbour should not be used as a primary sediment control mechanism. Sediment control systems must be implemented on site as the primary sediment containment mechanism.*

Operational procedures

a. *An operational plan for how contaminated water and sediment control systems will be implemented, operated and maintained;*

b. *A fuller description of what the water management plan will include, e.g. operation of silt curtains; employing bunding and filtrations systems, dewatering methods; and*

c. Details to prevent contaminated water, either treated or untreated, being discharged to Darling Harbour. Alternatives must be found (e.g. reuse of treated water onsite or discharge to sewer under a Trade Waste Agreement).

Wastewater and effluent reuse onsite

a. Criteria for wastewater or effluent reuse for either contaminated or clean sources; and

b. Management practices for reuse of treated wastewater from contaminated areas.

Waste

1. A stockpile, contamination soil and sediment management plan including (at a minimum):

a. The exact locations where contaminated waste material (including Acid Sulphate Soils) and non-contaminated waste material will be stockpiled. Contaminated and non-contaminated waste material must be stockpiled separately and the designated areas must be clearly marked and labelled (on the plans and on the ground);

b. Details of how stockpiled contaminated waste material will be kept separate from non-contaminated waste material;

c. Details of how runoff from stockpiled contaminated waste material will be kept separate from non-contaminated runoff;

d. Details of measures to be employed to manage leachate runoff from all stockpiles, including bunding, sediment ponds and hay bales. The Plan should include locations of each control measure, its specifications and its capacity to cope with runoff from a designed storm event (to be determined in consultation with DECCW (now EPA);

e. The maximum proposed heights and volumes for each stockpile to reduce the potential for dust and odour and greater detail on stockpile stabilisation and covering to minimise odour and vapour emissions;

f. Procedures for minimising the movement of waste material around the site and double handling; and

g. *Additional information detailing how materials proposed to be recycled / reused will be segregated on the site during operations. Particularly in relation to those wastes categorised as "Building" waste.*

2. PROJECT DESCRIPTION

Barangaroo is a significant site located on the north western edge of the Sydney Central Business District (CBD), adjacent to Sydney Harbour.

The NSW Government held an international urban design competition for the site in 2005 and the winning entry was used as the basis for the original Barangaroo Concept Plan which was approved in February 2007. This sets out the urban design and policy initiatives to be employed in the redevelopment of the site.

The approved Concept Plan (as modified) is the statutory planning approval to guide the urban renewal of Barangaroo and currently provides for the development of a mixed use precinct comprising commercial, retail, residential and community development and new public open space / public domain areas.

The Barangaroo Delivery Authority (BDA) is the state government authority that manages and delivers the development of Barangaroo.

2.1 Site Description

Barangaroo is a 22 ha site located on the north-western edge of the Sydney CBD. Its northern and western boundaries adjoin Sydney Harbour and its eastern boundary is formed by the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach. It is bound to the south by a range of new development dominated by large CBD commercial tenants. It is approximately rectangular in shape and has a 1.4 km frontage to the harbour foreshore.

Hickson Road delineates the eastern boundary of Barangaroo and is a public road.

2.1.1 Site History

The Millers Point gasworks operated on the site between 1840 and 1921. The site has subsequently been used for various activities, but predominantly as a commercial port facility and public road.

When the NSW Environmental Protection Authority (EPA) declared parts of Barangaroo and Hickson Road a “Remediation Site” (refer **Section 2.1.3**), it described the nature of the contamination as gasworks waste; that is, waste tar resulting from the operation of a gasworks plant.

2.1.2 Contamination

Numerous investigations have been undertaken to date in relation to site contamination. The most recent commentary on contamination is resented in AECOM’s Remedial Action Plan (RAP) (2013).

Separate phase gasworks waste and tar (SPGWT) as defined within the RAP (AECOM, 2013) refers to:

- Tar containing materials (TCM):

- Greater than 10% visible coal tar (where coal tar is a phase separate hydrocarbon by-product from coal gasification); and/or

- Contamination concentrations exceed the follow limits:

o polycyclic aromatic hydrocarbons (PAHs) = 2,000 mg/kg; or

o benzo(a) Pyrene (B(a)P) = 150 mg/kg.

- Dense non aqueous phase liquids (DNAPLs).

All SPGWT identified on the Site and in adjacent areas is required to be remediated to the extent practicable (AECOM, 2013).

Soil analytical testing has been undertaken (AECOM, 2013). An overview of the findings is listed below:

- Odour, staining and sheen in soil samples is identified as being common in fill materials.

- The maximum concentrations of contaminants of potential concern (CoPC) were generally located in proximity to and down gradient of the former gasworks infrastructure. CoPCs including lead, total petroleum hydrocarbons (TPH) (C_6 – C_9 and C_{10} – C_{36}), BTEX compounds, PAHs (including benzo(a)pyrene (B(a)P) and sulphate variably exceeded the adopted site investigation criteria.

- SPGWT was identified, therefore confirming that the former gasworks is a source of contamination.

- It is noted that it is reasonable to anticipate that asbestos may be present within fill at the Site.

The groundwater monitoring wells in Hickson road were generally installed within fill material (i.e. no significant horizons of marine sediments were encountered). CoPC concentrations were reported to exceed the groundwater site specific target criteria – voluntary management proposal ($SSTC^{VMP}$) within fill material within the former gasworks infrastructure where SPGWT has been identified (AECOM, 2013).

It was noted within the RAP (AECOM, 2013) that a significant improvement in contaminant mass flux would be realised by the proposed remediation.

2.1.3 EPA Declaration Area 21122

In May 2009, the EPA determined (Declaration) that a portion of land at Millers Point (part of the Barangaroo Site and an adjacent portion of Hickson Road), was contaminated in such a way as to present a significant risk of harm (SROH) to human health and the environment. As a consequence the EPA declared the area to be a remediation site (Declaration Number 21122; Area Number 3221) under the *Contaminated Land Management Act 1997*.

The Remediation Site Declaration 21122 indicates that the area of the declaration coincides with the known footprint of the former Millers Point gasworks facilities. This area is located on part of Barangaroo and part of Hickson Road adjacent to Barangaroo.

In accordance with Declaration Number 21122, the Declaration Area comprises:

- Part Lot 5 and Part Lot 3 DP 876514, Hickson Road, Millers Point, NSW 2000
- Part of Hickson Road adjacent to:
- 30-34 Hickson Road (Lot 11, DP1065410)
- 36 Hickson Road (Lot 5, DP873158)
- 38 Hickson Road (SP72797) Millers Point

The BDA has entered into a Voluntary Management Proposal (VMP) with the EPA for the Declaration Area (Approval No. 20101719). Phase 1 of this VMP involves investigation to determine a remediation design for the site and to obtain agreement on a proposed remediation methodology. Phase 2 of the VMP (to be finalised following Phase 1) will involve the implementation of the agreed remediation works.

An independent, EPA-accredited Environmental Site Auditor has been appointed to undertake a review of the proposed remediation works, and prepare statutory audit statements prior to and following completion of remediation.

The location of the Declaration Area is included within **Appendix 1**. The location of the Declaration Area in the context of the surrounding area is shown on the diagram enclosed within **Appendix 2**.

The EPA Declaration Area 21122 covers an area of approximately 2.1 hectares. For the purposes of planning and staging works, the EPA Declaration Area is divided into three areas as follows:

- Block 4 Remediation Area – the part of the Declaration Area on Barangaroo South.
- Block 5 Remediation Area – the part of the Declaration Area on Barangaroo Central (including remediation of some land adjacent to the Declaration Area on the west).
- Hickson Road Remediation Area – the part of the Declaration Area located on Hickson Road.

DA SSD 6617-2014 is for Hickson Road Remediation Area only. The remediation of the remaining parts of the Declaration Area (i.e., Block 4 and Block 5) will be the subject of separate development applications and are not considered further in this report.

2.2 Role of Lend Lease in the Remediation of the EPA Declaration Area

Lend Lease has been appointed by the BDA as their contractor to undertake remediation of the Declaration Area, which includes the Hickson Road Remediation Area. Prior to the commencement of

the associated works, Lend Lease has committed to a process of detailed assessment and design in order to develop the proposed remediation strategy for the Site.

Lend Lease has also been appointed by the BDA as the Proponent to undertake the development for Barangaroo South.

2.3 Planning Context

Approval for the works is being sought from the Minister for Planning under Part 4 of the *Environmental Planning and Assessment Act, 1979*.

2.4 Proposed Works

2.4.1 Overview

The proposed remediation of the Hickson Road part of the Declaration Area is detailed in the RAP prepared by AECOM (2013). The key objective of the remediation works, as identified in the RAP, is to enable the NSW EPA's declaration of the Declaration Area as a Remediation Site to be revoked.

The RAP details the remediation works required to achieve the remediation objectives, including the extent of remediation required, and the validation testing and monitoring to be undertaken to confirm completion of the remediation works.

The proposed works include temporary protection of existing stormwater drainage infrastructure within the site and / or diversion of stormwater to enable remediation to proceed, where required.

If the Ex-Situ method is undertaken a temporary Water Treatment Plant (WTP) on the Barangaroo site may be in operation throughout the duration of the Hickson Road Remediation Works for the treatment of extracted groundwater and surface water runoff (where required). Alternatively, extracted water will be tankered off-site for licensed disposal.

The RAP includes two potential options for remediating Hickson Road:

- In-situ remediation (chemical oxidation); or
- Ex-situ remediation (excavate, off-site disposal and backfill).

An overview of the Ex-situ Method is presented in the following section. For both options Hickson Road is to remain open for traffic and therefore temporary road closures/diversions are to be put in place during the undertaking of the remediation works.

The Development Application for Hickson Road includes both options. Following agreement with the NSW EPA one option will be adopted. The preferred remediation methodology is in-situ remediation.

This report assesses the soil and water impacts associated with the implementation of the potential Ex-Situ Method (alternative) only. It is noted that impacts for the in-situ method are being assessed and reported separately.

2.4.2 Ex-Situ Remediation

The remediation method associated with this option is excavation of contaminated materials followed by off-site disposal (and treatment where required) of the material at licensed facilities, backfilling and re-instatement of road/footpath.

An overview of the staging associated with this option is listed in **Table 2-1** and illustrated on **Figures 1** to **6**.

Table 2-1 Ex-situ Remediation Method – Staging Overview

Stage No.	Overview
1	East half – Establish/commissioning Temporary removal of street parking for works Remove street trees Divert traffic to west half Service diversion where required Install retention systems Install and commission odour structures Install dewatering infrastructure
2	East half - remediation Excavate, and dispose off-site (with licensed off-site treatment, where required) Dewatering
3	East half - remediation Validate excavations Backfill excavations Road/footpath restoration Decommission odour structures
4	West half - Establish/commissioning Divert traffic to east half Remove street trees Service diversion where required Adjust existing retention systems Install & commission odour structures Install dewatering infrastructure
5	West half – remediation Excavate, and dispose off-site (with licensed off-site treatment, where required) Dewatering

Stage No.	Overview
6	West half – remediation Validate excavations Backfill excavations Road/footpath restoration Decommission odour structures Reinstate street parking and trees

A summary of the works associated with this option are outlined below.

1. Licenses/Approvals

- Obtain all licences/approvals required.
- This includes a variation to the existing Environment Protection Licence (EPL), any waste approvals, conditions of planning approval, road authority etc.

2. Site Establishment

- Implement temporary traffic diversion as required, this includes the temporary removal of street parking. Maintain through traffic on Hickson Rd at all times.
- Implement pedestrian diversions, where required.
- Undertake local protection/pruning of Hickson Road trees, where required. To be undertaken as per the Arboricultural Impact Assessment (Tree Wise Men, 2014).
- Install general environmental controls for works (for example, bunding, sediment controls).
- Undertake remediation in two main stages:
- 1st stage - Temporarily close one half and undertake remediation, backfilling and re-surfacing, while traffic is diverted to other half.
- 2nd stage - Following 1st stage (including re-instatement), re-divert traffic and complete remaining stage.
- Hoard and fully secure exclusion zones and decontamination areas to prevent unauthorised access
- Establish plant/equipment and site accommodation.
- Organise after-hours deliveries for over-sized loads to minimise the impact on peak hour traffic.

3. Services Diversion

- Temporary diversions or protection of existing services, as required.

4. Perimeter Retaining Wall

- Install a groundwater control wall (for example, secant piles) at the boundary of 36 Hickson Road for the gasworks structures.
- Construct retention walls (for example, secant piles) within Hickson Road to facilitate excavation in controlled stages, as required.
- Implement odour control as per the Preliminary Hickson Road PRW Odour Control Plan (Lend Lease, 2014).
- Install temporary ground anchors or associated support structures.

5. Dewatering and Water Treatment

- Install dewatering infrastructure and piping to transfer dewatered groundwater to a temporary Water Treatment Plant (WTP) at Barangaroo, or transfer to a temporary storage prior to tankering off-site by licensed liquid waste contractors.
- Undertake groundwater extraction, transfer water to the WTP, treat water and discharge as per the EPL requirements.
- Where required, licensed liquid waste contractors to pump highly contaminated liquid waste (vacuum truck) and dispose material off-site.
- Roads disturbed by the placement of a trench for the dewatering infrastructure/piping to be appropriately restored to allow continued trafficking over it.

6. Construct Excavation Odour Control Structures

- Install temporary odour control structure(s) over required excavation areas, in stages. This may include installation of temporary ground structures (for example, piles/capping beam) and/or perimeter weights as required to provide support.
- Install odour control structures to ensure all odours are contained. Structures to include an air exhaust system and associated emissions control, air filters/treatment and stack. Structures may include retractable doors and an air lock system at the entrance/exit to minimise odour emissions.
- Final structures are subject to future detailed design.

7. Excavation

- Excavate contaminated soil from Hickson Road as per the AECOM RAP (2013). The indicative excavation volume is approximately 16,000m^3.
- Undertake excavation of eastern and western halves of Hickson Road in stages. All excavation to be undertaken beneath odour control structures.
- Excavate rock where required to facilitate contamination excavation from historic gasworks structures.

- Operate temporary odour control structures to manage and treat exhausted air.
- Decontaminate vehicles/plant in wheel wash/cleaning area, prior to moving off-site.
- Undertake detailed monitoring (air, noise and water) for the duration of the works.

8. Soil Treatment / Disposal

- Transport excavated contaminated material directly off-site for treatment or disposal in accordance with NSW EPA requirements and waste guidelines. Make allowance for temporary stockpiling, as required, to classify or inspect material.
- Transfer all material in sealed trucks (with odour suppressant foam or similar as required) to mitigate potential odours.
- Transport hazardous classified material off-site to a licensed treatment facility for treatment, prior to landfill disposal.

9. Hickson Road Area Validation

- Validate remediation areas as per the RAP (AECOM, 2013). This includes detailed soil and groundwater sampling and inspections.

10. Backfilling and Decommissioning

- Following each excavation stage, decommission the temporary odour control structures.
- Backfill and compact excavations with suitable imported fill or suitable excavated material.
- Undertake temporary restoration of the Hickson Road pavement and footpath where required to match existing.
- Plant new street trees to replace those removed (unless new landscaping requirements are approved generally for Hickson Road, under separate DA/approvals).

3. WATER SUPPLY AND WATER CONSERVATION

3.1 Relevant SEARs

This section has been prepared in response to the following SEAR:

- *Details of water supply including consideration of alternative water supply arrangements and water conservation measures.*

3.2 Overview

The demand for water generated by the proposed works outlined in **Section 2.4** will be minimal and will consist of:

- Site amenities, including kitchen facilities, toilets and showers.
- Dust control during excavation / backfilling.

Water demand at the Hickson Road Remediation Area will primarily be met by a connection to Sydney Water's potable water supply system.

Alternative sources of water may include harvested rainwater from the roofs of worker accommodation/site amenities and/or the roof over the excavation, and treated water from the WTP. These alternative water sources could substitute potable water for toilet flushing in the site amenities or for dust control across the site, and is subject to water quality and operational requirements.

3.3 Water Conservation Measures

In addition to the potential use of alternative water sources across the extent of the Hickson Road Remediation Area, the following water conservation measures should be implemented:

- The site accommodation should be fitted with water efficient devices, taps, showers and dual flush toilets to reduce water consumption.
- All hoses should be fitted with a trigger nozzle or device to prevent uncontrolled water flow.

4. STORMWATER

4.1 Relevant SEAR

This section has been prepared in response to the following SEAR:

- *Erosion, sediment and stormwater management and controls during construction and remediation.*

4.2 Definition

This section addresses stormwater, which is defined as that runoff from surfaces considered unaffected by contamination or construction, and therefore considered 'clean', noting that stormwater is typically not sufficiently clean to comply with ANZECC (2000) guidelines. Stormwater is considered to include runoff from areas such as roofs, roads, footpaths, general hardstand, parks and reserve areas.

Areas that have been exposed for remediation will generate contaminated runoff, which is to be treated as contaminated water and not stormwater. This is discussed further in **Section 7.2**.

This section assesses both stormwater generated on site and stormwater from upstream external catchments that must be conveyed through the site to Darling Harbour, and should be read in conjunction with **Section 6**, which details the erosion and sediment control measures used to manage areas under construction or during remediation. Contaminated water is discussed in **Section 5**.

4.3 Background

Barangaroo is located to the west of Hickson Road at the edge of Darling Harbour. The upstream catchment (Kent Street, High Street and Margaret Street) drains to a number of shallow low points along Hickson Road. It is expected that runoff generated from major rainfall events will typically exceed the capacity of the existing drainage system and will cause overland flow to pass through the Block 4 and 5 Remediation Areas, before discharging to the harbour.

The indicative locations of existing stormwater infrastructure are contained in **Appendix 3**.

4.4 Stormwater Concept Plan

The proposed remediation works have the potential to impact on the quality of stormwater that discharges into Sydney Harbour.

The existing City of Sydney stormwater infrastructure will generally continue to operate during the undertaking of the remediation works where they are located outside the footprint of the Remediation Area. In some cases it may be necessary to divert stormwater to neighbouring stormwater lines or otherwise around the Remediation Area utilising localised diversions. This will involve decommissioning existing pipes and constructing new pipes.

Overland flow paths would be temporarily managed through the site and would involve constructing localised surface flow diversions around the works. This would assist in ensuring no adverse offsite impacts. External flows would be safely conveyed through the site and the construction and remediation area would be avoided as far as practicable.

The principles of stormwater management for this site are as follows:

- Maintain conveyance of externally generated stormwater and overland flow, by implementing localised flow diversions.
- There are to be no significant stormwater or flood impacts external to the site.
- Divert all stormwater away from disturbed areas as far as practicable (including externally and internally generated runoff), including perimeter bunding of temporary odour control structures.
- Employ erosion and sediment controls to manage sediment-laden water from areas under construction.
- All contaminated water, including any stormwater that has run into contaminated areas or excavation pits, is to be treated in the temporary WTP. The treatment facilities will be constructed prior to the Hickson Road works being undertaken and therefore are considered to be existing in the context of the stormwater drainage assessment of Hickson Road.
- Continue to discharge stormwater directly to Sydney Harbour without further treatment (not including water from areas under construction or contaminated areas).
- Reinstate the stormwater and overland flow arrangements at the end of the works to current or improved conditions.
- Barriers would be installed to prevent ingress of stormwater into treatment areas

Temporary stormwater diversion works will be based on the methodology adopted by the contractor.

The final stormwater details to facilitate the proposed works will be the subject of further design development.

ULTIMATE DRAINAGE NETWORK AMENDMENTS

Flood modelling for the external catchment will be prepared as part of the detailed design process. The stormwater diversion works are to be designed in accordance with Australian Standards, Authority (City of Sydney Council) requirements and engineering principles.

4.5 Surface Water Impact Assessment

The site is currently impervious and the positioning of odour control structure(s) over the remediation works where possible will mean that the site will generally remain impervious while these works are occurring. Therefore the volume of runoff from the site prior to the remediation works and while the works are being undertaken is expected to be comparable.

It is expected that the site would yield a volumetric runoff co-efficient in the order of 0.9. The remediation area associated with Hickson Road is approximately 0.5 ha. For an average annual rainfall depth of 1,215 mm, it is expected that the average annual runoff from this area will be in the order of 5.5 ML.

Due to the impervious nature of the site prior to and during the undertaking of the remediation works, the proposed works would not have a significant impact on the surface water hydrology discharging to Darling Harbour.

4.6 Stormwater Quality

The implementation of erosion and sedimentation control measures, in accordance with standard industry practice as per *Managing Urban Stormwater* (Landcom, 2004) (refer to **Section 5**), would ensure that the stormwater runoff quality during the works is maintained at acceptable levels. Furthermore, measures can be implemented to ensure no stormwater contaminated through contact with the remediation area is discharged without treatment, as discussed in the following sections.

5. GROUNDWATER

5.1 Relevant SEARs

This section has been prepared in response to the groundwater component related to the following SEAR:

- *Assess impacts on water quality of Sydney Harbour and surface and groundwater hydrology and quality including proposed management, mitigation and monitoring measures.*
- *Consideration of any impacts on Groundwater Dependent Ecosystems.*

5.2 Definition

This section addresses issues pertaining to groundwater, which includes all subsurface water (both perched water and aquifers) collected by any site dewatering systems.

5.3 Existing Conditions

A specialist geotechnical desktop assessment has been undertaken by Coffey (2014).

Reference to the 1:100,000 Scale Geological Sheet indicates that the site is underlain by Fill and Quaternary age alluvium overlying Triassic age Hawkesbury Sandstone bedrock. An igneous dyke inferred to be of Jurassic Age is also shown passing through the southern extent of Hickson Road. (Coffey, 2014)

A limited number of boreholes have been drilled in the Hickson Road area and these have typically been undertaken to assess the subsoil environmental conditions and generally do not extend to bedrock. Therefore, Coffey (2014) developed a geotechnical model for the site based on geotechnical boreholes drilled for an adjacent area, as well as using archive information from the general vicinity of Hickson Road.

Coffey (2014) identified that the sub-surface conditions typically comprise the following:

- Asphalt concrete pavement overlying a heterogeneous fill of highly variable thickness (Unit 1) overlying
- Residual soils (Unit 3) and sandstone bedrock (Unit 4)

The following is a typical summary of the aforementioned units (Coffey, 2014):

- Unit 1 – Fill (typically 0.9 to 5.5 m thick, but can increase to between 9 and 10 m thick in the vicinity of the former gas holders)
- Unit 3 – Residual Soil (typically the depth to the top of the unit ranges from 1 to 4 m and typically 0.9 m thick)

- Unit 4 – Sandstone (typically the depth to the top of the unit ranges from 0.9 to 5.5 m, but increases to 9.75 m in the vicinity of the former gas holders)

Generally the sub-surface information indicates that the buried rock profile is consistent with the original natural shoreline geometry, with bedrock levels generally dropping away from the Hickson Road alignment (at Hickson Road they are observed to be generally close to the surface) (Coffey, 2014).

5.4 Dewatering and Water Ingress

A dewatering system will be installed for the remediation excavations.

Coffey (2014) conducted an assessment of inflow to the excavation for the Ex-situ Method of remediation based on the following key modelling assumptions. These assumptions were considered to be reasonable based on the information available (Coffey, 2014).

- Impermeable cut off walls for the soils enclose the site and penetrate into sandstone bedrock.
- The effects of individual high permeability features, such as igneous dykes, shear zones, were not taken into account. If these features exist inflows may increase.
- Sandstone permeability for the Barangaroo South site has been assessed (from borehole packer testing) to be in the order of 5×10^{-6} m/s.
- There is a hydraulic connection between the sandstone and the waters of Darling Harbour.

An estimate of the anticipated volume of water that will need to be removed from the fill materials within Hickson Road to achieve dewatering to the top of the bedrock has been developed. Based on an areal extent of approximately 5,000 m^2, approximately 0.75 ML of water is estimated to come from an average saturated sediment thickness of 0.5 m.

Seepage from beneath the cut off wall were not included in the above estimate. Unless localised high-permeability areas are encountered, seepage is likely to be limited to less than 5 L/sec (0.4 ML/day).

Coffey (2014) indicated that the expected volumes of water to be removed from Hickson Road may be achieved using conventional groundwater pumping equipment (i.e. sump pumps at created localised low points in the bulk excavations).

All groundwater collected from site dewatering would be treated in the temporary on-site WTP.

5.5 Groundwater Impact Assessment

The nearest receptor for contaminated groundwater originating from the site is considered to be ecosystems present within the groundwater down the hydraulic gradient of the site and ultimately Darling Harbour. No other environmentally sensitive receptors have been identified (AECOM, 2013).

In considering impacts of the planned site excavation and associated temporary dewatering for the excavations, the following is suggested.

5.5.1 Drawdown of Shallow Groundwater

The groundwater interception system and associated groundwater control and retention wall structures will be designed such that immediately at the excavation side base of the retaining walls, shallow groundwater drawdown matches the bottom of the excavation/sump collection zone for groundwater. Coffey (2014) indicate that the retention systems are likely to consist of relatively shallow walls (less than 5 m in height) retaining fill, except at discrete positions where service trenches, former gas works structures and buried infrastructure extend to greater depths. For Hickson Road, the anticipated typical groundwater drawdown would be less than 5 m, with it extending to 9 m in the vicinity of the gasworks structures.

The final design of the groundwater interception and extraction systems will be the subject of further design development.

5.5.2 Impacts on Groundwater Dependent Ecosystems

Investigations and analysis undertaken for this report indicate that there will be minimal impact on groundwater dependent ecosystems as a result of this localised and temporary dewatering of the excavation areas. This conclusion is based on the following:

- Initial project lead-in studies have not indicated any presence of organisms typically encountered in groundwater dependent ecosystems.
- It is unlikely that any significant groundwater based organisms (worthy of consideration for protection) would be present within groundwater associated with the uncontrolled filling that has occurred at the site within the underlying sediments, particularly given the high concentration of gasworks contamination that has occurred.
- Any remediation works will be to the benefit of such organisms (if present).

Notwithstanding, it is noted that the remediation works described in the AECOM RAP have been developed to consider, among other things, protection of potential groundwater dependent ecosystems down-gradient of the site (even in the absence of data indicating the presence or otherwise of such ecosystems).

5.5.3 Impacts on Surrounding Infrastructure

Coffey (2014) indicated that it is likely that some surface settlement may occur as a result of localised dewatering of the excavation areas (refer **Section 5.4**).

However, Coffey (2014) advised that it is unlikely that the structures along the Hickson Road Remediation Area will be affected by settlement during dewatering activities. This is because the sandstone foundations are unlikely to experience movement. In comparison buried services and roadways constructed in/on saturated soils may experience some settlement during dewatering activities.

Any impacts on surrounding infrastructure will be subject to the further detailed design of the groundwater extraction system. The final design of groundwater interception and extraction systems will be the subject of further design development.

5.5.4 Impact on Groundwater Quality

As the groundwater is considered to be contaminated in the area, the proposal to extract and treat the shallow groundwater (particularly localised to the filling and saturated sediments) will result in a local improvement in groundwater quality. The removal and off-site disposal of contaminated material will also have an inherent beneficial effect on groundwater quality.

5.5.5 Impact on Groundwater Flows

The Hickson Road remediation works will include some permanent retention walls that may obstruct the flow of groundwater through the Site.

It is known that groundwater at the site flows towards Sydney Harbour (ERM, 2007), and that groundwater levels in investigation wells show a strong tidal influence, particularly in wells closest to the harbour.

The remediation works are to be undertaken behind (and setback from the face of) the existing caisson wall and within retention walls. Therefore, there will not be any significant impacts on estuarine circulation or changes to hydrological regimes in the harbour itself as a result of the remediation works.

Perimeter retention walls and groundwater extraction undertaken during Stage 1A basement excavation were not observed to have an effect on groundwater flows or quality.

As such, it is considered that the proposed Hickson Road remediation works will not adversely impact on the groundwater regime within and around the EPA Declaration Area.

5.6 Operational Plan

The following activities are proposed to be implemented to ensure that groundwater extraction does not significantly impact on the surrounding groundwater regime:

- A suitable groundwater control and retention wall will be designed to intercept shallow groundwater flows where required.
- Localised grouting of groundwater control and retention walls will be installed where excess groundwater seepage occurs. The extent of grouting will be the subject of further design development, where required.
- The proposed groundwater extraction system is expected to have the ability to allow localised sump and pump extraction operations for the collection and pumping of localised perched water which may be associated with voids or chambers located in the fill.

- Water pumped to the temporary WTP should be initially screened/filtered at the interception point to reduce solids loads entering into the WTP. The objective of the screening/filtering is to minimise the risk of blockages occurring in transfer lines or at the WTP.
- Construction of the above measures will take into consideration the position of any retained services and the use of low impact installation methods. These are to be investigated if deemed as being required to protect such services.
- More detailed studies on the effects of shallow groundwater drawdown and settlements associated with localised dewatering of the staged excavations can be conducted where required.
- A groundwater monitoring plan will be instigated during the site dewatering and excavation process.
- In association with the groundwater monitoring plan (above), a site surface/infrastructure settlement effects survey will be undertaken (pre, during and post construction).

6. EROSION AND SEDIMENT CONTROL

6.1 Relevant SEARs

This section has been prepared in response to the following SEAR:

- *Erosion, sediment and stormwater management and controls during construction and remediation.*

6.2 Definition

The terms 'erosion and sediment control' and 'soil and water management' essentially cover the same subject matter. The following guidelines are provided in *Managing Urban Stormwater – Soils & Construction* (Landcom, 2004), which is the industry standard for erosion and sediment control:

- "Erosion and Sediment Control Plans should be prepared on smaller sites, such as, where more than 250 but less than 2,500 square metres of land will be disturbed," while
- "Soil and Water Management Plans generally should be prepared for all development works where more than 2,500 square metres of land will be disturbed and/or where development consent is required".

However, in line with the terminology used in the SEARs and to avoid confusion, the term 'erosion and sediment control' is generally adopted in this report.

This project and some of its stages will involve the disturbance of an area covering more than 2,500 square metres. Runoff from areas within the declaration area and related to the remediation works would be subject to standard erosion and sediment control procedures, e.g. silt fences, filter socks, sedimentation basins.

The potential impacts from the management of soil from drilling, excavation and stockpiles are:

- Sediment migration into stormwater and harbour outlets; and
- Mixing of contaminated and non-contaminated materials.

6.3 General Principles

All sedimentation and erosion control measures are to be designed, installed and maintained using procedures outlined in the principles and practices set out in *"Managing Urban Stormwater – Soils & Construction Volume 1" (*Landcom, 2004*).*

The general principals of erosion and sediment control for this site include the following:

- Minimise the area of soil disturbed and exposed to erosion.
- Stage work to minimise the total disturbed area.
- Divert clean runoff around disturbed areas where practicable.
- Install source controls to reduce movement of sediment.

- Protect exposed contaminated areas and stockpiles.
- Restrict the movement of materials to dedicated pathways.
- Control the movement of materials at entry and exit points.
- Use treated water for cleaning, where possible, otherwise use of potable water.
- Collect and treat sediment laden water.
- Regularly inspect and maintain control measures.

The sedimentation and erosion control system would be designed appropriately to a specific capacity, nominally the two (2) year average recurrence interval (ARI).

6.4 Erosion and Sediment Control Plan

Figures 1 to **6** illustrate the indicative erosion and sediment control plans associated with the remediation methods proposed for Hickson Road. In addition, erosion and sediment control measures will be required for excavations associated with stormwater diversions.

The erosion and sediment control measures for each stage will be further developed as the project progresses and more details become available.

6.5 Excavated Material Handling

The basis of the Ex-situ Method of remediation is the excavation of contaminated material. For this method all excavation is to be undertaken beneath odour control structures (with the exception of retention wall works or small excavations where appropriate controls such as foam application is agreed with NSW EPA).

Where practicable, pre-classification may take place at the time of excavation to enable separation of material into different streams such as non-contaminated/ contaminated, recyclable and oversize material, including timber, rock, concrete, steel and brick, from contaminated materials. In addition, in-situ waste classification of materials is proposed prior to the commencement of excavation works.

Some excavated uncontaminated material may be re-used as backfill in Hickson Road, where there is capacity or ability for it to be used. Alternatively, the material will be transported off-site to a suitably licensed facility for disposal or to a site for re-use in accordance with NSW EPA requirements.

Excavated contaminated material is to be transported in sealed trucks off-site to a licensed facility for treatment and disposal.

Associated with the transportation of excavated material via trucks is the risk of sediment and dust spreading. Refer to **Section 6.13** for further information relating to waste transport.

Stockpiling of material may occur (where required) for up to 24 hours (or greater where specific validation testing is required). Refer to **Section 6.6** for further information relating to stockpiles.

Assessment against approved soil criteria derived from an approved Human Health and Ecological Risk Assessment (HHERA) would take place to determine whether it is suitable for beneficial reuse on-site.

6.6 Stockpiles

Temporary stockpiling would be required for the ex-situ remediation (Option 2) and limited temporary stockpiling would be required for the in-situ remediation (Option 1).

Contaminated material would be transported directly off-site for disposal, however if stockpiling is required the material would be positioned beneath the odour control structure and hence not be exposed to rainfall or generate runoff.

Should the need arise for stockpiles external to the odour control structure then stockpiles can be surrounded by heavy duty filter socks (or approved alternative), sufficient to pond at least 150 mm, to retain sediment to this area. Stockpiles are to be located within the filter sock perimeter, and an additional impervious bund at least 400 mm high (or approved alternative) is to surround the stockpile perimeter, to retain runoff and leachate. All stockpiles are to be kept covered. The final details of external stockpiles, including the management of leachate will be subject to further design development.

The movement of waste material around the site and double handling of material shall be minimised.

The maximum proposed stockpile height is not likely to exceed four metres high, while the temporary remediation work area control structure is likely to be around 15 metres high.

Any stockpiles of any material likely to create sediment if exposed to rain or runoff should be appropriately controlled as per the measures described. Where practicable, stockpiles should be located where they will not be disturbed by demolition activities or vehicles traversing the site.

6.7 Tarping /Mulching/Gravel Armouring

Tarping/mulching/gravel armouring may be located on any external stockpiles and exposed soils, including fill. The purpose is to cover exposed surfaces, to prevent odour release, erosion and sedimentation.

Utilisation of crushed rock and/or geofabric armouring, tarps and the like may all be used for the management of exposed surfaces. The demolition of surface slabs is proposed to be undertaken in a sequential and staged manner to maximise utilisation of current hard stand practices. Likewise, the reinstatement of surfaces (temporary or otherwise) is proposed to be undertaken sequentially so as to minimise the extent of exposed surfaces.

External stockpiling of low level waste may be controlled using hydromulching, tarping stockpiles and application of surfactant to stockpiles or exposed surfaces where practicable.

6.8 Clean Water Diversion

The diversion of clean water around disturbed areas relates to both offsite (upstream) runoff and locally generated runoff. For discussion of the diversion of runoff, refer to **Section 4**.

Stormwater will be diverted wherever practicable to avoid contact with materials which may cause contamination. Exposed surfaces will be managed through the implementation of appropriate water and sediment control principles. The temporary diversion of external catchment areas and the ultimate drainage network amendments are discussed further in the stormwater section (**Section 4.4**).

All inlet pits on the site will require specific control measures. Specific significant open hardstand pits are to be generally sealed and surrounded by mesh and gravel filters (or other approved detail) on the perimeter. All other stormwater inlet pits should be protected with mesh and gravel filters around the perimeter and the pit grates covered by geotextile fabric (or other approved detail). Some key pits would be sealed to be watertight.

Kerb inlet pits should also incorporate a suitable mesh and gravel filter located in the gutter portion of the pit (including the pits in the public roads fronting the site) where practicable. The specialist remediation contractor should verify all existing pits on site and ensure all pits are appropriately protected.

Any pits external to the site that may be subject to runoff from the site must be protected using mesh and gravel filters.

The final details of specific control measures will be the subject of further design development.

6.9 Exposed Surfaces

The work will be staged to minimise exposed surfaces. Where practical, exposed surfaces may be temporarily sealed to minimise the time surfaces are exposed.

6.10 Sediment Fences or Impervious Barriers

Sediment fences or impervious barriers will be used to manage stormwater inlets and external stockpile perimeters where appropriate. The purpose is to prevent suspended sediment leaving the work area, therefore minimising downstream sedimentation.

The site will be bounded by solid panel hoarding to 2.4 metres in height, as well as Jersey barriers or equivalent where appropriate and fabric coated fence. Additional water and sediment controls should be incorporated to manage the works as required.

The site boundary fences and barriers may be installed with a filter sock to reduce inflow/outflow to/from the site between the gaps of the barrier fence. Along the site boundary adjacent to the public road domain, filter socks may be utilised as required (some areas may be sufficiently raised, e.g. walls and garden beds) to control either sediment laden flows exiting the site or reduce external flows entering the site.

The final detail, extent and general arrangements of sediment fences or impervious barriers will be subject to further design development.

6.11 Hardstand Area and Plant Wash Down

The purpose of wash down is to remove dust, debris and sediment from hardstand areas and plant to control the spread of these contaminates. It will be performed when it is deemed as being required. Treated water or potable water would be used where practicable.

Decontamination of mobile plant will be required when earthmoving plant has been working with contaminated material and is due to be removed from the site or transferred to a clean area. The decontamination area will typically have a drainage trap and pump system to allow all contaminated washout to be captured and pumped to the temporary WTP. Within the drains, sediment controls (filter socks) will intercept gross pollutants and coarse sediments where required.

The final detail, extent and general arrangements of wash down facilities will be subject to further design development.

6.12 Vehicle Cleaning

Where practicable, a single site entry/exit point should be provided for the remediation area. The entry may include vehicle wash down facilities for use by all vehicles to minimise the spread of sediment within the site and to the public roadway. Additional entries and exits to the odour control structure(s) should be provided as required to facilitate the remediation works.

A wheel wash facility may also be established along the internal roadway adjacent to the site exit or another approved location to ensure vehicle tyres are cleaned prior to the vehicle entering another area or the public roadway. Wheel wash dimensions should conform to best practice – allowing a minimum three complete rotations of truck tyres during a single pass where practicable.

Alternatively, a spray wash may be established with sizing and dimensions commensurate to expected loads and vehicle sizes. The spray wash must include shielding to prevent spray impacting on passing public or traffic. Contaminated spray wash water will be pumped to adjacent water tanks for primary sediment removal, and subsequently pumped to the temporary WTP for final treatment and discharge to stormwater.

Inspection of vehicles will be done by access control personnel prior to entry to new areas.

Treated water or potable water may be able to be used for cleaning purposes.

The final detail, extent and general arrangements of truck wash facilities will be subject to further design development.

6.13 Waste Transport

The purpose of the management of waste transport is to control the spread of sediment. Truck movements will be generally limited to the nominated work zones or Barangaroo site internal roadways to provide greater control over vehicle emissions and accidental spillage of materials. All loads must be inspected, covered with water proof tarps to reduce potential odour emissions if required and clean prior

to leaving the site. All loads transported onsite are proposed to be covered with fully sealed tarps or equivalent.

The movement of waste material around the site and double handling will be minimised. Primary sorting of different waste streams will occur during excavation, allowing demolition wastes and un-contaminated materials to be separated from the primary waste stream.

The final detail, extent and general arrangements of waste transport routes and their maintenance will be subject to further design development.

6.14 Temporary Odour Control Structure(s)

The temporary odour control structure(s) are proposed to be located over proposed excavation areas. They are designed to minimise the release of malodorous and potentially harmful emissions during excavation and treatment operations and also to prevent stockpiles and exposed surfaces being affected by rainfall or runoff. The temporary odour control structure(s) will include stormwater interception devices which will be installed to manage localised flooding of adjacent areas and to minimise the potential for stormwater to become contaminated by entering areas of excavation.

It is proposed that with the exception of recyclables and site reuse materials, that waste materials be stockpiled inside odour control structures, which will include appropriate means for the collection and control of runoff.

The maximum proposed stockpile height is generally not likely to exceed four metres, while the odour control structure(s) are likely to be around 15 metres high.

The final design of the temporary odour control structure(s), their foundations, associated plant and internal water management arrangements will be the subject of further design development.

6.14.1 Gutters

Gutters and drains will be used with the odour control structure(s) and other temporary buildings. The purpose of gutters is to manage rainfall and runoff, which must be controlled to manage clean stormwater such that it generally does not become contaminated by passing into treatment areas, and ensure erosion and sedimentation is minimised.

The final design of gutters and drains will be the subject of further design development.

6.14.2 Sediment Sumps

Sediment sumps will be located inside the odour control structure(s) where required. The purpose of the sediment sumps is to trap, collect and store sediment and provide a location to remove accumulated sediment.

Sediment sumps will be sized with consideration for the soil type, drainage area, stream flow and velocity. The sediment sumps should be located in an area suitable for maintenance and be located where sediment will accumulate.

No sediment laden runoff (i.e. Total Suspended Solids (TSS) > 50mg/L) is to be discharged directly to stormwater pits or to the harbour. Water will be transferred to the temporary WTP and removed sediment deposited to the temporary treatment facility.

The final design of sediment sumps will be the subject of further design development.

6.14.3 Runoff Diversion

Runoff will be diverted around the perimeter of the odour control structure(s) where practicable. The purpose of runoff diversion is to divert stormwater to avoid contact with materials which may cause contamination. Temporary diversion of external catchment areas and the ultimate drainage network amendments are discussed further in the stormwater section (**Section 4.4**).

Runoff interception channels will be created on the upstream sides of structures.

The final design of run off diversions will be the subject of further design development.

6.14.4 Shaker Grids

Shaker grids (or other approved vehicle cleansing arrangement) will be located at the odour control structure(s) exits where required. The purpose of shaker grids is to minimise fugitive dust and tracking of soil onto the roadway by shaking dirt and other debris from a vehicle on entering and exiting the site. The shaker grids will shake the vehicle while incorporating a cleaning jet to clean the bottom of vehicles. Treated water may be able to be used for cleaning jets.

The final design of vehicle cleansing arrangements will be the subject of further design development.

6.15 Sediment Basin

A sediment basin may be used, if practicable, to treat runoff from uncontaminated areas under construction. The final detail, extent and general arrangements of any sediment basin will be subject to further design development.

6.16 Operational Plan

This section describes the implementation, operation and maintenance of the water and sediment control systems. Further detail on monitoring can be found in **Section 8**.

The appropriate maintenance of water and sediment control measures is a fundamental requirement ensuring that control measures operate effectively as designed.

The following activities may be implemented to ensure the effectiveness of the water and sediment control devices:

- All water and sediment controls would be inspected each day, and after rainfall events.
- Sediment and erosion control devices would be regularly maintained and accumulated sediment removed before 50% of the storage capacity is used. Accumulated sediment would be classified and either treated or disposed off-site in an appropriate manner and at an appropriate facility.
- Fences, bunds, silt fences, mesh filters and silt socks would be checked regularly for rips, excessive build-up of sediment, and breaches by construction activities. Damage would be repaired on detection.
- The site would be kept clean and all rubbish and detritus collected and placed into bins.
- All sediment laden ponded water would be treated before discharge. No sediment laden runoff is to be discharged directly to stormwater pits or to the harbour.
- Significant dust causing activities (and any associated watering control) would be limited during periods of heavy rainfall or during any periods where water and sediment controls may be temporarily ineffective. Determination of dust control measures would be developed outside of this plan.

In general, all water and sediment controls would be maintained in an effective state until the works described in this report are complete.

In order to ensure the effective implementation of the above measures, the following would be undertaken:

(i) Preparation and maintenance of a site plan indicating all major operating areas, stockpiles, sediment sumps and bunded areas.

(ii) Maintenance of all relevant logs onsite.

(iii) Water and sediment controls and emergency responses to be part of regular toolbox meetings and site inductions.

The Site Manager will carry out routine site inspections to check bunded areas and will report any issues to the EHS Manager. In the event remedial measures are required, the EHS Manager will detail the proposed measures along with the recommendations for implementation and provide these to the Site Manager.

In the event of a significant incidence involving hazardous materials that could or have entered the external environment, the EHS Manager will advise the local protection authority as soon as possible or in accordance with legislation. The EPA has the authority to coordinate any actions in response to an environmental emergency.

7. CONTAMINATED WATER

7.1 Relevant SEARs

This section has been prepared in response to part of the following SEARs:

- *Assess impacts on water quality of Sydney Harbour and surface and groundwater hydrology and quality including proposed management, mitigation and monitoring measures.*
- *Details of water supply including consideration of alternative water supply arrangements and water conservation measures.*

7.2 Definition

The following types of water are likely to be contaminated and therefore will be treated in the temporary WTP:

- Groundwater recovered from any excavations.
- Rain run-off as collected from any open excavations (collected together with groundwater in the excavated pit). Currently there are no open excavations planned as part of the remediation works, as all excavations will be covered by an odour control structure.
- Run-off from areas contaminated by vehicular traffic transporting contaminated material (if this contamination cannot be suitably controlled by other means such as vehicle wash down and covering transported materials).
- Collected water in remnant underground structures or voids.
- Any other water from contaminated areas.

The following water sources are considered uncontaminated and will be discharged from the site without treatment:

- Rain water from roof areas of building structures.
- Stormwater from uncontaminated surfaces such as roads (outside of the main soil movement corridor), footpaths, general hardstand, parks and reserve areas.
- Stormwater generated upstream of the site that passes through the site, before discharging into the harbour.
- Any other water from uncontaminated areas.

Run-off from areas under construction, but not contaminated, would be subject to standard erosion and sediment control procedures (e.g. silt fences, filter socks, sedimentation basins). This includes construction works outside the site.

7.3 Anticipated Chemical Contaminants to Treat

The following chemical substances are considered to be the key COPCs for contaminated waters:

- PAHs.
- BTEX.
- ammonia.
- phenols.
- cyanide.

In addition, heavy metals, including lead, have been found dissolved in groundwater.

The WTP would be designed to treat heavy metals and the COPCs as listed above.

The presence of coal tars may also be a possibility (possibly as a Dense Non-Aqueous Phase Liquid (DNAPL) or mixed with Light Non-Aqueous Phase Liquid (LNAPL)) with collected site groundwater seepage or other waters from the site.

7.4 Reuse of Treated Water

If treated water is proposed to be reused the feasibility of reuse would be subject to a more detailed assessment of the health and safety implications once the treated water quality has been more accurately defined. It may not be possible to treat the water to a suitable quality for reuse applications that involve human contact, such as hosing, sprinkling and washing.

The final application of treated groundwater will be subject to further design development.

7.5 Discharge of Treated Water

No water is currently planned to be discharged off-site to the sewer system as part of the works that are to be undertaken under DA SSD 6617-2014. However, in the event that discharge to sewer is planned at a future point in time, the approval of Sydney Water Corporation would be sought.

Treated water will be discharged together with stormwater into the harbour under an approved Environmental Protection License.

Water quality monitoring to ensure compliance with the requirements of the license is discussed in **Section 8**.

8. WATER QUALITY MONITORING

8.1 Relevant SEARs

This section has been prepared in response to the following SEAR:

- *Assess impacts on water quality of Sydney Harbour and surface and groundwater hydrology and quality including proposed management, mitigation and monitoring measures.*

8.2 Summary

The water quality monitoring is proposed to be broken up into pre-remediation (baseline) and during remediation/construction monitoring.

The establishment of prior background/baseline harbour water quality conditions is essential to establishing, qualifying and quantifying either improvements or impacts in existing harbour water quality resulting from the development and remediation works that are to be undertaken.

WorleyParsons has completed the following report:

- *Barangaroo South, Baseline Water Quality Monitoring*, which includes a baseline monitoring program, monitoring results and site specific water quality objectives, which are to be used to manage in-pipe limits and their impacts on the marine environment arising from the project; and,

The outcomes of the baseline water quality monitoring study have been adopted and are discussed in the following sections.

To mitigate risks to the marine environment from discharge of treated water via the stormwater drains and to comply with the SEARs, a monitoring program is proposed during remediation/construction activities, consisting of three main activities:

- Sampling of treated water, prior to discharge to the harbour or reuse, to ensure it meets discharge criteria;
- Continuous automated monitoring of harbour water quality (turbidity), to enable detection of impacts associated with elevated concentrations of suspended solids, associated with the soil and water management measures; and,
- Environmental monitoring of water quality in the harbour, when in-pipe monitoring of contaminants identifies a breach of the discharge criteria.

8.3 Water Quality Monitoring Program

The following water quality monitoring program incorporates the findings of the baseline water quality monitoring study. The program may need to be revised following consultation with EPA.

8.3.1 Inspections

Daily inspections of the onsite water quality control measures and treatment system shall be conducted, within the vicinity of the following:

- Soil and water management infrastructure; and
- Temporary WTP.

8.3.2 Locations for Water Quality Monitoring

The final Water Quality Monitoring Plan requirements will be subject to consultation with the EPA. Water quality monitoring will be undertaken at the following locations:

- At the WTP (before and after treatment);
- Harbour; and,
- On-site sediment basins (if applicable).

The location of the treatment plant as well as the proposed monitoring locations (BG1, NF1 and NF2) are shown in **Diagram 8–1**. Refer to **Section 8.6.1** for an overview of the background to these locations. An indicative overview of the water quality monitoring, inspections and reporting is listed in **Table 8-1**.

A log of the date, time, weather conditions and comments associated with all inspections, monitoring and sampling would be kept on site and would be available for inspection.

Diagram 8-1 – Proposed Darling Harbour Monitoring Locations

Table 8-1 Indicative Water Quality Monitoring, Inspections and Reporting (subject to design development)

Activity	Purpose	Indicative Parameters	Location	Indicative Timing / Frequency	Method	Responsibility	Reported to
Onsite water quality sampling	Confirm EPA discharge criteria are being met	Phys-chem, metals, TPH, PAHs, BTEX as per Table 8.2	Immediately prior to discharge, following treatment	Daily for first two weeks then weekly	Land based sample collection and laboratory analysis	Water Treatment Contractor	Lend Lease Environmental Manager (EM) Construction Manager (CM)
Harbour Turbidity Monitoring	Comparison of water quality parameters adjacent to operations ("near field") with those at control ("background") sites	Turbidity, conductivity, temperature, pH	Two near field sites and one reference site, fixed stations (on buoys), and hand held monitors (as required)	Continuous (every 15 minutes)	Automated water quality monitoring stations, technicians and vessel for servicing.	Lend Lease / Water Quality Consultant	Lend Lease EM/CM
Harbour water quality sampling	Monitor impact on harbour water quality in event of breech of discharge criteria	Phys-chem, metals, TPHs, PAHs, BTEX as per Table 8.2	Two near field sites and one reference site as per fixed stations	Reactive – as required	Vessel based sample collection and laboratory analysis	Lend Lease / Water Quality Consultant	Lend Lease EM/CM
Inspections	Identify hazards and compliance	N/A	Construction site and stormwater discharge outlets	Weekly	Inspection Checklist	Lend Lease Site Superintendent / Environmental Officer	Lend Lease EM/CM

8.4 Water Quality Parameters

The preliminary water quality criteria for site water discharged to the harbour is listed in **Table 8-2**.

The baseline water quality monitoring study nominates site specific trigger values for cadmium, copper and zinc. These values are listed in **Table 8-2**, together with the corresponding ANZECC trigger values (in brackets).

Unless noted otherwise, the limits given in **Table 8-2** do not include an allowance for dilution prior to discharge. Where the parameter in question does not bio-accumulate and is unlikely to cause acute toxicity, there may be scope to raise the limits, allowing for the dilution that will occur at the discharge outlet, as the discharged water mixes with ambient harbour water.

In the event of an unexpected failure in the treatment process, the expected rapid dilution would provide a back-up or 'last resort' to meet water quality criteria. Nevertheless, it is not proposed to rely on dilution to meet water quality criteria. Diverters and storage basins should be used during unexpected failures to prevent discharge of "untreated" or non-compliant waters into Darling Harbour. This is particularly important for bioaccumulative or acutely toxic pollutants.

The baseline water quality monitoring study found that turbidity levels and TSS were well within the ANZECC guidelines. As a result, site specific trigger values were not developed.

Both TSS and turbidity will be measured in all samples, but only TSS will be used for assessment in the initial (construction/remediation) phases of the project.

The turbidity data collected during construction/remediation phase monitoring will be used to formulate a site-specific TSS-turbidity relationship. Generally the TSS-turbidity relationship can vary widely depending on the type of particulate matter present. Therefore for the laboratory analysis of organic contaminants one of the following approaches should be taken:

1) The samples are not filtered prior to any extraction procedures; or
2) The samples are filtered and the filtered particulate is also extracted, and added to the filtrate (or extract).

The above approach will result in the determination of the level of organic contaminants that should be expected for a given turbidity level and concentration of TSS. This can then be used to develop site specific TSS-turbidity relationships based on the level of organic contaminants present. This will serve as an equivalent turbidity limit to allow instantaneous site compliance checks.

Table 8-2 Preliminary Water Quality Limits (Indicative)

Indicator	Units	Criteria
Physico-chemical		
Total Suspended Solids (TSS)	mg/L	50 (100-percentile concentration limit that already incorporates dilution)
Turbidity	NTU	Monitor Only
Sheens or plumes	Daily inspections	No visible sheen or plumes
pH	pH	6.5 – 8.5 (100-percentile concentration limit that already incorporated dilution)
Dissolved Oxygen	mg/L	Monitor Only
Metals		
Arsenic	µg/L	2.3
Cadmium	µg/L	0.7
Copper	µg/L	1.3
Lead	µg/L	4.4
Mercury	µg/L	0.1
Zinc	µg/L	15
Chromium (trivalent)	µg/L	27
Chromium (VI) compounds	µg/L	4.4
Nickel	µg/L	7
Cyanide	µg/L	4
Ammonia as N	µg/L	910
BTEX		
Benzene	µg/L	500
Ethyl benzene	µg/L	80
Toluene	µg/L	180
m-Xylene	µg/L	75
p-Xylene	µg/L	75
o-Xylene	µg/L	350
Phenol	µg/L	400
TPH C10-C14 Fraction	µg/L	50[#]
TPH C15-C28 Fraction	µg/L	100[#]
TPH C29-C36 Fraction	µg/L	50[#]

Indicator	Units	Criteria
TPH C6-C9 Fraction	µg/L	20#
Oil and Grease	mg/L	10 (100-percentile concentration limit that already incorporates dilution)
PAHs		
Naphthalene	µg/L	50
Anthracene	µg/L	2*
Phenanthrene	µg/L	2*
Fluoranthene	µg/L	2*
Benzo(a)anthracene	µg/L	2*
Benzo(a)pyrene	µg/L	2*
Benzo(b)fluoranthene	µg/L	2*
Benzo(k)fluroanthene	µg/L	2*
Acenapthene	µg/L	2*
Acenapthylene	µg/L	2*
Chrysene	µg/L	2*
Indeno(1,2,3-cd)pyrene	µg/L	2*
Pyrene	µg/L	2*
Flourene	µg/L	2*
Benzo[ghi]perylene	µg/L	2*
Dibenz[a,h]anthracene	µg/L	2*
Total PCBs	µg/L	Early non-detects and this can be removed from any ongoing monitoring requirements

* In the case of PAHs the limit of reporting of 2 µg/L can be used even though ANZECC criteria are lower than this detection limit as this is the normal level available at most laboratories.

\# Standard limit of reporting.

\+ Temperature values are based on monitoring in October and November only, with seasonal variability expected to occur.

8.5 Temporary Water Treatment Plant

Contaminated water may be treated in a temporary WTP to meet quality criteria suitable for discharge into the Harbour, or it will be tankered off-site by licensed liquid waste contractors.

Both online or real time monitoring and grab sampling are proposed to occur for the treatment plant. Real time monitoring is not able to be completed for all analytes due to the testing procedures, requiring that samples be sent away for laboratory analysis. The suite of parameters for laboratory analysis would include TSS, turbidity, pH, various metals, BTEX and PAHs.

Note that water will not necessarily be retained on site until monitoring results are available, except during the commissioning phase of the water treatment system or where flow-rates and storage capacity permits. Details regarding the storage capacity will be determined by the treatment plant designers.

An automated water quality monitoring station at the treatment plant would be installed for real time monitoring. This would allow an immediate operational response through a traffic light system. This is discussed further in **Section 8.5.2**.

Sampling and monitoring would be undertaken of pre-treated water so that the quality of this water can be used to inform the treatment requirements of the treatment plant.

8.5.1 Commissioning Phase

During commissioning of the plant (for first month), water quality sampling would take place daily immediately prior to discharge for physico-chemical parameters, metals, PAHs and BTEX.

8.5.2 Commencement of New Phases

EPA has requested that for each start-up of new works e.g. commencement of significant dewatering activities, more intensive testing should be resumed. This may constitute daily sampling for the first two weeks.

8.5.3 Operational Phase

Once the satisfactory operation of the plant has been confirmed in accordance with the above sections, then weekly sampling for laboratory analysis would proceed throughout the operation of the treatment plant.

8.6 Stormwater and Harbour

Discharge to the stormwater system within the site will be transferred directly into Darling Harbour. Monitoring the stormwater system independently of the harbour is difficult and therefore water within the harbour will be monitored only.

Water quality within the harbour will be monitored for the duration of the remediation phase of the project. Harbour water quality adjacent to operations (“near field”) and background sites will be monitored for turbidity, conductivity, temperature and pH continuously (every 15 minutes). Automated water quality monitoring stations (two near field and one reference site fixed stations (on buoys / in pipes), and hand held monitors (as required)) will be used. Other elements include reactive water sampling and incidental measurements with hand-held meters, as per **Table 8-2**.

Untreated stormwater or groundwater from the site is expected to be significantly more turbid than harbour waters. Turbidity can therefore be used as a tracer for the untreated site water. The aim of the real-time stations is to quickly detect and warn of elevated turbidity concentrations that could be related to a breakdown or failure of the site water containment or treatment systems. Turbidity is specifically used for this task as it can be reliably and rapidly measured in situ, where most other contaminants cannot.

The final regime of harbour water monitoring is subject to further design development.

8.6.1 Turbidity Monitoring – Locations and Parameters (Indicative)

Three automated turbidity monitoring stations are proposed to be installed.

'Near-field' stations will be located at the northern (NF1) and southern (NF2) end of the site. These monitoring stations will fulfil the requirement for upstream and downstream / tide sites around the discharge location.

A 'reference' turbidity station will be located at BG1. This location has been selected following the collection of Baseline water quality data (October-November 2010) at four 'background' locations (BG1 to BG4) and at the two 'near-field' impact sites (NF1 and NF2). At the conclusion of the baseline monitoring analysis, the BG1 site was found to have the best turbidity concentration correlation with the near-field sites. BG1 was therefore selected as the 'reference' station.

Refer to **Table 8-3** and **Diagram 8–1** for further details about the locations of these stations.

Additional parameters (temperature, conductivity and pH) will be monitored at the automated turbidity monitoring stations, to aid in the interpretation of turbidity data and to monitor the freshwater/brackish water discharge into the Harbour.

The final regime of harbour water turbidity monitoring is subject to further design development.

8.6.2 Monitoring Locations (Indicative)

Preliminary locations for monitoring are indicated in **Table 8-3** and **Diagram 8–1**.

Table 8-3 - Preliminary Darling Harbour Monitoring Locations (Indicative)

Location	Latitude	Longitude	Indicative Purpose
NF1	33°51.712	151°12.025	North near-field turbidity monitoring location.
NF2	33°51.942	151°12.054	South near-field turbidity monitoring location.
BG1	33°51.749	151°11.770	Site selected as a reference turbidity monitoring location measuring background turbidity conditions in the harbour for comparison with the near-field sites.

8.7 Water Quality Monitoring Feedback

Automated water quality monitoring stations would be installed for real time monitoring. This would allow an immediate operational response through a traffic light system. If the monitoring results indicate a failure to meet the discharge criteria, then management measures are to be implemented as detailed below.

8.7.1 Trigger

A 'trigger' initiates appropriate action by the relevant personnel. Triggers would include any of the following:

- A visible surface plume;
- Complaints of a visible plume;
- Turbidity exceedance alarms from automated near-field stations;
- WTP exceedance alarms; or
- Laboratory test exceedances.

The system issues automated alarms via a text message to the project's construction and environmental personnel when set triggers are exceeded. For this project it is recommended that a "traffic light system" be implemented comprising "amber" and "red" alarms.

The purpose of an amber alarm is to provide a warning to relevant personnel (e.g. Site Supervisor, Environment Officer, Water Quality Officer) that the limit is being approached. As a result the cause of the alarm can be investigated and action taken as required.

The purpose of a red alarm is to provide notification to relevant personnel that the limit has been exceeded. A red alarm is triggered when near field values (based on the 12 hour moving average) exceed the corresponding background levels by 100% of the relevant criterion value. If a red alarm is triggered, an automated text message will be sent to the relevant personnel (including appropriate management representatives) and the protocol outlined below would be followed. It should be noted that the alarms would be issued based on raw data that is not quality controlled (i.e. may contain erroneous measurements taken by water quality instrumentation). As such, a more detailed analysis of the data may reveal that a red alarm was issued when the criterion was, in fact, not exceeded.

In addition to the monitoring stations, twice daily visual inspections will be undertaken from shore for potential visual surface plumes. These inspections will be undertaken at regular intervals, early in the morning and afternoon, for the duration of the construction activities during daylight hours to ensure that remedial actions can be implemented rapidly if required.

If an area of elevated turbidity is detected during visual inspections, it should be observed and any immediately apparent mitigation measures implemented. If the visible area of elevated turbidity persists for more than three hours then a visual plume is deemed to have occurred and the response protocol is triggered.

The final regime of water quality monitoring and associated triggers is subject to further design development.

8.7.2 Response Protocol

The response protocol would consist of the following:

(i) Trigger

(ii) Assessment and evaluation – is the elevated turbidity a result of Barangaroo Project works?

(iii) Determination of an appropriate course of action to prevent further discharge and mitigate impact

(iv) Instigate reactive treatment plant water quality water sampling to assess operational performance

(v) Instigate reactive harbour water sampling to assess impact

(vi) Reporting

(vii) Completion of a subsequent root cause analysis

(viii) Consider changes at the treatment plant

If the discharge criteria are being met in-pipe and/or it can be demonstrated that there is no measurable impact on Darling Harbour (i.e. water quality at near field locations is statistically similar to far field reference locations and or below site specific trigger values), then Lend Lease may recommence discharge of treated water.

8.7.3 Actions

Following confirmation that construction activities have resulted in an exceedance of criteria, reasonable and feasible contingency measures will be implemented by the relevant personnel. The timing for the measures will be dependent on the contingency measures, however where practicable will be implemented as early as practicable from receiving the notification of the exceedance.

The actions may include (but will not be limited to):

- Cease discharge of site water to Darling Harbour, divert to onsite storage;
- Inspection and repair of equipment associated with onsite water treatment and soil and water management;
- Additional turbidity monitoring using hand-held instrumentation at regular time intervals to monitor turbidity levels in the vicinity of any turbidity plume and construction activities; and,
- Temporary cessation of construction works.

It should be noted that contingency measures will be selected with consideration of:

- Current construction activities;
- Equipment placement and timing;

- Scale of exceedance; and,
- Meteorological, tidal and hydrological conditions.

8.8 Sediment Basins

Water in sediment basins (if applicable) would be tested for turbidity as required prior to discharge into the harbour.

9. MARINE ECOLOGY

9.1 Relevant SEARs

This section has been prepared in response to the following SEAR:

- *Assess impacts on water quality of Sydney Harbour and surface and groundwater hydrology and quality including proposed management, mitigation and monitoring measures.*

9.2 Estuarine Water Quality and Aquatic Ecology

9.2.1 Existing Conditions

Water quality monitoring of harbour water quality was undertaken by WorleyParsons on the 5th and 6th of May 2010. The results of this monitoring are documented in the Marine Ecology Impact Study and indicate that the physico-chemical conditions in Darling Harbour in the vicinity of Barangaroo are typical of those encountered in an east coast Australia estuary.

The results indicate that a mean surface water temperature of 19°C and mid-depth water temperature of 19.2°C on the days when monitoring occurred. This is somewhat higher than the harbour average for May of 15.9°C +/- 0.2°C (winter) (Hatje *et al.* 2001) and is likely attributable to uncharacteristically warmer air temperatures on the days when sampling was undertaken.

The results also indicated an average surface pH of 8.2, dissolved oxygen (DO) concentration of 8.2 mg/L (8.1 mg/L mid water) and electrical conductivity of 53µS/cm in the area adjacent to Barangaroo over the two days of monitoring. Turbidity measurements taken in surface waters (1.6 NTU) were slightly higher than at mid-depth (1.2 NTU), but were within the acceptable range (0.5 – 10 NTU) for subtropical eastern Australia as specified by ANZECC/ARMCANZ (2000).

During the Marine Ecology Impact Study (WorleyParsons, 2010) the marine habitats which were present adjacent to Barangaroo were surveyed using both diver investigations and with underwater towed video transects. Background searches for the existence of marine vegetation in the area were also undertaken (i.e. NSW DPI estuarine vegetation mapping 2005).

The benthic marine habitat in Darling Harbour, adjacent to Barangaroo, consisted mainly of silty sands. There was considerable bioturbation (displacement and mixing of sediment particles) evident in marine sediments at the site, likely caused by burrowing benthic marine organisms such as polychaete worms and invertebrate crustaceans (refer **Plate 9–1**).

The substrate towards the southern end of the development contained a higher percentage of clay and is relatively undisturbed. This is in contrast with the middle and northern sections of the site, which contain a higher percentage of silt. No marine vegetation, such as seagrass, mangroves, saltmarsh or macroalgae, was present.

Plate 9–1 - Sample Location BG 1

Groundwater in the EPA Declaration Area has been found to be contaminated by TPH, PAHs, BTEX, ammonia, phenol and cyanide at concentrations significantly exceeding the relevant trigger values for the protection of human health and aquatic ecosystems in the Australian and New Zealand Guideline for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

Groundwater at the site flows towards Sydney Harbour (ERM 2007). Groundwater observation levels in investigation wells show there to be a strong tidal influence, particularly in those wells closest to the harbour. The majority of impacts to groundwater appear to be related to the former gasworks, located adjacent to the proposed basement car park. Key findings from the AECOM RAP, were that the COPCs in soils across the site were lead, TPH, PAH, and BTEX.

9.2.2 Potential Impacts on Marine Ecology

Potential impacts on marine ecology are as follows:

- Groundwater contaminants include substances which are toxic to aquatic organisms. The migration of contaminated groundwater into Darling Harbour could therefore be toxic to marine fauna such as benthic invertebrates and fish in the vicinity of the site if not appropriately treated and contained.

- There is little potential for harm to aquatic vegetation through direct removal or smothering during construction activities at the site, as no aquatic vegetation currently exists within Darling Harbour in the vicinity of Barangaroo (WorleyParsons, 2010). Aquatic vegetation (macroalgae beds) does exist at Balmain, however the distance to this location from Barangaroo suggests that there will be no impact to this location.

9.2.3 Response to SEARs

The remediation works will be undertaken on land behind (and that is set back from) the existing caisson walls and the rock embankment beneath the existing wharf which form the current shoreline. In addition, the remediation works will be undertaken within groundwater control and retention walls (diaphragm, secant pile or equivalent). The greatest potential to impact the

water and the harbour is through the discharge of contaminated groundwater from the site. However, this assessment report has provided a range of comprehensive mitigation measures that can be implemented to manage this risk.

The risk of groundwater or sediment movement through or under the shoreline structures during the remediation process is insignificant. This is because the works are set back from the existing foreshore alignment and the remediation work specifically requires the control of contaminated groundwater and materials to prevent further contamination. This is planned to be achieved using retention walls. These issues have been dealt with in the previous sections of this report.

No marine vegetation was observed at the site during the Marine Ecology Impact Study, as noted in **Section 9.2.1**. Therefore, the smothering of benthic vegetated habitats (e.g. seagrass beds) from construction activities is unlikely. In addition, the smothering of non-vegetated habitats is also unlikely given that the majority of activities will be occurring behind the existing foreshore caisson structure alignment and within groundwater control and retention walls. To manage any potential water quality impacts, water quality control measures would be implemented, including monitoring, as described earlier in this report.

9.3 Riparian and Aquatic Habitats

It is considered that the remediation works will not improve riparian and aquatic habitats directly. However, it is considered that the process of remediation removes a potential existing source of contamination to the local environment, which would constitute an indirect improvement to the riparian and aquatic habitats.

Water quality would be controlled and monitored during remediation works as per the previous sections to minimise any potential impacts on aquatic habitats.

9.4 Estuarine Hydrodynamics

The remediation works are to be undertaken behind (and setback from the face of) the existing caisson wall and within groundwater control and retention walls. Therefore, there will not be any significant impacts on estuarine circulation or changes to hydrological regimes in the surrounding harbour waters.

10. CONCLUSIONS

Lend Lease Millers Point (Lend Lease) has been engaged by the Barangaroo Delivery Authority to remediate the portion of Hickson Road that is within the EPA declared Remediation Site at Barangaroo. The work will involve remediation of areas of the site that are known to be contaminated as a consequence of the former uses of the site. This report serves as the Soil and Water Impact Assessment for the Ex-Situ Method of remediation and has been prepared to accompany DA SSD 6617-2014. The DA covers Remediation Works and is to be submitted to the Minister for Planning for approval pursuant to Part 4 of the *Environmental Planning and Assessment Act, 1979*.

This report responds to the SEARs issued in relation to DA SSD 6617-2014 which are dated 18 August 2014. The issues raised by DECCW (now EPA) in its letter dated 12 August 2010 (referred to as MP 10 0023 *Basement and Bulk Earthworks Project*) have also been assessed.

The Soil and Water Impact Assessment also identifies measures that can be implemented during application of the Ex-situ Method of remediation to mitigate any potential for impacts to surface water runoff, groundwater, marine ecology, and harbour water quality. The techniques for management of erosion and sedimentation, stormwater, groundwater and contaminated water are documented within the body of the report along with the requirements for water quality monitoring.

Potential impacts to groundwater, stormwater, harbour water and marine ecology have also been assessed. The findings from the assessment indicate that there are no significant negative impacts. Where impacts have been identified, suitable industry standard mitigation measures have been proposed to limit impacts to within acceptable levels.

In the case of groundwater, the anticipated typical groundwater drawdown would be less than 5 m, with it extending to 9 m in the vicinity of the gasworks structures, while a long term beneficial effect on groundwater quality is expected.

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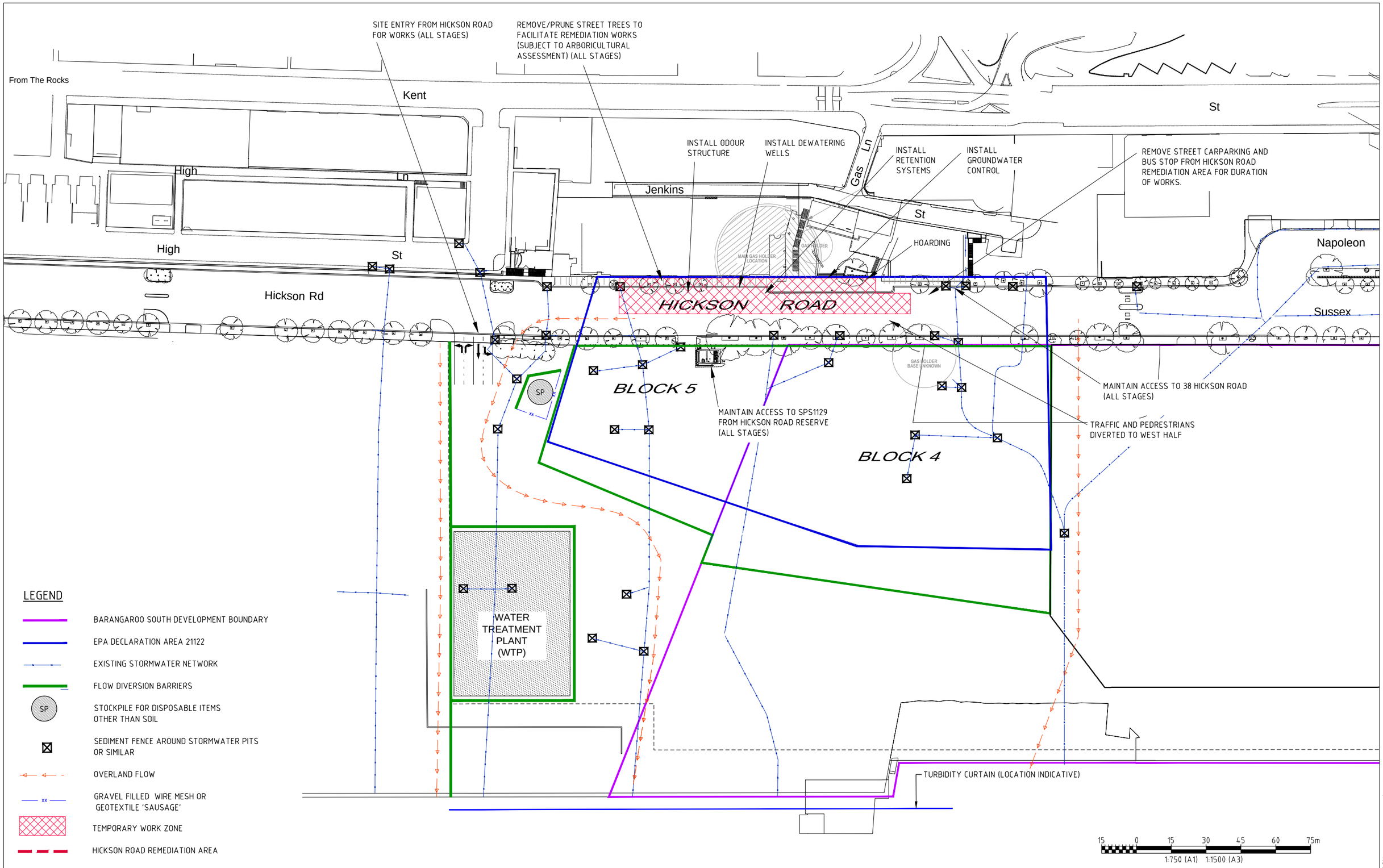
Figures



LEGEND

- BARANGAROO SOUTH DEVELOPMENT BOUNDARY
- EPA DECLARATION AREA 21122
- EXISTING STORMWATER NETWORK
- FLOW DIVERSION BARRIERS
- SP — STOCKPILE FOR DISPOSABLE ITEMS OTHER THAN SOIL
- SEDIMENT FENCE AROUND STORMWATER PITS OR SIMILAR
- OVERLAND FLOW
- xx — GRAVEL FILLED WIRE MESH OR GEOTEXTILE 'SAUSAGE'
- TEMPORARY WORK ZONE
- HICKSON ROAD REMEDIATION AREA

WorleyParsons
resources & energy

OneWay
to zero harm

ISSUE	DATE	ISSUE DESCRIPTION
0	13.11.14	FINAL
A	15.10.14	DRAFT - FOR CLIENT REVIEW

NORTH

BARANGAROO HICKSON ROAD REMEDIATION WORKS
STORMWATER CONCEPT PLAN & EROSION & SEDIMENT CONTROL PLAN
EX-SITU METHOD - STAGE 1
FIGURE 1

LOCATION: \\AUSYDWPDFS01V\AUSYD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\03532 - BARANGAROO BLOCK 5 REMEDIATION\TZ.0 DRAWINGS\SM - HICKSON RD\HICKSON RD FIGURE 1 TO 6.DWG
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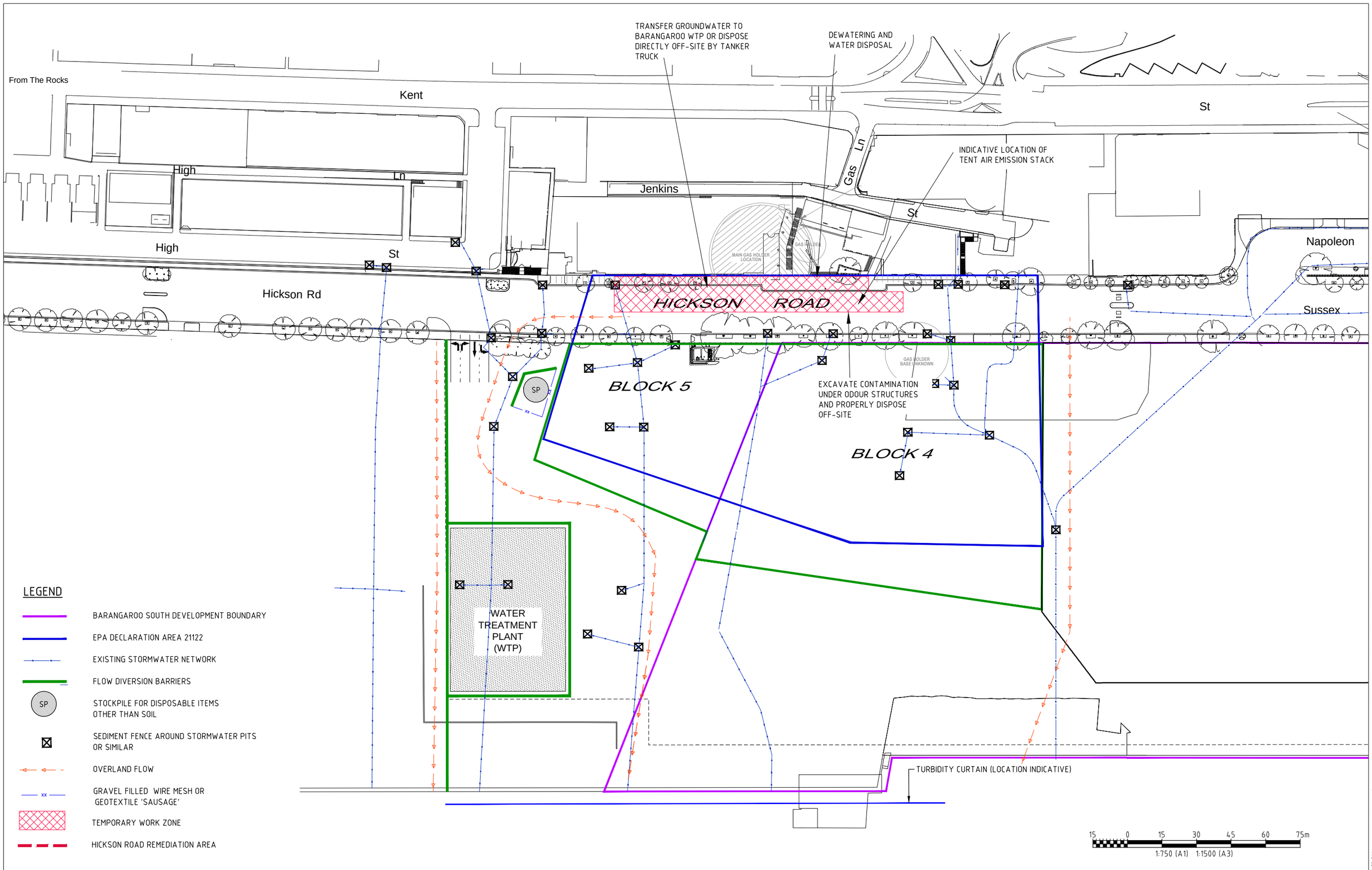

LEGEND

- BARANGAROO SOUTH DEVELOPMENT BOUNDARY
- EPA DECLARATION AREA 21122
- EXISTING STORMWATER NETWORK
- FLOW DIVERSION BARRIERS
- SP — STOCKPILE FOR DISPOSABLE ITEMS OTHER THAN SOIL
- SEDIMENT FENCE AROUND STORMWATER PITS OR SIMILAR
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- xx — GRAVEL FILLED WIRE MESH OR GEOTEXTILE 'SAUSAGE'
- TEMPORARY WORK ZONE
- HICKSON ROAD REMEDIATION AREA

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ISSUE	DATE	ISSUE DESCRIPTION
0	13.11.14	FINAL
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NORTH

BARANGAROO HICKSON ROAD REMEDIATION WORKS
STORMWATER CONCEPT PLAN & EROSION & SEDIMENT CONTROL PLAN
EX-SITU METHOD - STAGE 2
FIGURE 2

LOCATION: \\AUSYDWPDFS01V\AUSYD\WORLEY_INFRASTRUCTURE\PROJECTS\301051\03532 - BARANGAROO BLOCK 5 REMEDIATION\TZ.0 DRAWINGS\SM - HICKSON RD\HICKSON RD FIGURE 1 TO 6.DWG
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From The Rocks

Kent

High Ln

High St

Hickson Rd

ROAD/FOOTPATH RESTORATION

Jenkins

Gas Ln

St

St

Napoleon

Sussex

HICKSON ROAD

BLOCK 5

BLOCK 4

SP

VALIDATE AND BACKFILL EXCAVATION (WITH IMPORTED FILL)

DECOMMISSION ODOUR STRUCTURE

WATER TREATMENT PLANT (WTP)

TURBIDITY CURTAIN (LOCATION INDICATIVE)

MAIN GAS HOLDER LOCATION

GAS HOLDER

GAS HOLDER BASE UNKNOWN

LEGEND

- BARANGAROO SOUTH DEVELOPMENT BOUNDARY
- EPA DECLARATION AREA 21122
- EXISTING STORMWATER NETWORK
- FLOW DIVERSION BARRIERS
- SP — STOCKPILE FOR DISPOSABLE ITEMS OTHER THAN SOIL
- SEDIMENT FENCE AROUND STORMWATER PITS OR SIMILAR
- OVERLAND FLOW
- xx — GRAVEL FILLED WIRE MESH OR GEOTEXTILE 'SAUSAGE'
- TEMPORARY WORK ZONE
- HICKSON ROAD REMEDIATION AREA

15 0 15 30 45 60 75m

1:750 (A1) 1:1500 (A3)

WorleyParsons resources & energy

OneWay to zero harm

ISSUE	DATE	ISSUE DESCRIPTION
0	13.11.14	FINAL
A	15.10.14	DRAFT - FOR CLIENT REVIEW

NORTH

BARANGAROO HICKSON ROAD REMEDIATION WORKS
STORMWATER CONCEPT PLAN & EROSION & SEDIMENT CONTROL PLAN
EX-SITU METHOD - STAGE 3

FIGURE 3

LOCATION: \\AUSYDWPDFS01V\AUSYD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\03532 - BARANGAROO BLOCK 5 REMEDIATION\TZ.0 DRAWINGS\SM - HICKSON RD\HICKSON RD FIGURE 1 TO 6.DWG

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REMOVE/PRUNE STREET TREES TO FACILITATE REMEDIATION WORKS (SUBJECT TO ARBORICULTURAL ASSESSMENT)

From The Rocks

Kent

St

High Ln

Jenkins

HOARDING

Gas Ln

St

TRAFFIC AND PEDESTRIANS DIVERTED TO EAST HALF

High St

Napoleon

Hickson Rd

HICKSON ROAD

Sussex

MAIN GAS HOLDER LOCATION

GAS HOLDER

GAS HOLDER BASE UNKNOWN

BLOCK 5

BLOCK 4

SP

INSTALL ODOUR STRUCTURES

INSTALL RETENTION SYSTEMS

INSTALL DEWATERING WELLS

INSTALL ODOUR STRUCTURE

WATER TREATMENT PLANT (WTP)

TURBIDITY CURTAIN (LOCATION INDICATIVE)

LEGEND

- BARANGAROO SOUTH DEVELOPMENT BOUNDARY
- EPA DECLARATION AREA 21122
- EXISTING STORMWATER NETWORK
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- SP — STOCKPILE FOR DISPOSABLE ITEMS OTHER THAN SOIL
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- xx — GRAVEL FILLED WIRE MESH OR GEOTEXTILE 'SAUSAGE'
- TEMPORARY WORK ZONE
- HICKSON ROAD REMEDIATION AREA

15 0 15 30 45 60 75m

1:750 (A1) 1:1500 (A3)

WorleyParsons resources & energy

OneWay to zero harm

ISSUE	DATE	ISSUE DESCRIPTION
0	13.11.14	FINAL
A	15.10.14	DRAFT - FOR CLIENT REVIEW

NORTH

BARANGAROO HICKSON ROAD REMEDIATION WORKS
STORMWATER CONCEPT PLAN & EROSION & SEDIMENT CONTROL PLAN
EX-SITU METHOD - STAGE 4
FIGURE 4

LOCATION: \\AUSYDWPDFS01V\AUSYD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\03532 - BARANGAROO BLOCK 5 REMEDIATION\TZ.0 DRAWINGS\SM - HICKSON RD\HICKSON RD FIGURE 1 TO 6.DWG

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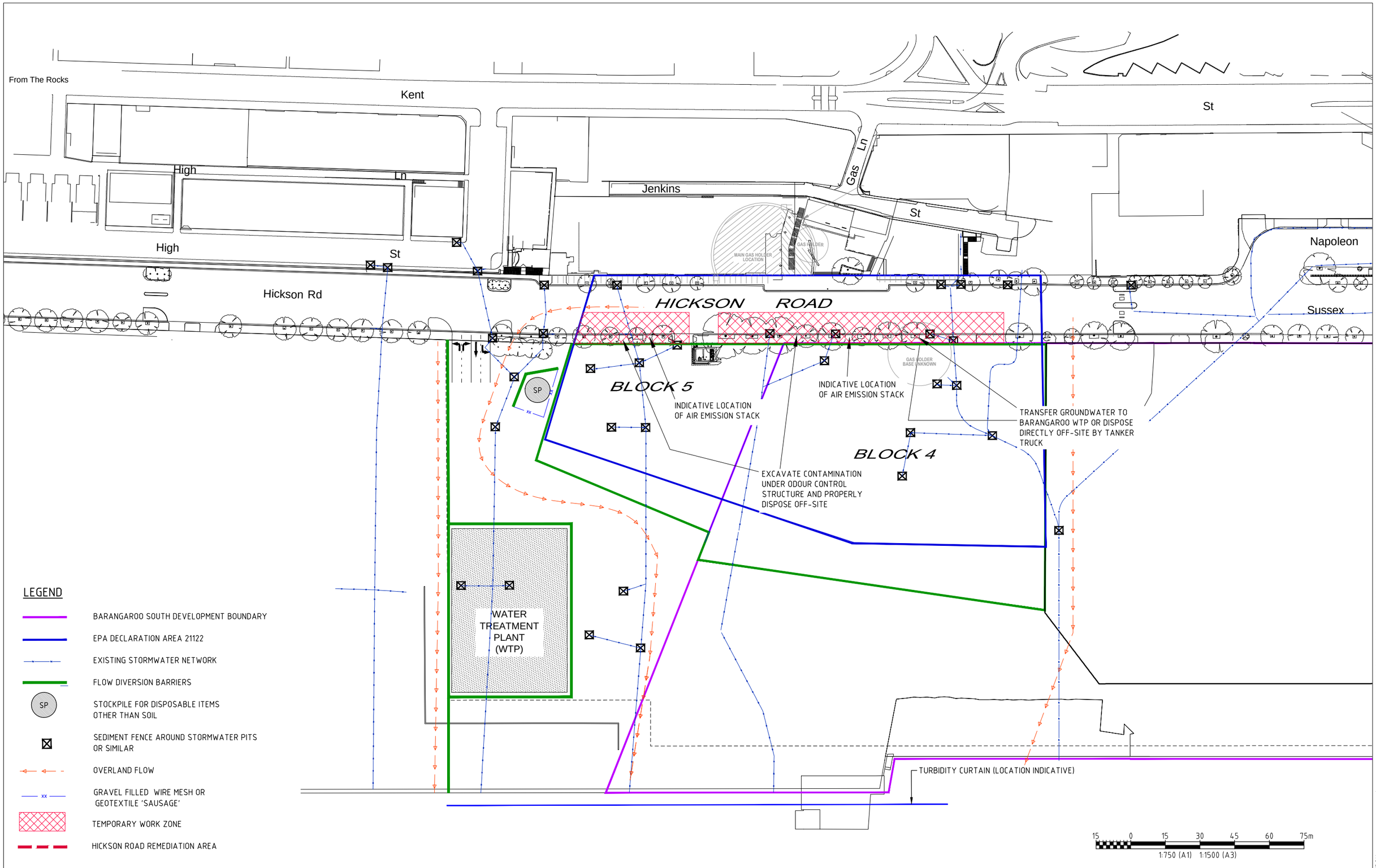
PLOT DATE & TIME: 13/11/2014 4:09:12 PM SAVE DATE & TIME: 13/11/2014 8:12:05 AM



LEGEND

- BARANGAROO SOUTH DEVELOPMENT BOUNDARY
- EPA DECLARATION AREA 21122
- EXISTING STORMWATER NETWORK
- FLOW DIVERSION BARRIERS
- SP — STOCKPILE FOR DISPOSABLE ITEMS OTHER THAN SOIL
- SEDIMENT FENCE AROUND STORMWATER PITS OR SIMILAR
- OVERLAND FLOW
- xx — GRAVEL FILLED WIRE MESH OR GEOTEXTILE 'SAUSAGE'
- TEMPORARY WORK ZONE
- HICKSON ROAD REMEDIATION AREA

WorleyParsons
resources & energy

OneWay
to zero harm

ISSUE	DATE	ISSUE DESCRIPTION
0	13.11.14	FINAL
A	15.10.14	DRAFT – FOR CLIENT REVIEW

NORTH

BARANGAROO HICKSON ROAD REMEDIATION WORKS
STORMWATER CONCEPT PLAN & EROSION & SEDIMENT CONTROL PLAN
EX-SITU METHOD - STAGE 5
FIGURE 5

LOCATION: \\AUSYDWPDFS01VVAU\SYD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\05532 - BARANGAROO BLOCK 5 REMEDIATION\TZ.0 DRAWINGS\SM - HICKSON RD\HICKSON RD FIGURE 1 TO 6.DWG
USER NAME: enosh.newar CTB FILE: Worley-Full.ctb Plotter-None
PLOT DATE & TIME: 13/11/2014 4:16:15 PM
SAVE DATE & TIME: 13/11/2014 8:12:05 AM

PLANT NEW STREET TREES AT COMPLETION OF WORKS

From The Rocks

Kent

High

Ln

High

St

Hickson Rd

VALIDATE AND BACKFILL EXCAVATION (WITH IMPORTED FILL)

Jenkins

Gas Ln

St

REINSTATE STREET CARPARKING AND BUS STOP IN HICKSON ROAD REMEDIATION AREA

MAIN GAS HOLDER LOCATION

GAS HOLDER

St

Napoleon

Sussex

HICKSON ROAD

GAS HOLDER BASE UNKNOWN

BLOCK 5

SP

DECOMMISSION ODOUR STRUCTURES

ROAD AND FOOTPATH RESTORATION

DECOMMISSION ODOUR STRUCTURES

VALIDATE AND BACKFILL EXCAVATION (WITH IMPORTED FILL)

ROAD AND FOOTPATH RESTORATION

BLOCK 4

WATER TREATMENT PLANT (WTP)

TURBIDITY CURTAIN (LOCATION INDICATIVE)

15 0 15 30 45 60 75m

1:750 (A1) 1:1500 (A3)

LEGEND

- BARANGAROO SOUTH DEVELOPMENT BOUNDARY
- EPA DECLARATION AREA 21122
- EXISTING STORMWATER NETWORK
- FLOW DIVERSION BARRIERS
- SP — STOCKPILE FOR DISPOSABLE ITEMS OTHER THAN SOIL
- SEDIMENT FENCE AROUND STORMWATER PITS OR SIMILAR
- OVERLAND FLOW
- xx — GRAVEL FILLED WIRE MESH OR GEOTEXTILE 'SAUSAGE'
- TEMPORARY WORK ZONE
- HICKSON ROAD REMEDIATION AREA

WorleyParsons resources & energy

OneWay to zero harm

ISSUE	DATE	ISSUE DESCRIPTION
0	13.11.14	FINAL
A	15.10.14	DRAFT – FOR CLIENT REVIEW

NORTH

BARANGAROO HICKSON ROAD REMEDIATION WORKS
STORMWATER CONCEPT PLAN & EROSION & SEDIMENT CONTROL PLAN
EX-SITU METHOD - STAGE 6

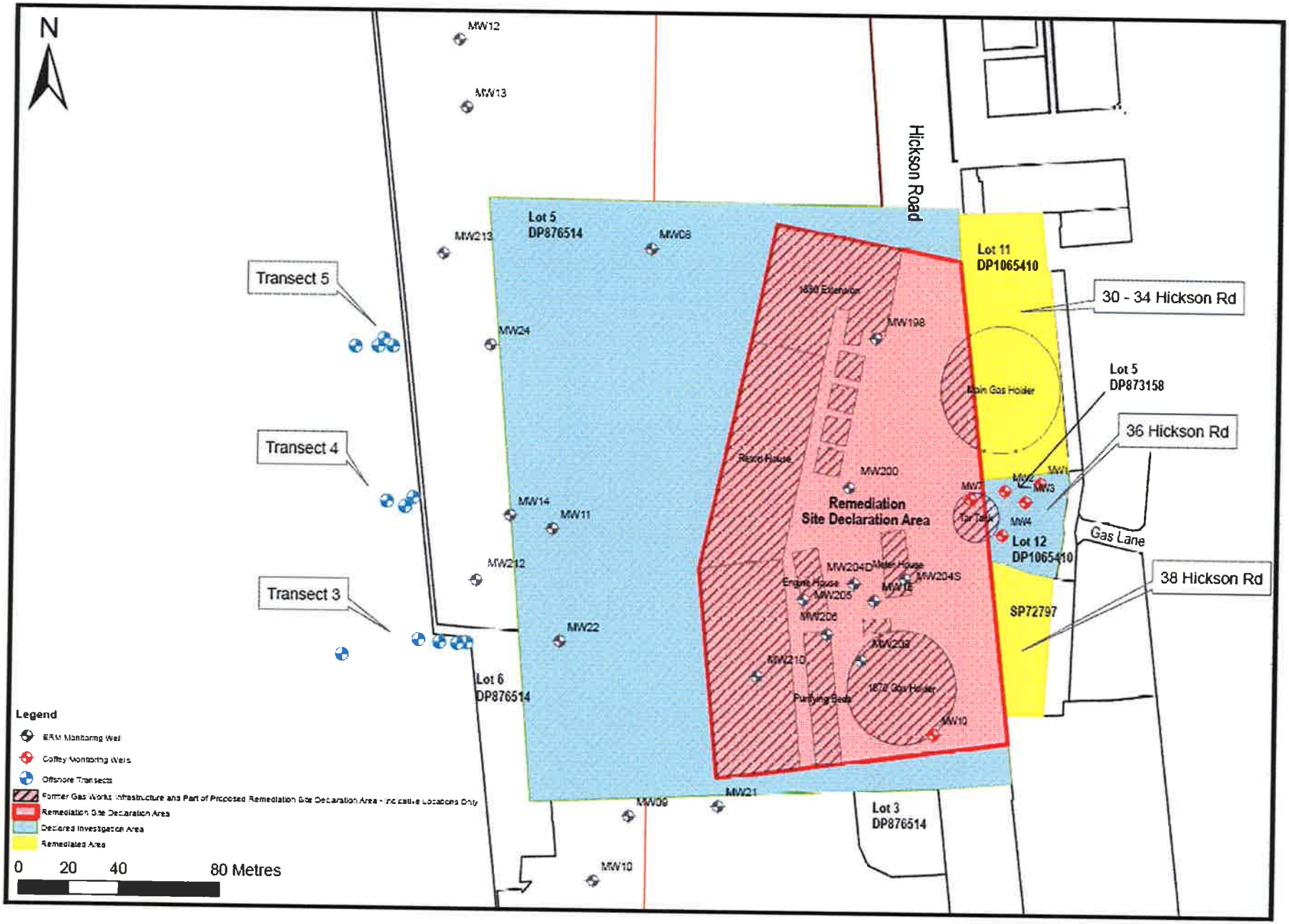
FIGURE 6

LOCATION: \\AUSYDWPDFS01V1\AUS\SYD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\03532 - BARANGAROO BLOCK 5 REMEDIATION\TZ.0 DRAWINGS\SM - HICKSON RD\HICKSON RD FIGURE 1 TO 6.DWG

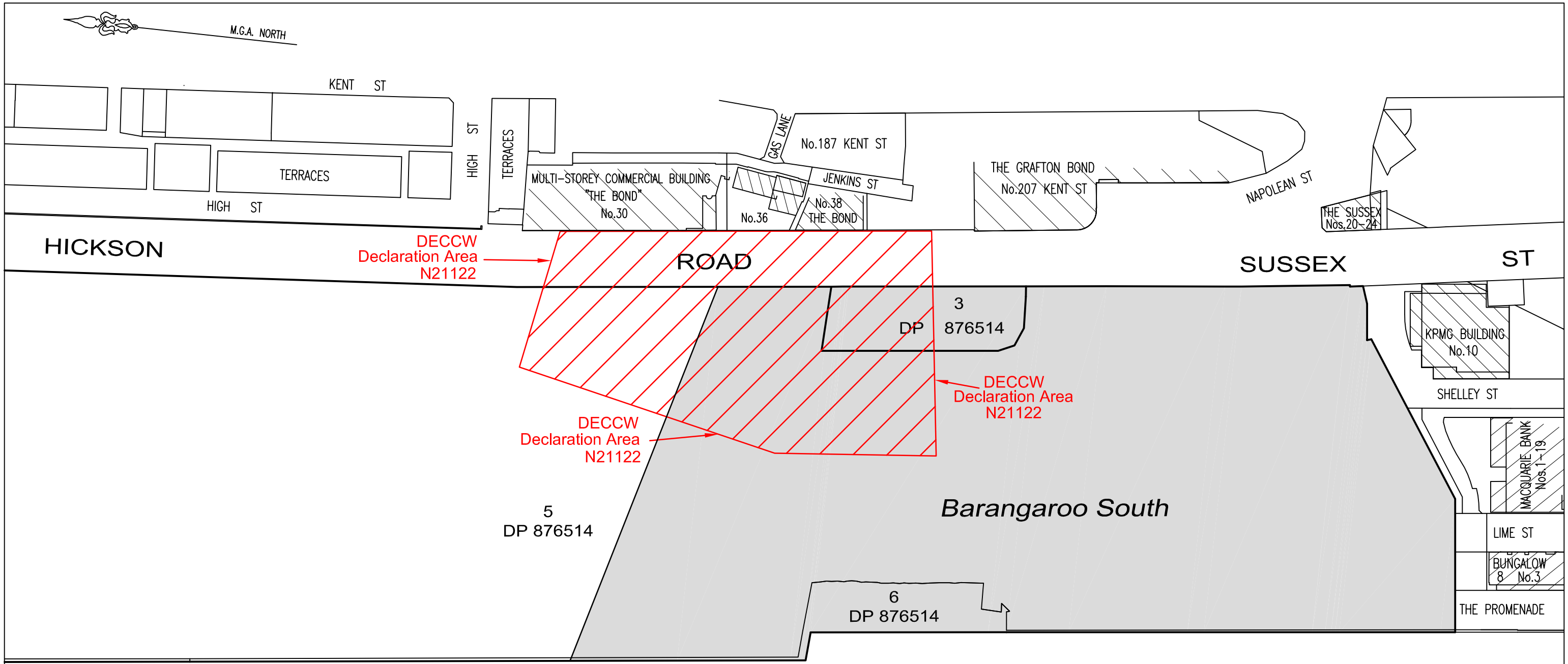
USER NAME: enosh.newar CTB FILE: Worley-Full.ctb Plotter-None

PLOT DATE & TIME: 13/11/2014 4:16:28 PM SAVE DATE & TIME: 13/11/2014 8:12:05 AM

Appendix 1 2009 EPA Remediation Site Declaration Area Map


N
MW12
MW13
Hickson Road
Lot 5
DP876514
MW213
MW08
Lot 11
DP1065410
30 - 34 Hickson Rd
Transect 5
MW24
MW198
1830 Extension
Lot 5
DP873158
Main Gas Holder
36 Hickson Rd
Transect 4
Retort House
MW200
MW14
MW11
Remediation
Site Declaration Area
MW1
MW2
MW3
MW4
Tar Tank
Lot 12
DP1065410
Gas Lane
MW212
MW204D
Meter House
MW204S
Engine House
MW205
MW15
38 Hickson Rd
Transect 3
MW206
SP72797
MW22
MW209
MW210
1878 Gas Holder
Purifying Beds
Lot 6
DP876514
MW10
MW09
MW21
Lot 3
DP876514
MW10
Legend
ERM Monitoring Well
Coffey Monitoring Wells
Offshore Transects
Former Gas Works Infrastructure and Part of Proposed Remediation Site Declaration Area - Indicative Locations Only
Remediation Site Declaration Area
Declared Investigation Area
Remediated Area
0
20
40
80 Metres

Appendix 2 EPA Declaration Area Contextual Plan



DATE	AMENDMENTS	REV.

DECCW DECLARATION AREA IS TAKEN FROM THE DRAWING ATTACHED TO DECLARATION No.21122 (DATED 15 JUNE 2009) ISSUED BY THE NSW EPA.

GeoStrata
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e: info@geostrata.com.au

PLAN SHOWING Barangaroo South and DECCW DECLARATION AREA

LEND LEASE (Millers Point) PTY. LTD.

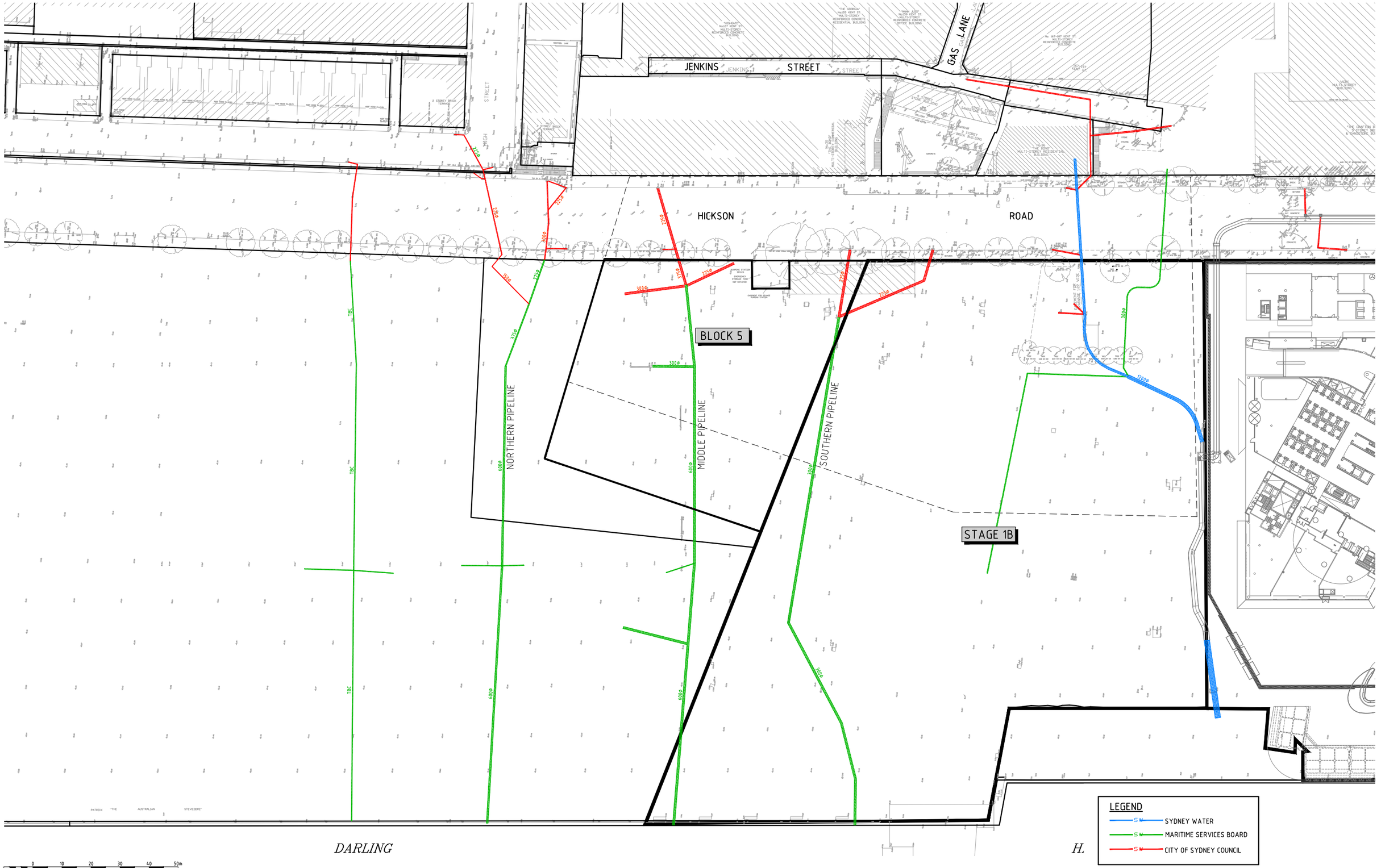
SCALE: 1:2000 | DATE: 6/7/2010

SHEET SIZE: A3 | REVISION:

LOCALITY: BARANGAROO

DRAWING No. 1400 Barangaroo South + DECCW AREA

Appendix 3 Existing Stormwater Drainage Infrastructure (Cardno, 2014)



Key Plan

Rev.	Item	Revision Description	Date	Rev.	Item	Revision Description	Date
01		ISSUED FOR INFORMATION ONLY	12.06.14				

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Lead Architects	RSHP Australia Pty Ltd Ivan Harbour | Principal Architect RAIA NSW ARB 8484 Sydney NSW 2000	
Collaborating Architects	Lend Lease Graham W Jones | Principal Architect FRAIA NSW ARB 4005 ABN 97 000 098 162	
Consultant		
Principal	Lend Lease	
	Developer	Lend Lease
	Project Management & Construction	Lend Lease
	Design	Lend Lease
	30 The Bond 30 Hickson Road Millers Point NSW 2000	www.lendlease.com

Project: BARANGAROO SOUTH

MP

Title: EXISTING STORMWATER ASSETS

Drawn By	Designed	Checked	Approved By	Date
AE	PL	DBW	MKH	DEC 12

Scale: 1:500 — INFORMATION ONLY

Project No.	Site No.	Drawing No.	Revision
161804	50613044-SKC000		01

B1