



WATER & STORMWATER MANAGEMENT SUB-PLAN

BARANGAROO STAGE 1

Document No: H010106LLC006

MP10_0227	Commercial Building C5	-	Yes
MP11_0044	Commercial Building C3	-	Yes
MP10_0025	Commercial Building C4	MOD1	Yes
MP10_0023	Bulk Excavation and Basement Car Parking	MODS1,3,4	Yes
<i>Approval no.</i>	<i>Project</i>	<i>Modifications</i>	<i>Included in current revision</i>

E	07/12/2012	Revised issue for additional permits and modifications
D	18/05/2012	Revised issue for additional approvals and modifications
C	23/09/2011	Revised issue for addition of C4 and authority comment
B	10/06/2011	Revised issue for construction including authority comments
A	16/12/2010	Initial issue for authority comment
<i>Revision</i>	<i>Date</i>	<i>Description of Change</i>

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WATER & STORMWATER RELATED ACRONYMS & GLOSSARY

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AS	Australian Standards
ASS	Acid Sulfate Soils
DECCW	Department of Environment, Climate Change and Water (now EPA)
DOP	Department of Planning (now DP&I)
DP&I	Department of Planning & Infrastructure (formerly DOP)
EPA	Environmental Protection Authority (formerly DECCW, OEH)
EPL	Environmental Protection Licence, issued by OEH
MCoA	Ministers Conditions of Approval
OEH	Office of Environment & Heritage (now EPA)
PASS	Potential Acid Sulfate Soils
POEO Act	Protection of the Environment Operations Act 1997
SOC	Statement of Commitments

INTRODUCTION

The Barangaroo site has been divided into three distinct redevelopment areas – the Headland Park, Barangaroo Stage 2 and Barangaroo Stage 1. Lend Lease was successfully appointed as the preferred proponent to develop Barangaroo Stage 1 (otherwise known as Barangaroo South) in 2009.

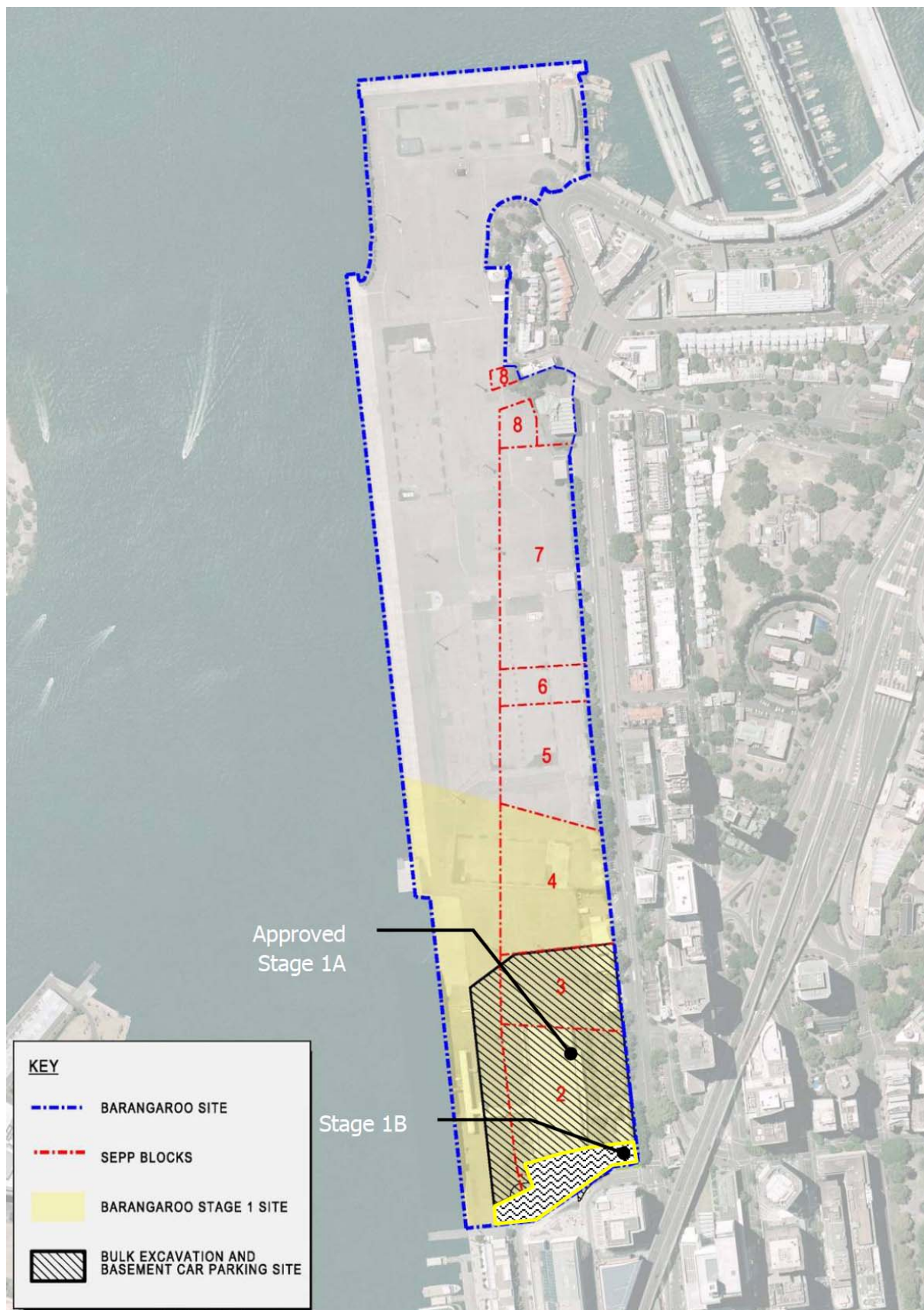
Barangaroo Stage 1 is located on the north western edge of the Sydney Central Business District (CBD). The redevelopment is bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point and The Rocks to the east; and by a range of new commercial development to the south. The location of the Stage 1 construction works in relation to the remainder of the Barangaroo redevelopment area and the CBD is shown in Figure 1 below. The footprint of commercial buildings C3, C4 and C5 are entirely within Barangaroo Stage 1.

The initial phases of Barangaroo Stage 1 consist of retention wall construction and bulk excavation to create building basements, construction of a basement car parking area, and piling and construction of commercial buildings C3, C4 and C5. This management sub-plan covers these phases, and will be revised when needed to reflect the various stages of work. The current scope of this management sub-plan is summarised below.

Approval	Phase	Activities	Included in sub-plan revision
MP10_0023 Bulk Excavation & Basement Carparking Including MOD1 and MOD3	Establishment	<ul style="list-style-type: none"> Site establishment including hoarding, access, amenities, parking and ancillary requirements. Installation of environmental controls including dewatering & water treatment facilities. Demolition of existing in-ground structures, footings & slabs, clearing and grubbing. Removal of existing below ground foundations and structures such as caissons and piles. Archaeological and other investigations. Decommissioning, capping off and relocation of existing services. 	Yes
	Perimeter Retaining Wall	<ul style="list-style-type: none"> Construction of the basement PRW using bentonite, concrete and piles. Temporary stockpiling of excavated material. Transportation and disposal of material off-site where is cannot be reused on-site. Dewatering operations, including water treatment and recycling. 	Yes
	Bulk Excavation and Construction	<ul style="list-style-type: none"> Bulk excavation of the basement within Blocks 1, 2, 3 and the adjacent public domain area. Loading and transport of spoil to Headland Park for reuse as fill. Classification and off-site re-use of spoil deemed unsuitable for on-site re-use. Classification and off-site disposal to licensed landfill of spoil deemed unsuitable for re-use. Crushing and screening facilities and operations. Concrete batching. Stormwater works along Hickson Road, Shelley St and Lime St. Structural works, comprising the construction of foundations, basement levels, up to 880 car spaces 	Yes

		<p>and all associated elements and structures.</p> <ul style="list-style-type: none"> • Road works, including the extension of Margaret Street and Lime Street. • Construction of temporary vehicular access from Hickson Road and permanent vehicular access from Margaret Street. • Temporary use of the basement for construction related storage and activity. 	
MP10_0025 Commercial Building C4 Including MOD1	Piling, Podium and Tower	<ul style="list-style-type: none"> • Piling for construction of Building C4 foundations. • Construction of the podium and public domain. • Construction of the building and facade. 	Yes
MP11_0044 Commercial Building C3	Piling, Podium and Tower	<ul style="list-style-type: none"> • Piling for construction of Building C3 foundations. • Construction of the podium and public domain. • Construction of the building and facade. 	Yes
MP10_0227 Commercial Building C5	Piling, Podium and Tower	<ul style="list-style-type: none"> • Piling for construction of Building C5 foundations. • Construction of the podium and public domain. • Construction of the building and facade. 	Yes

Figure 1: Site Layout

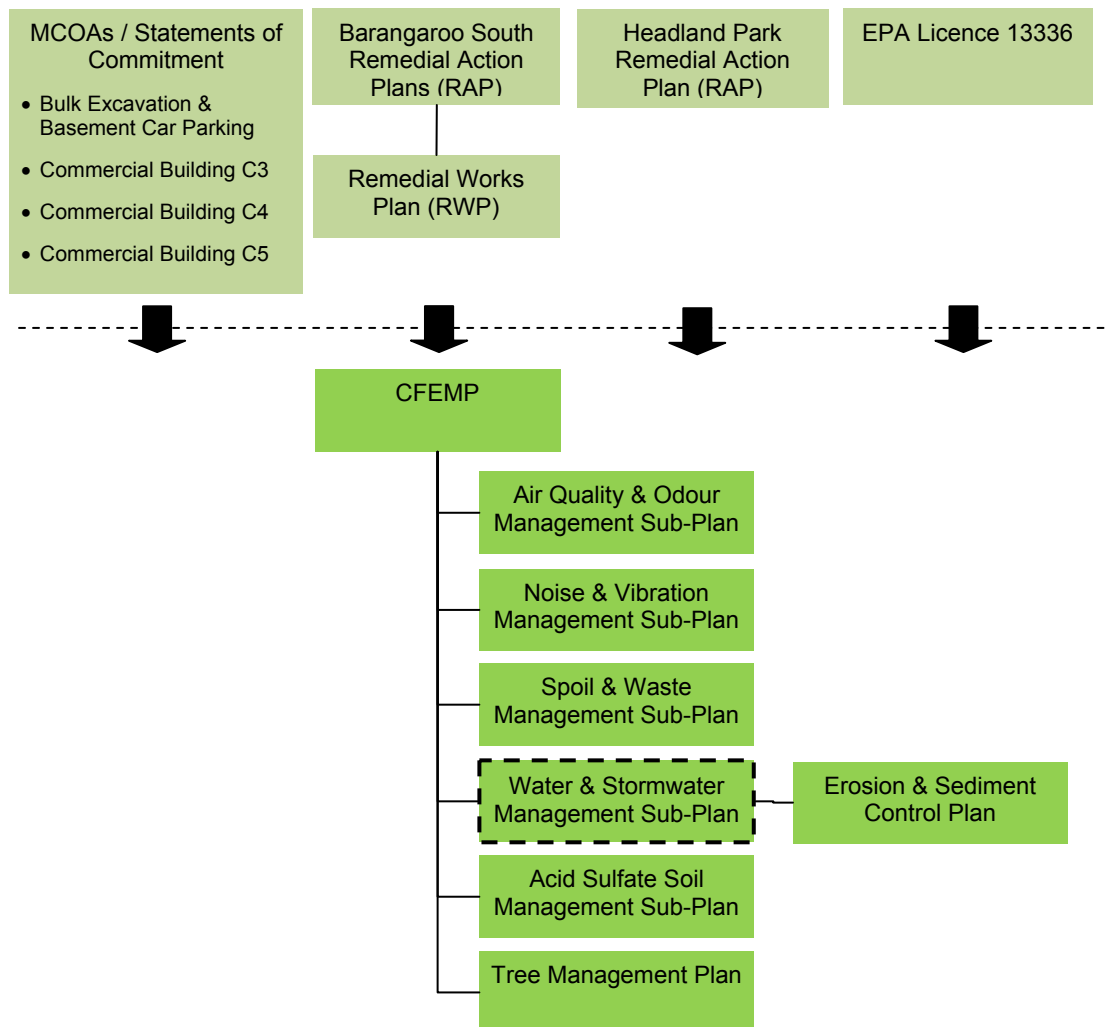


GOALS, OUTCOMES, KEY ISSUES

Scope	<p>This <i>Water & Stormwater Management Sub-Plan</i> provides prevention and mitigation measures to minimise and manage the impacts on water quality during construction. It defines a monitoring program that enables control of the impacts of the construction activities on potentially affected areas. The major focus is on the protection of waters and the receiving aquatic ecosystems of Sydney Harbour from the construction activities associated with the Bulk Excavation and Basement Car Park Works.</p> <p>This sub-plan forms part of the Lend Lease Project Management & Construction Environmental Management System (the Blue Book) and should be read in conjunction with plans shown below in Figure 2.</p>
Goals	<ul style="list-style-type: none"> • Ensure that construction activities are managed to meet water quality objectives set out in the Environmental Assessment, conditions of approval and Environment Protection Licence (EPL) No. 13336 issued by the Environment Protection Authority (EPA). • Provide adequate erosion and sedimentation controls, including controls to minimise dust and vehicular mud-tracking. • Monitor the effects of activities and the effectiveness of mitigation measures. • Effectively manage the bulk excavation activities and associated dewatering, including contaminated water removed from the identified contamination hot-spots.
Intended Outcomes	<ul style="list-style-type: none"> • Erosion and sediment controls are to be effective and properly maintained at all times. • Water treatment plant to treat stormwater and dewatered groundwater to achieve water quality criteria set out in EPL 13336.
Key Issues and Sensitive Areas	<p>Background</p> <p>Water quality studies indicate that physico-chemical conditions in Darling Harbour, adjacent to Barangaroo, are typical of an eastern Australian estuary. The studies showed an average surface pH of 8.2, temperature of 19°C, dissolved oxygen concentration of 8.2 mg/L and conductivity of 53mS/cm. Turbidity in surface waters (1.6 NTU) are slightly higher than mid-water (1.2 NTU), but were within the general acceptable range (0.5 – 10 NTU) for subtropical eastern Australia.</p> <p>Benthic habitat indicates the presence of burrowing organisms such as polychaete worms and invertebrate crustaceans, but no marine vegetation. The substrate at southern end of the site contains clay and is relatively undisturbed, in contrast with central and northern sections which contain a higher percentage of silt.</p> <p>Contaminated sediments have been previously reported within the vicinity of the Barangaroo site. A layer of silty / gravelly sand was encountered in all boreholes drilled at the site, varying in thickness from 0.5 – 21m. In central and southern portions of the site, the fill layer was underlain by natural marine sediments generally comprising sandy clays. A number of samples had metal concentrations above the NEPM (1999) Interim Urban Ecological Investigation Levels. Contaminants in soils were lead, TPH, PAH, and Benzene, Toluene Ethylbenzene and Xylenes (BTEX).</p> <p>Groundwater at the site flows towards Sydney Harbour, with strong tidal influence in areas closest to the harbour. The majority of impacts to groundwater are related to the former gasworks, located adjacent to the basement car park.</p> <p>Construction Issues</p> <p>Water quality is regulated by the EPA and the Minister's Conditions of Approval (MCOA) requirements.</p> <p>A summary of likely water sources, treatment options and the hierarchy of water disposal and use are included in Appendix 3, <i>Water Management Strategy</i>. It is not expected that construction works would result in adverse water quality impacts in Sydney Harbour given that:</p>

	<ul style="list-style-type: none"> • Works will be carried out landward of the existing caisson walls. • As there is a low risk of groundwater or sediment movement through or under the caissons during construction of the basement retention system, a silt curtain would be used during this period. • Once the basement retention system is constructed, it will prevent any movement of groundwater between the construction area and the harbour. Water quality risks will therefore be reduced once construction of the retention system is complete. <p>There is potential for minor water quality impacts during construction including:</p> <ul style="list-style-type: none"> • Sedimentation impacts related to general site based earthworks such as material stockpiles, stormwater works, concrete batching facilities, silt and dust on site and vehicular mud tracking. These effects are likely to be minimal given the water quality control measures in Section 5 of this sub-plan. • Stormwater and dewatered groundwater within the basement, although this water will be collected and treated to EPA licence water quality limits as per Appendix 1. <p>In May 2009, the then DECCW (now EPA) determined that a portion of Barangaroo and adjoining Hickson Road (coinciding with the location of the former Millers Point gasworks facilities) was contaminated in such a way as to present a significant risk of harm to human health and the environment. As a consequence DECCW declared the portion to be a remediation site (Declaration Number 21122; Area Number 3221) under section 9 of the <i>Contaminated Land Management Act 1997</i>. The works proposed under the Bulk Earthworks and Basement Car Park Planning Approval (MP10_0023) lie outside the DECCW Declaration Area.</p>
Statutory Requirements	<p><i>Protection of the Environment Operations Act 1997 (NSW) (POEO Act)</i></p> <ul style="list-style-type: none"> • Section 120 of the Act provides that it is illegal to pollute or cause or permit pollution of waters. • Under the Act, 'Water Pollution' includes introducing litter, sediment, oil, grease, wash water and debris into waters or placing such material where it is likely to be washed or blown into waters or the stormwater system or percolate into groundwater. <p><i>Protection of the Environment Operations (General) Regulation 2009</i></p> <p>The Regulation contains provisions relating to environment protection licences, the issuing of penalty notices under the Act and certain related environmental legislation, the appropriate regulatory authority for certain type of activities, and notification of pollution incidents.</p> <p>Other applicable legislation are the <i>Water Act 1912</i> and <i>Water Management Act 2000</i>.</p>
Relationship to Other Plans	<ul style="list-style-type: none"> • Acid Sulfate Soils Management Sub-Plan. • Incident & Emergency Management Plan. • Spoil & Waste Management Sub-Plan. <p>All environment-related plans are shown in Figure 2 below.</p>
Environmental Aspects & Impacts	Refer to the Project EHS Risk Assessment, which forms part of the Project EHS Plan.
Licence & Permit Requirements	The requirements of EPA Licence 13336 that relate to Barangaroo Stage 1 are included in Section 4 of this sub-plan. These requirements will be updated with each relevant licence variation issued by EPA.

Figure 2: Environment Documentation Structure



1 MCOA REQUIREMENTS

Bulk Excavation and Basement Carparking (MP10_0023)

No.	Original Ref.	Relevant Requirement	Reference
Stormwater and Water Management Plan			
1.	A12	Prior to the commencement of barging/shipping of materials from the site, the proponent shall update the Environmental Construction Management Plan, as outlined in the Statement of Commitments. All 'barging/shipping details must be reviewed by the EPA prior to the commencement of barging/shipping activities. Environment Protection Licence No 13336 must also be varied, where relevant, prior to the commencement of barging/shipping activities to ensure environmental impacts of this activity are appropriately regulated.	Not applicable at this stage
2.	A13d	<p>Prior to the issue of a construction certificate for the installation and operation of the concrete batching plant, the proponent shall update the following Plans in accordance with the terms of the respective conditions and provide a copy to the department and the City of Sydney Council:...</p> <p>d. C4 Stormwater and Water Management Plan (Note: the Stormwater and Water Management Plan is to be updated to incorporate the Soil and Water Management Plan prepared by Worley Parsons dated 31 August 2012 and the Water Management Plan prepared by Boral and dated 31 August 2012 to the satisfaction of the EPA).</p> <p>All management, monitoring and mitigation measures incorporated into the endorsed plans, as relevant to the operation of the concrete batching plant, are to be fully implemented for the term of operation of the concrete batching plant.</p>	This sub-plan
3.	C2.1(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);	Section 5
4.	C2.6	Details of the de-watering process, including the specifications for any on-site water treatment plant.	Appendix 2
5.	C4.1	Prior to the commencement of each stage of works, the proponent must develop and provide to the DECCW for review and comment a <i>Stormwater and Water Management Plan</i> .	This Sub-Plan
6.	C4.2	All groundwater from the excavations must be collected, managed and / or treated in a manner that ensures that it can be discharged to sewer or waters.	Section 5 Appendix 5
7.	C4.3	All water discharged from the site to Darling Harbour must comply with the table of limits (see Attachment 3 of DECCW letter to Department of Planning dated 11 October 2010) unless otherwise agreed by DECCW.	Section 6 Appendix 2
8.	C4.3	In addition to the limits (Attachment 3), a total suspended solids (TSS) limit of 50mg/l will be applied to the end of discharge pipe from the project water treatment plant.	Section 6
9.	C4.3	Monitoring of turbidity in Darling Harbour water adjacent to the project will be required. The locations of turbidity monitoring are to be agreed with DECCW and documented in the <i>Stormwater and Water Management Plan</i> . In the initial stages of the project an interim limit of 50mg/l for TSS would be applied at the monitoring locations.	Section 6
10.	C4.3	Procedures for visual monitoring for turbidity in adjacent Darling Harbour water and response measures are to be documented in the	Section 6

		<i>Stormwater and Water Management Plan.</i>	Section 9
11.	C4.3	Silt curtain(s) should be employed during the site establishment and construction of the diaphragm wall. The length and location should be documented in the <i>Stormwater and Water Management Sub-Plan</i> and agreed with DECCW prior to commencement of these works. Ongoing use of silt curtains in subsequent stages of the works is to be agreed with DECCW prior to the commencement of each subsequent stage.	Section 5 – WQ8 Erosion & Sediment Control Plan
12.	C4.4	Any discharge structure constructed to allow water to be discharged to Darling Harbour must include a discharge diffuser to allow for dilution. The discharge point must be installed inside an appropriately installed silt curtain arrangement. Details of dilution of the discharge water will be included in the <i>Stormwater and Water Management Plan</i> . No water that is contaminated may be reused on site for dust suppression or other activities without being treated.	Section 5 - WQ21
13.	C4.5	The water treatment plant must be designed to remove all relevant contaminants (including petroleum hydrocarbons, PAHs, BTEX, sediments and metals) to levels in the water management plan or as otherwise agreed by DECCW.	Section 5 Appendix 2
14.	C4.6	Untreated water must be held on site until results from monitoring are available for review until otherwise agreed by DECCW.	Section 6 Appendix 4
15.	C10	Prior to the commencement of work, suitable measures are to be implemented to ensure that sediment and other materials are not tracked onto the roadway by vehicles leaving the site. It is an offence to allow, permit or cause materials to pollute or be placed in a position from which they may pollute waters.	Section 5 - WQ13, WQ14
Monitoring			
16.	C4.1 (Monitoring)	The water management plan must include a detailed proposal for monitoring water quality.	Section 6 Appendix 4
17.	C4.2 (Monitoring)	The monitoring program must include at least an on-site program for waters held on site prior to discharge and an ambient monitoring program that checks water quality in Darling Harbour.	Appendix 4
18.	C4.3 (Monitoring)	The monitoring on site program needs to cover all types of water on the site that needs to be discharged including clean stormwater, higher turbidity stormwater from areas without much soil contamination, stormwater that has been in contact with contaminated areas and contaminated groundwater from the excavations.	Section 6 Appendix 4
19.	C4.4 (Monitoring)	The monitoring of ambient waters program must include an up and downstream/tide sampling location around the discharge structure as well as a reference location. Water to be discharged to Darling Harbour must be monitored on a daily basis for the first two weeks of operations. The monitoring frequency of subsequent discharges must be not less than weekly unless otherwise agreed by DECCW and/or permitted by licence conditions.	Appendix 4

Commercial Building C4 (MP10_0025)

No.	Original Ref.	Relevant Requirement	Reference
20.	B19	Water and Stormwater Management Plan/Sub Plan Prior to the issue of a relevant Construction Certificate, an updated Water and Stormwater Management Plan prepared by a suitably qualified person shall be submitted to the satisfaction of DECCW, and approved by the Certifying Authority. Any effluents/liquid waste streams associated with the construction of the building that are directed to the site Wastewater Treatment Plant are treated sufficiently to ensure compliance with all concentration limits required by Environmental Protection Licence 13336 prior to discharge to Darling Harbour.	This sub-plan
21.	B22	Erosion and Sedimentation Control Soil erosion and sediment control measures shall be designed in accordance with the document Managing Urban Stormwater – Soils & Construction Volume 1 (2004) by Landcom. Details are to be submitted to the satisfaction of the Certifying Authority prior to the issue of the relevant Construction Certificate.	Appendix 5
22.	C1	Environmental Protection Licence Prior to the commencement of works, the Proponent must ensure that the existing Environmental Protection Licence (EPL) issued to the Barangaroo Delivery Authority is varied, where required, to reflect and permit the works conducted on site. All works undertaken on site must be done in a manner which ensures compliance with EPL conditions at all times.	EPL 13336
23.	D2	Erosion and Sediment Control All erosion and sediment control measures, as designed in accordance with Condition B23, are to be effectively implemented and maintained at or above design capacity for the duration of the construction works and until such time as all ground disturbed by the works has been stabilised and rehabilitated so that it no longer acts as a source of sediment.	Section 5 (assume reference is to B22)
24.	D3	Disposal of Seepage and Rainwater Any seepage or rainwater collected on-site during construction shall not be pumped to the street stormwater system unless separate prior approval is given in writing by the relevant authority.	Section 5, WQ11

Commercial Building C3 (MP10_0227)

No.	Original Ref.	Relevant Requirement	Reference
25.	B19	Water and Stormwater Management Plan/Sub Plan Prior to the issue of a relevant Construction Certificate, an updated Water and Stormwater Management Plan prepared by a suitably qualified person shall be submitted to the satisfaction of DECCW, and approved by the Certifying Authority. Any effluents/liquid waste streams associated with the construction of the building that are directed to the site Wastewater Treatment Plant are treated sufficiently to ensure compliance with all concentration limits required by Environmental Protection Licence 13336 prior to discharge to Darling Harbour.	This sub-plan
26.	B22	Erosion and Sedimentation Control Soil erosion and sediment control measures shall be designed in accordance with the document Managing Urban Stormwater – Soils & Construction Volume 1 (2004) by Landcom. Details are to be submitted to the satisfaction of the Certifying Authority prior to the issue of the relevant Construction Certificate.	Appendix 5

No.	Original Ref.	Relevant Requirement	Reference
27.	C1	Environmental Protection Licence Prior to the commencement of works, the Proponent must ensure that the existing Environmental Protection Licence (EPL) issued to the Barangaroo Delivery Authority is varied, where required, to reflect and permit the works conducted on site. All works undertaken on site must be done in a manner which ensures compliance with EPL conditions at all times.	EPL 13336
28.	D2	Erosion and Sediment Control All erosion and sediment control measures, as designed in accordance with Condition B23, are to be effectively implemented and maintained at or above design capacity for the duration of the construction works and until such time as all ground disturbed by the works has been stabilised and rehabilitated so that it no longer acts as a source of sediment.	Section 5 (assume reference is to B22)
29.	D3	Disposal of Seepage and Rainwater Any seepage or rainwater collected on-site during construction shall not be pumped to the street stormwater system unless separate prior approval is given in writing by the relevant authority.	Section 5, WQ11

Commercial Building C5 (MP11_0044)

No.	Original Ref.	Relevant Requirement	Reference
30.	B19	Water and Stormwater Management Plan/Sub Plan Prior to the issue of a relevant Construction Certificate, an updated Water and Stormwater Management Plan prepared by a suitably qualified person shall be submitted to the satisfaction of DECCW, and approved by the Certifying Authority. Any effluents/liquid waste streams associated with the construction of the building that are directed to the site Wastewater Treatment Plant are treated sufficiently to ensure compliance with all concentration limits required by Environmental Protection Licence 13336 prior to discharge to Darling Harbour.	This sub-plan
31.	B22	Erosion and Sedimentation Control Soil erosion and sediment control measures shall be designed in accordance with the document Managing Urban Stormwater – Soils & Construction Volume 1 (2004) by Landcom. Details are to be submitted to the satisfaction of the Certifying Authority prior to the issue of the relevant Construction Certificate.	Appendix 5
32.	C1	Environmental Protection Licence Prior to the commencement of works, the Proponent must ensure that the existing Environmental Protection Licence (EPL) issued to the Barangaroo Delivery Authority is varied, where required, to reflect and permit the works conducted on site. All works undertaken on site must be done in a manner which ensures compliance with EPL conditions at all times.	EPL 13336
33.	D2	Erosion and Sediment Control All erosion and sediment control measures, as designed in accordance with Condition B23, are to be effectively implemented and maintained at or above design capacity for the duration of the construction works and until such time as all ground disturbed by the works has been stabilised and rehabilitated so that it no longer acts as a source of sediment.	Section 5 (assume reference is to B22)
34.	D3	Disposal of Seepage and Rainwater Any seepage or rainwater collected on-site during construction shall not be pumped to the street stormwater system unless separate prior approval is given in writing by the relevant authority.	Section 5, WQ11

2 STATEMENT OF COMMITMENT REQUIREMENTS

Bulk Excavation and Basement Carparking (MP10_0023)

No.	Original Ref.	Relevant Requirement	Reference
35.	1.4	To manage any potential water quality impacts, water quality monitoring will be undertaken as described in the Water Quality Monitoring Requirements report at Appendix H [of the PPR].	Appendix 4
36.	1.4	Appropriate excavation methods, installation of turbidity (silt) curtains, erosion and sediment control measures, dewatering and water treatment, routine visual inspections, stormwater management, water quality monitoring, and monitoring of weather and tides.	Section 5 Section 6 Erosion and Sediment Control Plan
37.	1.4	Water quality monitoring activities required for the bulk excavation and car park basement activities would be incorporated into a Water Quality Monitoring Plan developed for the overall project.	Appendix 4
38.	1.4	Additional water quality monitoring will be undertaken during construction operations in response to potential water quality exceedance events when required.	Section 10 Appendix 4
39.	1.4	Water quality criteria that will be applied for this project will be generally based on recommendations provided in the ANZECC Guidelines.	Section 6 Appendix 4
40.	1.4	Prior to the issue of the relevant construction certificate, Lend Lease commits to the preparation of a detailed Water and Stormwater Management Plan that addresses the specific water quality and water monitoring matters identified in DECCW's submission, as follows:	This Management Plan
41.	1.4	Water volume management.	Section 5
42.	1.4	Anticipated volumes of water generated on-site including potential volumes of groundwater and stormwater discharges.	Appendix 2
43.	1.4	Volumes of wastewater to be treated on site.	Appendix 2
44.	1.4	Volumes of recycling/reuse.	Appendix 2
45.	1.4	Volumes to be discharged to sewer.	No discharge to sewer
46.	1.4	Criteria for nominating areas and different sources of site water as clean or contaminated.	All water to be treated.
47.	1.4	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.	Section 5
48.	1.4	Water discharge criteria and monitoring frequency for parameters listed in the "Water Quality Monitoring Requirements" document prepared as part of the EA.	Section 6
49.	1.4	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.	Section 6, Appendix 4

50.	1.4	Details of specific discharge and monitoring points for onsite 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.	Erosion & Sediment Control Plan, Appendix 6
51.	1.4	Suitability of chosen reference site(s) based on turbidity data from a proposed monitoring program.	Appendix 4
52.	1.4	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 (silt) curtain. Note that 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.	Appendix 4
53.	1.4	Criteria development for wastewater discharges that would trigger a review of water management systems. These criteria will trigger operational responses that help in ensuring licence conditions are not exceeded.	Appendix 4
54.	1.4	A detailed description of measures for stormwater and sediment control for specific locations on the site.	Section 5 Erosion and Sediment Control Plan.
55.	1.4	Silt curtain arrangements for the protection of Darling Harbour as a secondary protection control.	Section 5 Erosion and Sediment Control Plan.
56.	1.4	An operational plan detailing how contaminated water and sediment control systems will be implemented, operated and maintained.	Summary included as Appendix 3.
57.	1.4	A description of the operation and maintenance of environmental protection structures and the like such as (not limited to) silt curtains, bunding and filtration systems, dewatering plant and methodology etc.	Section 6
58.	1.4	Details of the prevention of contaminated water being discharged to Darling Harbour.	Section 5, Section 10
59.	1.4	Criteria for wastewater or effluent reuse for either contaminated or clean sources of water.	All water to be treated. Dust suppression waters to comply with discharge standards.
60.	1.4	Management practices for reuse of treated wastewater from contaminated areas.	All water to be treated. Dust suppression waters to comply with discharge standards.
61.	1.4	Lend Lease is committed to designing stormwater infrastructure at Barangaroo South facilitating either reuse of stormwater via building based rainwater tanks or alternatively treated to National Best Practice with an integrated approach to Water Sensitive Urban Design.	End use operational issue being incorporated into design
62.	1.4	Lend Lease commits to entering into the necessary arrangements and obtaining the necessary approvals for water supply, sewer and stormwater connections from the relevant authorities, as required. A Water Servicing Coordinator will be engaged as suggested by Sydney Water in its submission as relevant to the proposed works.	End use operational issue being incorporated into design

Commercial Building C4 (MP10_0025)

No.	Original Ref.	Relevant Requirement	Reference
63.	SOC35	Construction and site management relating to the construction of Building B4 will be in generally accordance with the Environmental, Construction and Site Management Plan prepared by Cardno & Bovis Lend Lease included at Appendix EE of the Environmental Assessment Report prepared by JBA Urban Planning Consultants dated November 2010.	This sub-plan
64.	SOC36	<p>The Environmental Construction and Site Management Plan prepared by Cardno & Bovis Lend Lease will be updated to include the following:</p> <ul style="list-style-type: none"> - A requirement that the wastewater treatment measures associated with the building C4 works are incorporated. - A requirement that all water discharged from the site to Darling Harbour must comply with the table of limits provided by DECCW unless otherwise to agreed to by DECCW. In addition to the table of limits provided by DECCW, a turbidity or TSS limit may be applied to the ambient monitoring locations (to trigger site response in the event of an exceedance). Once sufficient ambient data is available from both the ambient locations and the reference location a final limit will be developed which will include consideration of background; - A requirement that no contaminated water may be reused on site for dust suppression or other activities without being treated; - A detailed proposal for monitoring water quality that includes at least an on site program for waters held on site prior to discharge and an ambient monitoring program that checks water quality in Darling Harbour. The monitoring on site program will cover all types of water on the site that needs to be discharged including clean stormwater higher turbidity stormwater from areas without much soil contamination, stormwater that has been in contact with contaminated areas and contaminated groundwater from the excavations. - A requirement that the waste water treatment plant be designed to remove all relevant contaminants to levels in the Water Management Plan or as otherwise agreed by DECCW. - A requirement that all untreated water be held on site until results from monitoring are available for revise or until otherwise agreed by DECCW. 	<p>Note ECMP is CFEMP for construction</p> <p>This sub-plan</p> <p>Section 5, WQ19</p> <p>Appendix 3</p> <p>Section 6 & Appendix 5</p> <p>Appendix 2</p> <p>Appendix 2</p>

Commercial Building C3 (MP10_0227)

No.	Original Ref.	Relevant Requirement	Reference
65.	SOC34	<p>Env, Const & Site Management</p> <p>Construction and site management relating to the construction of Building C3 will be in generally accordance with the Environmental, Construction and Site Management Plan prepared by Cardno & Lend Lease included at Appendix CC of the Environmental Assessment Report prepared by JBA dated November 2011.</p> <ul style="list-style-type: none"> - In the event that barging of soil is undertaken, requirements, for: <ul style="list-style-type: none"> • Management of spillage of spoil during loading I movement of barges; • Procedures in the event of an incident (such as a fuel spill or collision with structures I vessels on the water); and • Reporting of any incidents, (such as a fuel spill) on the water. 	This sub-plan

Commercial Building C5 (MP11_0044)

No.	Original Ref.	Relevant Requirement	Reference
66.	SOC34	<p>Env, Const & Site Management</p> <p>Construction and site management relating to the construction of Building C3 will be in generally accordance with the Environmental, Construction and Site Management Plan prepared by Cardno & Lend Lease included at Appendix CC of the Environmental Assessment Report prepared by JBA dated November 2011.</p> <p>In the event that barging of soil is undertaken, requirements, for:</p> <ul style="list-style-type: none"> • Management of spillage of spoil during loading I movement of barges; • Procedures in the event of an incident (such as a fuel spill or collision with structures I vessels on the water); and • Reporting of any incidents, (such as a fuel spill) on the water. 	This sub-plan

3 OTHER REQUIREMENTS

Dewatering Licence - 10BL605180

No.	Original Ref.	Relevant Requirement	Reference
67.	1	Water shall not be pumped or extracted from the work(s) authorised by this license for any purpose other than temporary construction dewatering.	Noted
68.	2	<p>The licensee shall within two (2) months of completion or after tile issue of the Licence if the work is existing, furnish to NSW Office of Water :-</p> <p>(a) details of the work as set out in the form "a" (must be completed by a driller, duly licensed in NSW).</p> <p>(b) a plan showing accurately the location of the work in relation to portion and property boundaries,</p> <p>(c) details of any pumping tests carried out,</p> <p>(d) details of any water analysis;</p>	CFEMP Appendix 9, Table 1
69.	3	The licensee shall allow NSW Office of Water or any person authorised by it, full and free access to the works, either during or after construction, for the purpose of carrying out inspection or test of the works and its fittings and shall carry out any work or alterations deemed necessary by the department for the protection and proper maintenance of the works, or the control of the water extracted and for the protection of the quality and the prevention from pollution or contamination of sub-surf ace water. .	Noted
70.	4	<p>(a) the licensee shall notify NSW Office of Water if a flowing supply of water is obtained. The bore shall then be lined with casing and cemented and a suitable closing gear shall be attached to the borehead as specified by NSW Office of Water.</p> <p>(b) if a flowing supply of water is obtained from the work, the licensee shall only distribute water from the bore head by a system of pipe lines and shall not distribute it in drains, natural or artificial channels or depressions.</p>	Noted

71.	5	If a work is abandoned at any time the licensee shall notify NSW Office of Water that the work has been abandoned and seal off tile aquifer by:- (a) backfilling the work to ground level with clay or cement after withdrawing the casing (lining); or (b) such methods as agreed to or directed by NSW Office of Water .	Noted
72.	6	Tailwater drainage shall not be allowed to discharge onto adjoining roads, crown land or other persons land, or into any river as defined under tile water act, or any groundwater aquifer, by surface or sub-surface drains or pipes or any other means.	Section 5, WQ10
73.	8	The licensee shall maintain a record of the actual volume of groundwater pumped (in kilolitres or megalitres) from the dewatering works, the discharge rate (in litres per second) and duration of pumping (number of days or weeks) and provide this information to the department on an agreed basis, at the completion of construction, or upon request from the department.	Monthly WTP Performance Reports
74.	9 & 10	The licensee shall maintain a record of the actual volume and quality of any tailwater generated by the dewatering, including testing of the pH of the water prior to the commencement of pumping and twice daily thereafter for the period of operation, and provide this information to the department on an agreed basis, at the completion of construction, or upon request from the department.	Noted – no tailwater expected
75.	11	The licensee shall provide all raw monitoring data to the department within 6 months of completion of the pumping authorised by this license in an electronic format that is compatible with Microsoft Office and Adobe Acrobat software.	CFEMP Appendix 9, Table 1
76.	12	The work authorised by this license shall be managed and operated in accordance with any acid sulphate soil or other groundwater-related management plan for the site including plans developed under the Protection Of The Environment Operations Act 1997 or the Contaminated Land Management Act 1997.	This sub-plan Acid Sulfate Soil Management Sub-Plan
77.	13	The licensee shall not allow the discharge of water from the site unless:- (a) the pH of the discharge water is between 6.5 and 8.5 and no other contaminants are present; or (b) the discharge water has been treated to bring the pH to a level between 6.5 and 8.5 and remove any contaminants prior to discharge; or (c) the water is being discharged to a receiving water body in accordance with the conditions of a license granted under the protection of the environment operations act 1997; or (d) the water is being discharged to sewer under a written agreement with the relevant authority.	Section 5, WQ10, WQ20
78.	17	The volume of groundwater extracted from the works authorised by this license shall not exceed 142.0 megalitres for the term of this license.	Monthly WTP Performance Reports

4 LICENCE AND PERMIT REQUIREMENTS

EPA Licence 13336

No.	Original Ref.	Relevant Requirement	Ref.																				
79.	P1.3	<div>The following utilisation areas referred to in the table below are identified in this licence for the purposes of the monitoring and/or the setting of limits for any application of solids or liquids to the utilisation area.</div> <table><tr><th>EPA identi- fication no.</th><th>Type of monitoring point</th><th>Type of discharge point</th><th>Description of location</th></tr><tr><td>1</td><td>Discharge to waters</td><td>Discharge to waters</td><td>Discharge pipe installed through existing slab as described in document titled Barangaroo South S.1 Bulk Exc & Basement Carpark EPL variation Appl. 10 Dec 2010</td></tr><tr><td>2</td><td>North Near Field Turbidity Monitoring</td><td></td><td>Site NF1 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.</td></tr><tr><td>3</td><td>South Near Field turbidity Monitoring</td><td></td><td>Site NF2 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.</td></tr><tr><td>4</td><td>Reference Turbidity Monitoring Point</td><td></td><td>Site BG1 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.</td></tr></table>	EPA identi- fication no.	Type of monitoring point	Type of discharge point	Description of location	1	Discharge to waters	Discharge to waters	Discharge pipe installed through existing slab as described in document titled Barangaroo South S.1 Bulk Exc & Basement Carpark EPL variation Appl. 10 Dec 2010	2	North Near Field Turbidity Monitoring		Site NF1 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.	3	South Near Field turbidity Monitoring		Site NF2 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.	4	Reference Turbidity Monitoring Point		Site BG1 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.	Appendix 4
EPA identi- fication no.	Type of monitoring point	Type of discharge point	Description of location																				
1	Discharge to waters	Discharge to waters	Discharge pipe installed through existing slab as described in document titled Barangaroo South S.1 Bulk Exc & Basement Carpark EPL variation Appl. 10 Dec 2010																				
2	North Near Field Turbidity Monitoring		Site NF1 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.																				
3	South Near Field turbidity Monitoring		Site NF2 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.																				
4	Reference Turbidity Monitoring Point		Site BG1 as described in Fig 5.3 in LVA supporting information supplied to the EPA on 10 Dec 2010.																				
80.	L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.	Section 5																				
81.	L3.2	For each monitoring/discharge point or utilisation area specified in the table\ below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table. [See licence 13336 for table].	Appendix 4																				
82.	L3.2	Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.	Appendix 4																				
83.	L3.3	To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\ s.	Section 5																				
84.	L4.1	<div>For each discharge point or utilisation area specified below (by a point number), the volume/mass of:</div> <div>(a)liquids discharged to water; or;</div> <div>(b)solids or liquids applied to the area;</div> <div>must not exceed the volume/mass limit specified for that discharge point or area.</div> <table><tr><th>Point</th><th>Unit of measure</th><th>Volume/Mass Limit</th></tr><tr><td>1</td><td>kilolitres per day</td><td>6480</td></tr></table>	Point	Unit of measure	Volume/Mass Limit	1	kilolitres per day	6480	Appendix 2														
Point	Unit of measure	Volume/Mass Limit																					
1	kilolitres per day	6480																					

No.	Original Ref.	Relevant Requirement	Ref.						
85.	M2.1	For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency, specified opposite in the other columns: [table]	Appendix 4						
86.	M3.2	Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.	Appendix 4						
87.	M7.1	<p>For each discharge point or utilisation area specified below, the licensee must monitor:</p> <p>(a) the volume of liquids discharged to water or applied to the area;</p> <p>(b) the mass of solids applied to the area;</p> <p>(c) the mass of pollutants emitted to the air;</p> <p>at the frequency and using the method and units of measure, specified below.</p> <p>POINT 1</p> <table><tr><th>Frequency</th><th>Unit Of Measure</th><th>Sampling Method</th></tr><tr><td>Daily</td><td>kilolitres per day</td><td>No method specified</td></tr></table>	Frequency	Unit Of Measure	Sampling Method	Daily	kilolitres per day	No method specified	Appendix 2 Section 6
Frequency	Unit Of Measure	Sampling Method							
Daily	kilolitres per day	No method specified							
88.	M8.1	<p>For the purposes of the tables above:</p> <p>Discharges to Waters - Water Quality Monitoring - WTP (point 1), Special Frequency 1 means:</p> <ul style="list-style-type: none">Once prior to discharge during batch operation, up to 36 hours duration;Once daily during intermittent continuous operation, up to 72 hours duration;Once daily for the first fourteen days of continuous operation, then weekly; andWeekly post basement dewatering, during discharge. <p>Ambient Water Quality - Water Quality Monitoring - (points 2, 3 and 4), Special Frequency 2 means: Every 15 Minutes.</p>							
89.	E2.1	Commencing one month from the first day of operations of the WTP and monthly thereafter or unless otherwise agreed in writing by the EPA, the licensee must submit to the Manager Sydney Industry, EPA, PO Box 668 Parramatta NSW 2124, a monthly WTP Performance Report. The report must review and compare the performance of the WTP against the requirements of this EPL, including DP1 concentration limits, discharge volumes, recycled water quantities and quality as well as ambient monitoring results. The report must outline the circumstances which triggers additional monitoring arrangements and include details about incidents and responses. The report must include the results of the visual inspections of water quality controls including silt curtains and any remedial action undertaken to ensure compliance with licence conditions including O1 and O2.	Section 6, ongoing						
90.	E2.2	Within 60 days from the date of commissioning, the licensee must submit to the Manager Sydney Industry, EPA, PO Box 668 Parramatta NSW 2124, a Water Treatment Plant (WTP) commissioning report ("the report"). The report must include but not be limited to details about plant performance when treating a representative range of influents encountered during the initial stage of the works, namely, establishment works and installation of the perimeter retaining wall. The report must be updated ("the updated report") as works progress and as other influents are encountered at the site and directed to the WTP for treatment (for example contaminated groundwater, clean storm-water/surface water; contaminated stormwater/ surface water; stockpile leachate etc). The updated report must be made available to an Authorised EPA officer on request.	Complete.						

No.	Original Ref.	Relevant Requirement	Ref.
91.	E5.1	<p>Ambient Water Quality Monitoring Reporting</p> <p>Commencing one month from the first day of operations of the ambient water quality monitoring network and monthly thereafter or unless otherwise agreed in writing by the EPA, the licensee must submit to the Manager Sydney Industry, EPA, PO Box 668 Parramatta NSW 2124, a monthly Ambient Water Quality Monitoring Report. The report must include all results for ambient water quality monitoring around the site, an interpretation of those results and any relevant site management responses.</p>	Section 6, ongoing
92.	E5.2	<p>Ambient Water Quality Trigger</p> <p>A management trigger for turbidity at Points 2 and 3 must be established as outlined in Section 3.3.2 of Appendix 4 of the document entitled Water & Stormwater Management Sub-Plan - Barangaroo Stage 1 prior to any discharges from the works. If the trigger is exceeded the licensee must implement the actions listed in Section 3.3.6 of Appendix 4 of this document.</p>	Complete

5 MITIGATION MEASURES

Ref.	Mitigation Measure	Design	Site Establishment	Construction	Relevant Location / Activity	Relevant Approval Conditions	Responsibility	Timing
GENERAL								
WQ1.	Store all fuels, oils and chemicals in secure bunded areas and as per <i>Dangerous Goods Storage</i> requirements where applicable. Cover all permanent bunded areas. The bund capacity is to be capable of storing 110% of the capacity of the largest tank stored (DECC, 2007).	■	■	■	Entire Site	General	CM / CS / EM	Throughout construction
WQ2.	Use temporary bunds for short term periods of up to two weeks where required.		■	■	Entire Site	General	CS	Throughout construction
WQ3.	Provide spill kits at all key construction areas, including any refuelling areas, near any permanent fuel / chemical storage bunds, near the site water treatment system.		■	■	Entire Site	General	CM / CS / EM	Throughout construction
WQ4.	Ensure suitable marine containment booms are available at all times, and stored near the western limit of the site for marine deployment.		■	■	Near western boundary	General	CM / CS	Throughout construction
WQ5.	Report any spills immediately to the Construction Supervisor who in turn is to notify the EHS Manager (Environment) / EHS Co-ordinator.		■	■	Entire Site	General	ALL	Throughout construction
WQ6.	Report any spill likely to cause harm to the environment immediately to EPA via the EPA Pollution Line (131 555). Report any water based spills to Sydney Ports (9296 4000) and the Harbour Master.		■	■	Entire Site	General	EM	Throughout construction
WQ7.	Implement the <i>Spill Management Procedure</i> in the event of a land-based or water based fuel, oil or chemical spill.		■	■	Entire Site	General	CS / EM	Throughout construction
SILT CURTAIN								
WQ8.	Install a 2.5m deep silt curtain at the existing wharf prior to any excavation, comprising a floating boom with a weighted silt curtain.	■	■		At the existing wharf	Basement MCoA C4.3	CM / EM	Establishment & retention wall
EROSION & SEDIMENT CONTROL MEASURES								
WQ9.	Implement and maintain all site erosion and sedimentation controls as per the <i>Site Erosion and Sedimentation Control Plan</i> . Update the plan to address changing site conditions and construction activity.		■	■	Entire Site	General	CS / EC	Throughout construction
WQ10.	Create a continuous impervious water retention barrier around the perimeter of the site as per <i>Erosion and Sedimentation Control Plan</i> .	■	■	■	Entire Site	General	CM / CS	Throughout construction

WQ11.	Cap and re-align the existing stormwater system to capture and pump all water within the barrier to the site water treatment plant.	■	■	■	Entire Site	C4 MCOA D11	CM	Throughout construction
WQ12.	Install sumps for stormwater collection with a small berm around the surface to remove sediment before overflowing into the sump. Remove sediment build-up around these sumps as required.		■	■	Entire Site	General	CS	Throughout construction
WQ13.	Cover all loads coming onto the site and departing site, including internal loads, to minimise potential spillage / dust generation.		■	■	Entire Site	Basement MCOA D3	CS / EC	Throughout construction
WQ14.	Ensure all vehicles leaving the site or moving from unsealed to sealed roads (eg. between excavation areas and Headland Park) traverse over a rumble-grid and pit prior to exiting, with physical removal of dirt / mud using a pressure washer if required.		■	■	Exit points from the site.	Basement MCOA C10	CS / EC	Throughout construction
WQ15.	Cover any soil stockpiles identified as being contaminated or potentially contaminated whilst not active and provide bunding around the base.		■	■	Spoil handling	General	CS	Throughout construction
WQ16.	Cover uncontaminated soil stockpiles during windy / rainy conditions. Provide bunding around the base if required.		■	■	Spoil handling	General	CS / EC	Throughout construction
WQ17.	Coat uncontaminated stockpiled soil that remains inactive for >2 weeks with a dust sealant or similar to prevent erosion and dust generation.		■	■	Spoil handling	General	CS / EC	Throughout construction
WQ18.	Locate soil stockpiles away from drainage lines to minimise sediment loading on the site water treatment system.	■	■	■	Spoil handling	General	CM / EM	Throughout construction
WQ19.	Divert clean water away from the concrete batch plant. Delineate cementitious and dirty runoff zones within the batch plant. Install and maintain a first flush capacity equivalent to a minimum of 20mm of runoff across concrete batch site. Maintain capacity in preparation for rainfall events. Recycle captured water in the plant process. Treat any water that cannot be captured in the water treatment system.			■	Concrete batch plant	Basement MCOA A13d	CM / EM	During batch plant operation
DEWATERING & WATER TREATMENT								
WQ20.	Install and operate a water treatment system to treat captured surface water and extracted groundwater. Treat water to comply with EPL 13336.	■	■	■	Water management / treatment	Basement MCOA C4.5	CM / EM	Throughout construction
WQ21.	Discharge treated water via a diffuser. Locate the discharge point (as per the <i>Erosion & Sediment Control Plan</i>) within a silt curtain.	■		■	Water management / treatment	Basement MCOA C4.4	EM	After site establishment
WQ22.	For site establishment and temporary works prior to operation of the water treatment system, use temporary water detention basins to hold and treat surface and extracted groundwater.	■	■		Water management / treatment	Basement MCOA C2.1(d)	CM / EM	Site establishment
Key: EM – EHS Manager (Environment), CM – Construction Manager, CS – Construction Supervisor, EC – EHS Co-ordinator								

6 MONITORING

Detail	Frequency	Applicable standards	Reporting	Responsibility
<p>Water quality monitoring in accordance with the program set out in Table 3.1 of Appendix 4:</p> <ul style="list-style-type: none"> Water quality monitoring of discharge from water treatment plant. Discharge volumes from the water treatment plant. Recycled water volumes from the water treatment plant (if used). Monitoring in Darling Harbour utilising three continuous monitoring buoys (two adjacent to the silt curtain and one as background) measuring temperature, electrical conductivity, pH, and turbidity. Supplementary monitoring of receiving waters in response to plumes, incidents, audits and other compliance programs. 	As set out in the monitoring plan (Appendix 4).	Environmental Protection Licence requirements	<p>As per Appendix 4 & Environmental Protection Licence Requirements.</p> <p>Selected data to EPA as part of the monthly WTP Performance Report.</p> <p>Selected data to EPA as part of the monthly Ambient Water Quality Monitoring Report.</p>	EHS Manager (Environment) Specialist Contractor
Inspection of the construction site and stormwater discharge outlets	Weekly and daily after rainfall	-	To be documented in the Weekly EHS Checklist.	EHS Co-ordinator Construction Supervisor
Visual inspection of silt curtain, and for turbidity and plumes.	Minimum daily during perimeter retention wall works, with subsequent frequency depending on the nature of the works being carried out, as per Appendix 4.	-	<p>To be documented in ProjectWeb diary entries.</p> <p>Summary to EPA as part of the monthly WTP Performance Report.</p>	EHS Manager (Environment) EHS Co-ordinator Specialist Contractor
Diver inspection of the silt curtain.	Six-monthly, or more frequently as required	Integrity and effectiveness of silt curtain	Inspection report to EHS Manager (Environment).	EHS Manager (Environment) Specialist Contractor

7 TRAINING AND RESOURCES

Training

In addition to other Lend Lease training requirements discussed in the CFEMP, inductions are required and are to address:

- Site adjacent to sensitive Darling Harbour.
- Site water treated in the Water Treatment Plant at northern end of the site prior to discharge.
- Spill equipment available on site in yellow bins. Use the equipment in case of oil or hydraulic spills.
- Notify foreman or supervisors if any problems are observed.

Toolbox talks to be conducted on:

- Maintenance of erosion and sediment control measure.
- Stormwater management and control points.
- Road cleanliness and the importance of minimising sediment accumulation on the roadways / worksite.
- Location and purpose of spill response kits.

Specialist training:

- Deployment of marine containment booms and land-based spill kits.
- Operation of water quality monitoring equipment (by or with specialist staff only).

Resources

- Temporary erosion and sediment control materials (geotextiles, silt curtains, etc.).
- Water treatment plant and water transfer pipes, pumps and tanks.
- Water storage/recycling tanks at batch plant.
- Water carts / street sweepers.
- Rumble grid complete with sump and high-pressure washer.
- Bunded oil / fuel / chemical storage areas.
- Temporary bunds for the short term (<2 weeks) storage of oils / fuels / chemicals.
- Water quality probe.
- Water sample bottles.
- Spill kit stock and refills.
- Marine boating / barge contractor.
- EHS Co-ordinator, EHS Manager (Environment).

8 CONSULTATION & CONTACTS

Contacts

For contact names, numbers and positions, see the *Project Contacts List*.

9 REFERENCES AND REVISIONS

Related Documents

Spoil and Waste Management Sub-Plan

Preferred Project Report, Bulk Excavation and Basement Car Parking, Barangaroo Stage 1, JBA Planning Sept 2010

Preferred Project Report, Commercial Building C4, Barangaroo South, JBA Planning, February 2011.

Preferred Project Report, Commercial Building C3, Barangaroo South, JBA Planning, February 2012.

Preferred Project Report, Commercial Building C5, Barangaroo South, JBA Planning, February 2012.

Section 75W - Concrete Batch Plant Soil and Water Management Plan, Worley Parsons, 31 August 2012

Barangaroo Onsite Batch Plant - Water Management Plan, Boral, 31 August 2012

Community and Stakeholder Engagement Strategy

Procedures

Water Quality Plume Response Procedure

Forms

Weekly EHS Checklist, Environment Response Form, Water Quality Depth Profiles and Sampling Form

References

ANZECC & ARMCANZ (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

NSW Department of Housing/Landcom (2004) *Managing Urban Stormwater: Soils and Construction*.

DECC (2007) *Storing and Handling Liquids: Environmental Protection: Participants Manual*.

Revision, Control & Amendment

Revisions to this plan are to be made in accordance with the Document Control Procedure.

10 COMPLAINTS HANDLING AND SITUATION PLANNING

Complaints Handling Procedures			
<p>The <i>Community & Stakeholder Engagement Strategy</i> identifies policies and procedures for managing community specific issues arising from construction activities. If an environmental complaint is received, the complaints management process outlined in the Strategy will be followed. This will involve the complaint being referred directly to the EHS Manager (Environment) and/or Construction Manager. If they are on site at the time an entry in 'Consultation Manager', the project consultation database, will be made to ensure appropriate action and monitoring. A response would be required to 'close out' the complaint, and the resolution would be recorded in Consultation Manager.</p> <p>The <i>Community & Stakeholder Engagement Strategy</i> also outlines a number of proactive strategies for dealing with community and stakeholder issues.</p>			
Situation Planning & Response			
Potential situations that could arise during the works include the following:			
No.	Situation	Response	Responsibility
1	Unauthorised discharge of water that does not meet EPL criteria.	<p>Discharge, or relevant part of discharge, to immediately cease and the EHS Manager (Environment) contacted. As the water treatment system will be modular, it may be possible to isolate the effected module and continue treating / discharge. Retest water. Investigate the cause of the exceedence. Recirculate water through the water treatment plant until acceptable criteria is met prior to release. Depending on the nature / extent of the unauthorised discharge, the EHS Manager (Environment) is required to:</p> <ul style="list-style-type: none"> - report the situation to the EPA environment line (131 555) and also include the non-conformance in the monthly reporting. - report the situation internally according to the Incident and Emergency Management Plan. 	<p>EHS Manager (Environment) Construction Supervisor Specialist Contractor</p>
2	Oil or fuel spill (eg. hydraulic hose burst).	<p>Machinery or process to cease, if safe to do so. Spill kit to be used to contain and clean up spill. Machinery or process responsible for the spill is not to start operation until a full inspection and necessary repairs / corrective action has been implemented.</p>	<p>Construction Supervisor EHS Manager (Environment)</p>
3	Temporary erosion and sedimentation controls are damaged / ineffective.	<p>A review of the area is to be undertaken by a member of the environment team, accompanied by the Construction Supervisor. The erosion / sedimentation control is to be repaired or replaced immediately if possible, or within the same day of detection.</p>	<p>EHS Manager (Environment) Construction Supervisor</p>
4	Breakdown / inadvertent stoppage of site water treatment system.	<p>If safe to do so, water pumping to the system is to cease and the problem identified. As the water treatment system will be modular, it may be possible to isolate the effected module and continue treating / discharge. Construction activities to be modified if required to allow repair of the water treatment system. System is to be repaired and placed back into operation and monitored for the initial hour / day for reoccurrence. Corrective and preventative action is to be implemented prior to discharge recommencing. Incident report to be completed by the EHS Manager (Environment) and water treatment contractor.</p>	<p>EHS Manager (Environment) Construction Supervisor Specialist Contractor</p>

5	Disruption / damage to silt curtain in harbour during perimeter retention wall activities.	<p>Maintenance boat is to be used to access the problem and undertake repairs / untangling if required.</p> <p>If cause of the problem is more severe, for example – entanglement with another boat and / or underwater damage - the installation contractor is to be contacted immediately for repairs. Works are to be restricted to non-risk activities (in consultation with EHS Manager (Environment)) in the vicinity of the curtain until the silt curtain has been repaired and placed back into operation. An incident report is to be completed by the EHS Manager (Environment).</p>	<p>Construction Supervisor</p> <p>EHS Manager (Environment)</p> <p>Specialist Contractor</p>
6	Visual plume observed during construction activities associated with the perimeter retention wall.	<p>Works associated with the retention wall are to immediately cease to allow investigation of the plume and the EHS Manager (Environment) contacted.</p> <p>In consultation with the construction team and relevant contractors, a source of the problem and feasible solution to be derived and implemented.</p> <p>Upon recommencement of works, the area of the previous plume is to be monitored frequently (every 30 mins as a minimum) for the first four hours of works recommencing to ensure effectiveness of the implemented solution.</p> <p>Depending on the nature / extent of the plume, the EHS Manager (Environment) may be required to report the incident to the EPA environment line (131 555) and the Harbour Master. An incident report is to be completed by the EHS Manager (Environment).</p> <p>The EHS Manager (Environment) may also be required to report the situation internally according to the Incident and Emergency Management Plan.</p>	<p>Construction Supervisor</p> <p>EHS Manager (Environment)</p>

APPENDIX 1: WATER QUALITY LIMITS (as per EPL 13336)

Water quality limits at discharge point 1 in EPL 13336

Indicator	Units	Criteria
Total Suspended Solids	mg/L	50
Turbidity	NTU	Monitor
Sheens or plumes	Inspections	No visible sheen or plumes outside the silt curtain.
pH	pH	6.5–8.5
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	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	200
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#
TPH C6-C9 Fraction	µg/L	20#
Oil and Grease	mg/L	10
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)fluoranthene	µg/L	2*
Acenaphthene	µg/L	2*
Acenaphthylene	µg/L	2*
Chrysene	µg/L	2*
Indeno(1,2,3-cd)pyrene	µg/L	2*
Pyrene	µg/L	2*
Fluorine	µg/L	2*
Benzo[ghi]perylene	µg/L	2*
Dibenz[a,h]anthracene	µg/L	2*
Electrical conductivity		Monitor
Dissolved Oxygen		Monitor
Total PCBs	µg/L	Early non-detects, can be removed from ongoing monitoring required

* 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

APPENDIX 2: WATER MANAGEMENT SYSTEM OUTLINE

Water and Groundwater Management

A comprehensive site and ground water management strategy will be implemented and all stormwater and groundwater will be collected, managed and treated appropriately prior to reuse or discharge.

Surface Water Collection

A perimeter containment method will be adopted by installing a continuous impervious water retention barrier around the entire construction site. Existing stormwater pits will be sealed and adjacent sumps constructed and plumbed into the site water collection and treatment system.

All collected surface water, which includes site and stockpile runoff, will be treated through the primary, secondary and tertiary stages of the water treatment plant. Similarly, all collected groundwater will be treated through all three primary, secondary and tertiary stages.

Dewatering (Groundwater)

Site investigations indicate that contaminants of potential concern include lead, heavy metals, TPH, PAH, Benzene, Toluene, Ethylbenzene and Zylenes (BTEX). During excavation of the perimeter retaining wall, groundwater containing the above contaminants may be encountered.

During the Establishment Stage of the works, the primary source of water will be rainwater and groundwater collected from the saturated material being excavated for the perimeter wall. This material is to be stockpiled on an elevated draining bed, with a leachate/runoff collection system linked to the water treatment system.

Towards the later stages of the Establishment works, dewatering of the basement area will commence in preparation for bulk excavation.

Dewatering of the basement area will be achieved through a combination of both sump point dewatering and spear point dewatering arrangements, allowing for contingency measures to deal with unknown and potentially erratic groundwater hydrology.

Dewatering spears will be inserted into aggregate in addition to the installation of a series of sumps and submersible pumps within the surface levels of the aggregate. The submersible pumps will assist in the ground dewatering in the case that recharge in the area is not adequate enough to supply the spears or the spears become blocked.

Volumes of Water

The design of the water treatment system allows for modular additions, with the first module being capable of treating up to 25L/sec to cater for surface water, rain events and discharges during construction of the perimeter retaining wall. It is anticipated that during the initial stages of the works, water generation will fluctuate, with a maximum discharge rate of approximately 10L/sec.

Prior to commencement of dewatering of the basement bulk excavation area, the water treatment system will be amplified with the addition of two further modules, each with a capacity of 25L/s, allowing for a total treatment capacity of 75L/s.

The average daily discharge rate from the site (during dewatering of the basement bulk excavation area) is calculated as 6480 kL/day. This will be measured after treatment in the water treatment plant, and prior to discharge. Fluctuations in flow rate from dewatering spears and sumps may mean that maximum daily discharges are higher than average.

Water volumes being used for dust suppression will also be measured. Recycling of treated water primarily for dust management may be up to 20,000L per day depending on weather conditions and reuse opportunities given saline groundwater.

Water Treatment Summary – General

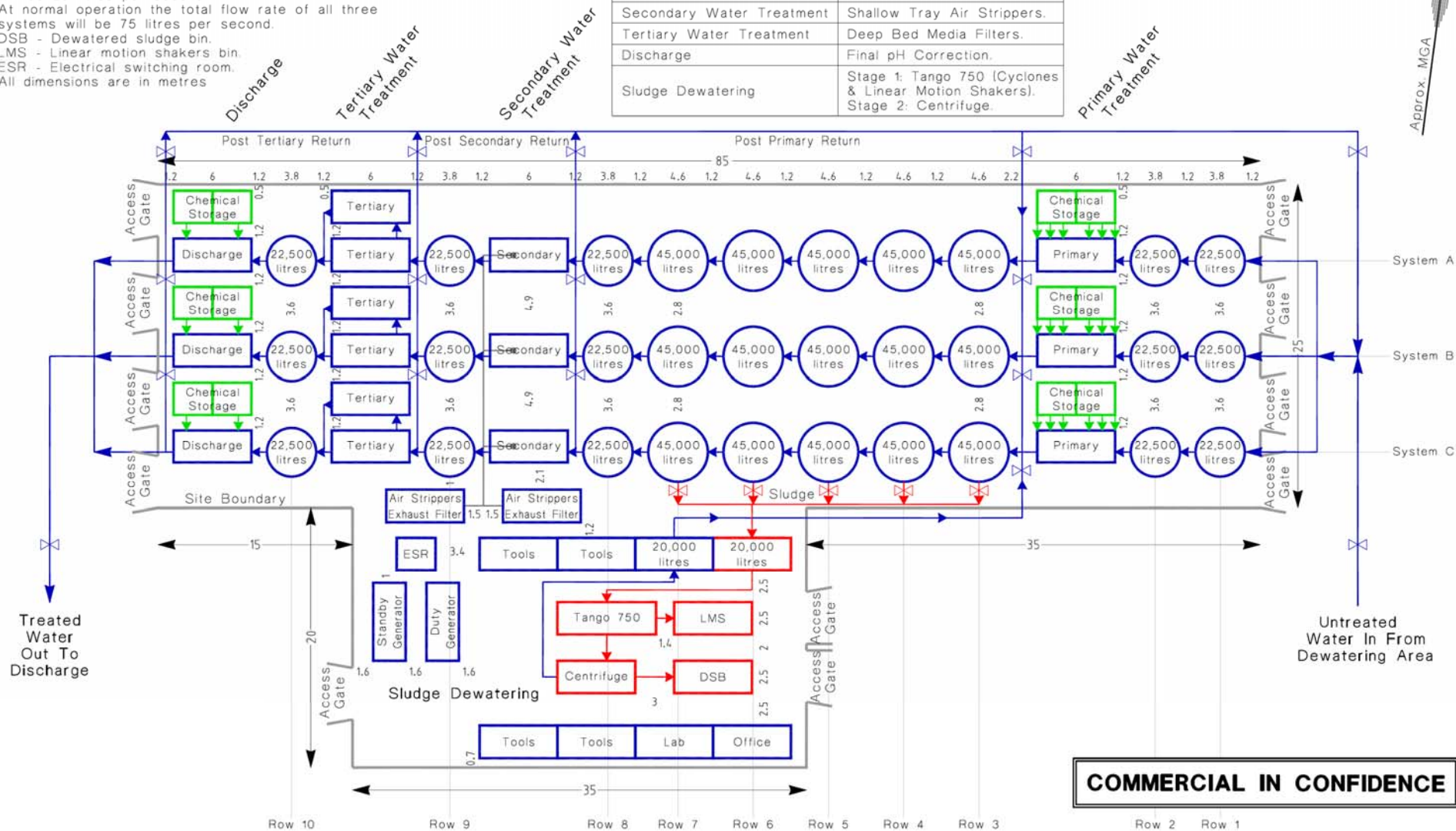
A water treatment plant will be used to treat the volumes and types of water listed above. Further details relating to the plant, including an indicative schematic of water treatment processes, is provided below.

There will be three water treatment systems running in parallel each with three stages: Primary, Secondary and Tertiary. These are described further below.

Note that surface water will be treated using detention basins until the water treatment plant is installed and commissioned. Water will be retained in the basins until suitable for discharge, meeting relevant water quality limits.

- ✱ Three water treatment systems in parallel will be used.
- ✱ Each system will be capable of variable flow rates between 15 and 35 litres per second.
- ✱ At normal operation the flow rate of each system will be 25 litres per second.
- ✱ At normal operation the total flow rate of all three systems will be 75 litres per second.
- ✱ DSB - Dewatered sludge bin.
- ✱ LMS - Linear motion shakers bin.
- ✱ ESR - Electrical switching room.
- ✱ All dimensions are in metres

Primary Water Treatment	Initial pH Correction, Coagulant, Flocculant, Chemical Dosing & Ozone Injection.
Secondary Water Treatment	Shallow Tray Air Strippers.
Tertiary Water Treatment	Deep Bed Media Filters.
Discharge	Final pH Correction.
Sludge Dewatering	Stage 1: Tango 750 (Cyclones & Linear Motion Shakers). Stage 2: Centrifuge.



Approx. MGA

1 PRIMARY TREATMENT - PH CORRECTION & SUSPENDED SOLIDS

The Primary Treatment system consists of a chemical dosing system and water transfer pumps regulated by programmable logic control (PLC). This system has stand alone capabilities with respect to flocculant and coagulant addition also automatically buffering pH to a pre set value.

Incoming and outgoing sedimentation tanks will be monitored via level probes to ensure a consistent flow of water to assist flocculated and/or coagulated particles to drop out of suspension. In addition, hydrocyclones and coalescing plate separators may be used to remove heavy end hydrocarbons collected post Primary Treatment prior to passing through subsequent stages to prevent fouling of the trays in the Secondary Treatment system.

There will be large holding tanks before and after the Primary Treatment system to achieve the following:

- Capacity to handle large influxes of water (for example after rainfall or king tide events);
- Provision of a constant flow to the chemical dosing system at a rate at a workable rate;
- Large decrease in the water's potential energy after chemical dosing to promote solids separation; and
- Provision to recycle treated groundwater after treatment to ensure discharge criteria is achieved before releasing into Darling Harbour.

The Primary Treatment system will have an integrated telemetry system capable of sending error messages, warnings and other real time data to designated technicians and field operatives sent via SMS over the Telstra NextG network. Errors message will include, but not be limited to, the following:

- pH out of specified range;
- Sedimentation tank high and low level;
- Chemical levels low;
- Dosing pump fault; and
- Transfer pump faults.

The Primary Treatment system will generate sludge in the bottom of the settling tanks post chemical dosing. Each tank will have multiple points to enable sludge recovery.

The Primary Treatment system has built in contingencies with scope to inject any combination of additional chemicals that may be required. Ferric chloride injection is a viable option if co-precipitation is required for further removal of heavy metals. It is important to note that no further infrastructure will need to be added to the Primary Treatment systems in this case as they have the ability to buffer water pH accurately to meet a set point.

2 SECONDARY TREATMENT - VOC'S

Volatile compounds present as contaminants in groundwater have the potential to partition into the air. The principle of air strippers is to accentuate this natural process by taking water and pushing air through it so as to evaporate any volatile compounds that may be present within. Air strippers have been shown to remove over 98% of volatile organic hydrocarbons (C6-C9 VOC's) in applications such as the treating of contaminated groundwater. Shallow tray air strippers will be used within the Secondary Treatment phase of our water treatment cycle. All recovered surface and groundwater will be treated in the Secondary Treatment phase of the water treatment cycle.

Air strippers are very effective at removing dissolved phase volatile organic hydrocarbons from waste water. However any hydrocarbon chains greater than C9 is more difficult to remove by an air stripper process. It is important to ensure that only dissolved hydrocarbons are being treated through air strippers. If any free phase is present in the water to be treated it must be removed before the water is passed through an air stripper otherwise fouling of components within the air stripper will occur.

Therefore the Primary Treatment phase of our water treatment cycle will be configured to ensure free phase products are prevented from entering the Secondary Treatment phase.

The plant will have one shallow tray air stripper designed to a maximum flow of 35 litres per second on each of the three water treatment systems running in parallel at an average flowrate of between 20 and 25 litres per second during normal operation. This way during normal operation when all three systems

are running at an average of between 20 and 25 litres per second the air strippers will be more than sufficient to provide effective removal of volatile organic hydrocarbons. When one system is shut down for scheduled maintenance, flow rates on the other two systems will be increased to a flowrate of 35 litres per second to ensure contract water treatment flow rate targets are maintained. The remaining two operational shallow tray air strippers have been designed to accommodate this increased flowrate.

Emissions from air strippers

Exhaust air from all three of the shallow tray air strippers running in parallel will be manifolded into a single vapour extraction unit for filter treatment. The filter will provide for adsorption of the recovered volatile organic hydrocarbon contaminants in filter beds containing granulated activated carbon (GAC) suited for vapour treatment.

The vapour extraction unit will be an independent and custom constructed filter vessel contained within a modified shipping container. A summary of the vapour extraction unit features are:

- Vessel is fully contained within a 20 foot shipping container walls, including inlet and outlet ports and media service ports for material change out.
- Inlet port and plenum floor with stainless steel mesh designed to achieve even distribution of air flow over the entire media bed.
- Structurally engineered for capacity to hold the weight of the entire media bed.
- Media bed area maximised to achieve low velocity of air flow through carbon.
- Container modifications include access hatches, process port penetrations and fastening the vapour extraction unit.

The reactivated GAC will be subject to programmed lot testing to ensure consistency of performance for VOC adsorption efficiency.

The filter vessel has been subjected to rigorous quality testing to ensure consistency of performance such as volatile organic hydrocarbon adsorption efficiency. The performance of the vapour treatment unit depends largely on site conditions and is strongly influenced by:

- Air velocity;
- Contaminants of concern;
- VOC concentration of influent air;
- Air temperature; and
- Moisture.

Emissions from water treatment tanks

Exhaust air from the water transfer tanks will be manifolded into an activated carbon treatment drum for filter treatment, as shown in Figure 2. The drums are Tetrasolv GAC 200 litre filter drums filled with approximately 80kg of GAC.

At a maximum dewatering flowrate of 75 L/s, this equates to a maximum flowrate of 270 m³/hour of air flow venting from the water transfer tanks. A single drum is designed to provide sufficient contact time for 300 m³/hour of exhaust across the GAC filter.

3 TERTIARY TREATMENT - PAH AND TPH

All recovered surface and groundwater will be treated in the Tertiary Treatment phase of the water treatment cycle. The Tertiary Treatment system consists of deep bed media filters which are capable of more specialised contaminant removal.

Assuming treated water will not satisfy the required PAH and TPH discharge criteria for Darling Harbour post Primary and Secondary treatment, Tertiary treatment will be required to ensure this is achieved. Tertiary Treatment will consist of the water being pumped through a series of deep bed media filters. Initially, activated carbon will be the media used, but if required, sand and/or organoclay may be used as the adsorption media instead. Zeolite is not an appropriate filter media when water is saline (as much of the groundwater will be at Barangaroo) however it may still serve a purpose with respect to primary treatment.

Six deep bed media filters will be set up in parallel, two on each of the three water treatment systems. The design has allowed for a significantly large volume deep bed media filter by comparison to the average flowrate through each of the three water treatment systems. This will ensure the residence time of water within the filter media is longer allowing efficient contaminant removal. When one deep bed filter is required to be taken off line for backwash or media replacement, treatment at full capacity will still be able to occur through the remaining two treatment systems at an increased rate through all primary, secondary and tertiary phases.

After tertiary treatment, treated water will be discharged to Darling Harbour from a point within the silt curtain. The discharge point will either be a fitted diffuser or single pipe (if diffusion and velocity are suitable). A fitted diffuser will be installed during commissioning of the water treatment plant, and trialled to assess its suitability. It may be modified or removed to allow efficient operation of the water treatment plant.

4 SLUDGE TREATMENT

Sludge would be spadeable and able to be transported via conventional trucks rather than the more expensive vacuum tankers.

The plant will use one of or a combination of the following to dewater and stabilise the sludge recovered from the Primary Treatment system.

- Lineal accelerator scalping screens;
- De-sanding and de-sludging hydrocyclone banks;
- Centrifuge; and
- Batch mixing plant to mix in flyash and cement for microencapsulation.

5 VERIFICATION OF PROCESS

The water treatment system is procured on a design-install-operate contract, including a performance warranty and compliance monitoring. Lend Lease will also utilise independent advice to review the water treatment system, verify commissioning results, and monitor operations.

All flows during the commissioning, proving and operating periods will be subject to primary, secondary and tertiary treatment. All flows will be tested on-line, where practicable, and by a NATA-accredited laboratory for all analytes set out in Table 5.1 at the following points:

- Prior to primary treatment;
- Post primary treatment;
- Post secondary treatment, and;
- Post tertiary treatment.

The full water treatment plant will be rigorously commissioned for peak loads and flows. Treated water will be monitored daily by a NATA-accredited laboratory for an initial 14 day *proving period* to verify that treated water meets water quality criteria in the environmental protection licence. The initial proving period includes the following:

- Water from the site will be pumped to the water treatment plant for proving intermittently over seven days.
- Each batch of water will be stored on site for NATA lab testing, with a 24 hour turn-around time.
- If testing shows that it is compliant, it will be discharged from the licenced discharge point subject to a hold point, and another water treatment trial undertaken.
- If testing shows that it is non-compliant, the proving period will extend until it is compliant. Water cannot be discharged from the site until it is compliant with the licence criteria.

A 30 day *commissioning period* will then follow, with daily discharge monitoring by a NATA-accredited laboratory.

The proving period above will also be repeated to recommission the plant:

- prior to the commencement of any groundwater extraction;
- prior to the commencement of basement dewatering;
- prior to staged amplification of the plant.

APPENDIX 3: WATER MANAGEMENT STRATEGY

Water Management Strategy

Stage	Water Source	Control Measures	Treatment Process	Potential Outputs
Stage 1: Initial site establishment, temporary works and stormwater works <ul style="list-style-type: none"> Site establishment works Minor temporary works Wheel wash operation Stormwater works No water treatment plant in operation, or exceeds treatment capacity of WTP 	<ul style="list-style-type: none"> Surface water runoff Minor excavation dewatering Wheel wash bay 	<ul style="list-style-type: none"> Temporary water detention basin Construction of continuous impervious barrier around perimeter of site Holding tanks Wheel wash facility 	<ul style="list-style-type: none"> Water infiltration or detention, and flocculant if required. 	<ul style="list-style-type: none"> Wheel wash recharge using treated water that meets discharge limits Discharge in accordance with EPL 13336 Groundwater infiltration Off-site disposal (licenced treatment facility)
Stage 2: Retention wall establishment and piling <ul style="list-style-type: none"> Perimeter wall excavation – approx 18,000m³ Spoil stockpiling and transport Bentonite plant operation Piling activities Concrete pours Spoil dewatering Wheel wash operation Commencement of groundwater extraction Water treatment plant operational (25L/s flow capacity) 	<ul style="list-style-type: none"> Surface water runoff Groundwater extraction Spoil dewatering Wheel wash bay Contaminated material runoff 	<ul style="list-style-type: none"> Water transfer tanks and pre-treatment Water treatment system with a treatment capacity of 75L/s. 8 x 45KL holding tanks Stockpile drainage for spoil dewatering. Sediment collection within dewatering sumps. Impervious barrier around perimeter of site Wheel wash facility 	<p>All surface and ground water collected from site will pass through the following treatment phases:</p> <p>Primary treatment – Removal of suspended solids, pH adjustment.</p> <p>Secondary treatment – Removal of VOC's, BTEX and ammonia using an air stripper.</p> <p>Tertiary treatment – PAH, BTEX and TPH reduction using deep-bed media filters containing activated carbon and if required sand and / or organoclay.</p>	<ul style="list-style-type: none"> Dust suppression using tertiary treated water that meets discharge limits Concrete crusher (if used) dust suppression using treated water that meets discharge limits Wheel wash recharge using treated water that meets discharge limits Harbour discharge in accordance with EPL 13336 Sewer discharge (SW MoU would be required) Offsite disposal (licenced treatment facility)
Stage 3: Bulk Excavation <ul style="list-style-type: none"> Bulk excavation – approx 312,000m³ Spoil stockpiling and transport Stormwater diversion works Contaminated material handling Concrete pours Spoil dewatering Wheel wash operation Groundwater extraction – spears and pump/sump Water treatment plant operational (75L/s flow capacity) 				

APPENDIX 4: WATER QUALITY MONITORING PROGRAM



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BARANGAROO STAGE 1

Construction Water Quality Monitoring Program

301015-02234

1 May 2012

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PROJECT 301015-02234 - BARANGAROO STAGE 1

REV	DESCRIPTION	ORIG	REVIEW	WORLEY- PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	DRAFT incorporating BLL comments	<u> </u> P Lawless	<u> </u> C Taylor	<u> </u>	24-11-10	<u> N/A </u>	
0	FINAL for issue	<u> </u> P Lawless	<u> </u> C Taylor	<u> </u> C Taylor	26-11-10	<u> </u>	
1	Revised FINAL	<u> </u> P Lawless	<u> </u> C Taylor	<u> </u> C Taylor	24-02-11	<u> </u>	
2	Revised FINAL	<u> </u> P Lawless	<u> </u> C Taylor	<u> </u> C Taylor	10-06-11	<u> </u>	
3	Revised FINAL	<u> </u> P Lawless	<u> </u> C Taylor	<u> </u> C Taylor	01-09-11	<u> </u>	
3	Revised FINAL	<u> </u> P Lawless	<u> </u> C Taylor	<u> </u> C Taylor	01-05-12	<u> </u>	



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CONSTRUCTION WATER QUALITY MONITORING PROGRAM

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CONSTRUCTION WATER QUALITY MONITORING PROGRAM

1. INTRODUCTION

1.1 Background to the Project

Lend Lease Millers Point is developing the Barangaroo site on Darling Harbour in a number of stages. The development is divided into three 'sites': North (Headland Park), Centre and South. Stage 1 involves construction of basements on the southern site. Lend Lease are required to address Minister's Conditions of Approval (MCoA), as well as the EPA licence 13336, relating to the project.

1.2 Water Quality Issues

Contaminated sediments have been reported within the vicinity of the redevelopment site. ERM (2007) undertook a Combined Environmental and Geotechnical Site Assessment of East Darling Harbour, to identify and document existing geotechnical and environmental site conditions. A layer of silty / gravelly sand was encountered in all boreholes drilled at the Barangaroo site, varying in thickness from 0.5 – 21 m. In the central and southern portions of the site (within the vicinity of the underground car park area), the fill layer was underlain by natural marine sediments generally comprising sandy clays. A number of samples reported metal concentrations above the NEPM (1999) Interim Urban Ecological Investigation Levels (EILs). Groundwater at the site flows towards Sydney Harbour (ERM 2007). The majority of contaminants in groundwater appear to be related to the former gasworks, located adjacent to the basement car park in the 'centre' site.

Key findings from the most recent ERM (2008) investigation were that the Contaminants of Potential Concern (COPC) in soils across the site were lead, TPH, PAH, Benzene, Toluene, Ethyl-benzene and Xylenes (BTEX).

The bulk excavation and the basement car park works are unlikely to have any direct interaction with the water or bed of the harbour. This is due to the following:

- all the works will be undertaken on land behind (and set back from) the existing caisson walls and the rock embankment beneath the existing wharf which form the current shoreline; and
- the major excavation and remediation works which have the greatest potential to impact to the water and the harbour will largely be undertaken upon completion of the basement perimeter retention systems.

All ground water from dewatering and stormwater will be collected and treated onsite, before discharge to the harbour via an outfall and diffuser or beneficially reused on site. Water quality risks associated with harbour discharge are elevated turbidity and suspended sediment loads generated by construction activities and possibly elevated levels of contaminants, as previously reported in ERM (2007) and ERM (2008).

There is also a low risk of groundwater or sediment movement through or under the shoreline structures during construction of the basement retention systems (WorleyParsons, September 2010).



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To mitigate risks to the marine environment from discharge of treated wastewater via the outfall and to comply with the conditions of approval, a water quality monitoring program will be undertaken during construction activities, with three main activities:

- regular sampling of treated stormwater/groundwater, prior to discharge to the harbour or reuse, to ensure it meets discharge criteria;
- continuous automated monitoring of water quality (turbidity) in the harbour, for rapid detection of impacts associated with elevated concentrations of suspended solids, associated with the soil and water management measures; and
- responsive environmental monitoring of water quality in the harbour, when contaminant monitoring in pipe, reports a breach in discharge criteria.

1.3 Scope of this Report

This *Construction Water Quality Monitoring Program* (CWQMP) deals with the water quality monitoring requirements associated with construction of Barangaroo Stage 1. The key objective of this Program is to ensure appropriate environmental monitoring procedures are implemented during construction activities, to manage potential impacts to the local marine environment.

This CWQMP forms part of an overarching *Water and Stormwater Management Sub-Plan* (WSMP). The WSMP describes how stormwater and groundwater will be collected, treated, stored and discharged from the site.

This CWQMP has been prepared to address obligations in conditions of approval for the project.



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CONSTRUCTION WATER QUALITY MONITORING PROGRAM

2. WATER QUALITY MONITORING COMPLIANCE REQUIREMENTS

2.1 Compliance Obligations

Relevant compliance obligations from project approvals for Barangaroo are listed below in **Table 2.1** with a cross reference to where the requirement is addressed in this CWQMP or the WSMP.

Table 2.1 MCoA relevant to water quality from project approvals

Aspect	No.	Condition	Reference
<i>Bulk Earthworks and Basement Car Park – MP10_0023</i>			
Stormwater and Water Mgmt Plan	C4.1	Prior to the commencement of works, the proponent must develop and provide to DECCW for review and comment a comprehensive Stormwater and Water Management Plan	WSMP
	C4.2	All groundwater from the excavations must be collected, managed and/or treated in a manner that ensures that it can be discharged to the sewer or waters.	WSMP, CWQMP section 3.2
	C4.3	All water discharged from the site to Darling Harbour must comply with the table of limits (see Attachment 3 of DECCW letter to DOP dated 11 October 2010) unless otherwise agreed by DECCW.	CWQMP s3.2 and 3.3
	C4.3	In addition to the limits (Attachment 3), a total suspended solids (TSS) limit of 50mg/l will be applied to the end of discharge pipe from the project water treatment plant.	CWQMP Section 3.2
	C4.3	Monitoring of turbidity in Darling Harbour water adjacent to the project will be required. The locations of turbidity monitoring are to be agreed with DECCW and documented in the <i>Stormwater and Water Management Plan</i> . In the initial stages of the project an interim limit of 50mg/l for TSS would be applied at the monitoring locations.	CWQMP Section 3.3
	C4.3	Procedures for visual monitoring for turbidity in adjacent Darling Harbour water and response measures are to be documented in the <i>Stormwater and Water Management Plan</i> .	CWQMP Section 3.3
	C4.3	Silt curtain(s) should be employed during the site establishment and construction of the diaphragm wall. The length and location should be documented in the <i>Stormwater and Water Management Sub-Plan</i> and agreed with DECCW prior to commencement of these works. Ongoing use of silt curtains in subsequent stages of the works is to be agreed with DECCW prior to the commencement of each subsequent stage.	WSMP
	C4.4	Any discharge structure constructed to allow water to be discharged to Darling Harbour must include a discharge diffuser to allow for dilution.	WSMP



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CONSTRUCTION WATER QUALITY MONITORING PROGRAM

		The discharge point must be installed inside an appropriately installed silt curtain arrangement. Details of dilution of the discharge water will be included in the <i>Stormwater and Water Management Plan</i> . No water that is contaminated may be reused on site for dust suppression or other activities without being treated.	
	C4.5	The water treatment plant must be designed to remove all relevant contaminants (including petroleum hydrocarbons, PAHs, BTEX, sediments and metals) to levels in the water management plan or as otherwise agreed with DECCW.	WSMP
	C4.6	Untreated water must be held on site until results from monitoring are available for review (or) until otherwise agreed by DECCW.	WSMP, CWQMP Section 3.2
Monitoring	C4.1	The water management plan must include a detailed proposal for monitoring water quality.	CWQMP entire
	C4.2	The monitoring program must include at least an on site program for waters held on site prior to discharge and an ambient monitoring program that checks water quality in Darling Harbour.	CWQMP Sections 3.2 and 3.3
	C4.3	The monitoring on site program needs to cover all types of water on the site that needs to be discharged including clean stormwater, higher turbidity stormwater from areas without much soil contamination, stormwater that has been in contact with contaminated areas and contaminated groundwater from the excavations.	WSMP CWQMP Section 3.2
	C4.4	The monitoring of ambient waters program must include an up and down stream/tide sampling location around the discharge structure as well as a reference location.	CWQMP Section 3.3
	C4.4	Water to be discharged to Darling Harbour must be monitored on a daily basis for the first two weeks of operations. The monitoring frequency of subsequent discharges must be not less than weekly unless otherwise agreed by DECCW and/or permitted by licence conditions.	CWQMP Section 3.2
Commercial Building C4 – MP10_0025			
Stormwater and Water Mgmt Plan	B19	Prior to the issue of a relevant Construction Certificate, an updated Water and Stormwater Management Plan prepared by a suitably qualified person shall be submitted to the satisfaction of DECCW, and approved by the Certifying Authority. Any effluents/liquid waste streams associated with the construction of the building that are directed to the site Wastewater Treatment Plant are treated sufficiently to ensure compliance with all concentration limits required by Environmental Protection Licence 13336 prior to discharge to Darling Harbour.	WSMP



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CONSTRUCTION WATER QUALITY MONITORING PROGRAM

3. MONITORING PROGRAM

3.1 Introduction

Water quality monitoring has been designed to be sufficiently flexible to be incorporated into monitoring programs for future stages of the project, subject to future project applications. The monitoring program has two main streams:

- Onsite Monitoring – Monitoring of 'site water' (stormwater and groundwater from excavations), prior to discharge to ensure discharge criteria are being met. This will involve laboratory analysis of water samples from the treated site water prior to the harbour discharge point and visual inspections of water quality management systems. Note that this 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.
- Darling Harbour Monitoring - Monitoring of harbour waters to detect any impact on harbour water quality. This involves a network of automated monitoring stations located on buoys, in-situ measurements using hand-held meters, laboratory testing of water samples, and visual inspections of water quality management systems.

A summary of the monitoring, inspection, and reporting that will be undertaken as part of the CWQMP is provided in **Table 3.1**.

3.2 Onsite Water Quality Monitoring

MCoA MP10_0023 conditions C4.2, C4.3 and C4.6 (refer **Table 2.1**) require that all stormwater and groundwater is collected, managed and/or treated on site prior to discharge to the harbour. The techniques and procedures for collection and handling of site water (including stormwater and groundwater) are detailed in the WSMP.

There are two scenarios for the onsite monitoring:

- monitoring of untreated water (clean and turbid stormwater from uncontaminated areas), which has to be held on site until monitoring results are available to establish water is suitable for discharge (unless otherwise agreed with EPA); and
- 'In pipe' monitoring of contaminated water post-treatment, before it is discharged into the harbour. Note that this 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.

In both cases the monitoring will require collection of water samples for laboratory analysis of a suite of parameters, including TSS, pH, various metals, PCBs (initially), TPHs, BTEX and PAHs. Onsite monitoring of all water to be discharged, will be conducted daily for the first two weeks of water treatment plant operations, and weekly thereafter, providing the treatment plant is operating satisfactorily.



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CONSTRUCTION WATER QUALITY MONITORING PROGRAM

Table 3.1 Water Quality Monitoring, Inspections and Reporting

Activity	Purpose	Parameters	Location	Timing / Frequency	Method	Responsibility	Reported to
Onsite water quality sampling	Confirm EPL discharge criteria are being met	Phys-chem, metals, TPH, PAHs, BTEX as per Table 3.2	Immediately prior to discharge, following treatment	Daily during commissioning and proving then weekly	Land based sample collection and laboratory analysis	Water Treatment Contractor	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 (outside of the silt curtain) and one reference site, fixed stations (on buoys or wharf structures),	Continuous (every 15 minutes)	Automated water quality monitoring stations, technicians and vessel for servicing.	Lend Lease / Water quality consultant	EM/CM
Harbour water quality sampling	Monitor impact on harbour water quality in event of breach of discharge criteria	Phys-chem, metals, TPHs, PAHs, BTEX as per Table 3.2	Two near field sites (outside of silt curtain) and one reference site as per fixed stations, plus one near outlet inside silt curtain	Reactive – as required	Vessel or land based sample collection and laboratory analysis	Lend Lease / Water quality consultant	EM/CM
Weekly Inspections	Identify hazards and compliance	N/A	Construction site and stormwater discharge outlets	Weekly	ProjectWeb Job Diary	Site superintendant / environmental officer	EM/CM
Visual plume inspections	Compliance with water quality objectives	Visual plumes or sheens	Around curtains at construction area/ stormwater discharge outlets	Minimum daily during perimeter retention wall works, with subsequent frequency depending on the nature of the works being carried out.	ProjectWeb Job Diary	Site superintendant / environmental officer	EM/CM
Silt curtain inspections	Monitor integrity / effectiveness of silt curtain.	N/A	In the vicinity of the curtains around the construction area/discharge outlet/s		ProjectWeb Job Diary	Site superintendant / environmental officer	EM/CM



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CONSTRUCTION WATER QUALITY MONITORING PROGRAM

3.2.1 Water Quality Criteria

The water quality criteria for site water discharged to the harbour for the project have been provided in the MCoA, as outlined in **Table 3.2**. Note that limits for turbidity are relevant to receiving waters, not treated wastewaters in pipe, pre discharge. Both TSS and turbidity will be measured in all samples, but only TSS will be used for assessment. A site specific TSS–turbidity relationship will be used to develop an equivalent turbidity limit to allow instantaneous site compliance checks.

Unless noted otherwise, limits in **Table 3.2** do not include an allowance for dilution prior to discharge.

Revision of licence limits to incorporate dilution may be assessed on an analyte by analyte basis, where an analyte does not bioaccumulate and is unlikely to cause acute toxicity. This would allow for the dilution that will occur at the diffuser, as discharged water mixes with ambient harbour water (DECCW, 2010).

To justify any revision of licence limits for dilution, it will be necessary to define a mixing zone and demonstrate that target dilution is achieved within this zone, by additional measurements or modelling.

3.2.2 Locations and Parameters

Water samples for analysis will be collected from treated water on site, immediately prior to discharge into the harbour. The location of the treatment plant and the harbour discharge point is indicated on **Figure 3-1**. Water samples will be analysed to detect the concentration of all analytes listed in **Table 3.2**.

3.2.3 Water Quality Response Protocol

If monitoring results for the treated water breach water quality criteria for discharge in **Table 3.2**, discharge (or relevant discharge from part of the treatment plant) must cease and the treatment process inspected to determine the cause of exceedence and rectified. Follow-up water testing is to be undertaken to ensure compliance with discharge criteria prior to recommencement of discharge to the harbour.

Reactive water sampling would be undertaken in Darling Harbour in accordance with **Section 3.3.7** to establish the level of impact on the water quality of the harbour.

If monitoring results for untreated water held onsite indicate that any water criteria are exceeded then this water must be treated prior to discharge.

3.2.4 Inspections

Daily inspections of any sediment basins, treatment system, and turbidity / visual plumes / sheens within and surrounding the silt curtain shall be conducted during perimeter retention wall works, within the vicinity of the following:

- Soil and water management infrastructure;
- Water treatment plant; and
- Discharge outlet and silt curtain.



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Table 3.2 Water Quality Limits as per the Attachment 3, *Bulk Earthworks and Basement Car Park Project Approval (MP10_0023)*

Indicator	Units	Criteria
Total Suspended Solids	mg/L	50 (100%ile concentration limit that incorporates dilution)
Turbidity	NTU	0.5 – 10 (ambient guideline for outside silt curtain – a trigger value above background could be calculated for ambient monitoring/licence limit purposed for wet and dry weather). NTU discharge criteria from sediment basins would need to be developed based on a good site specific relationship with TSS
Sheens or plumes	Daily inspections	No visible sheen or plumes outside the silt curtain
pH	pH	6.5 – 8.5 (100%ile concentration limit that already incorporates dilution)
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	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	200
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 [#]
TPH C6-C9 Fraction	µg/L	20 [#]
Oil and Grease	mg/L	10 (100%ile concentration limit that 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 [*]



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Indicator	Units	Criteria
Benzo(a)pyrene	µg/L	2*
Benzo(b)fluoranthene	µg/L	2*
Benzo(k)fluoranthene	µg/L	2*
Acenaphthene	µg/L	2*
Acennaphthylene	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*
Electrical conductivity		Monitor
Dissolved Oxygen		-
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.

In addition, inspection of the marine silt curtain will be undertaken every six months by divers. The diver inspections are to check the integrity and effectiveness of the silt curtain, with the findings presented in a report with photographs. More frequent inspections may be undertaken by boat or divers after severe storms or severe westerly winds.

3.3 Darling Harbour Water Quality Monitoring

Darling Harbour is the receiving water for treated stormwater and groundwater discharged from the site. The primary element of Darling Harbour 'ambient' water quality monitoring involves continuous monitoring of basic physico-chemical parameters (turbidity, conductivity, temperature, pH) by automated stations reporting in real time. Other elements include reactive water sampling and incidental measurements with hand-held meters, as per **Table 3.1**.

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 events 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 measured in situ, where most other contaminants cannot.

3.3.1 Turbidity Monitoring - Locations and Parameters

Three automated turbidity monitoring stations will be installed as per MCoA Condition C4.4. 'Near-field' stations will be located just outside the silt curtain north (NF1) and south (NF2) of the discharge point,



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fulfilling the requirement for up and downstream / tide sites around the discharge structure. These locations will correspond as closely as possible, given operational requirements for clearance from the silt curtain and boating movements, to the sites used in the baseline water quality monitoring (WorleyParsons, 2011), as per **Figure 3.1** and **Table 3.3**.

Baseline water quality data was collected (October-November 2010) at four 'background' locations (BG1 to BG4) and at two near field impact sites (NF1 and NF2) (WorleyParsons, 2011). At the conclusion of the baseline monitoring period, the site with the best correlation in turbidity values to the near-field sites was selected for the 'reference' turbidity station. This site was BG1. This site was moved slightly to the west to meet NSW Maritime and Harbour Master requirements.

Figure 3.1 shows turbidity monitoring locations to be used throughout construction.

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

Table 3.3 Darling Harbour Monitoring Locations

Location	Latitude	Longitude	Purpose
NF1	333537 E	6251632 S	North near-field turbidity monitoring location outside silt curtain. This site will be downstream of discharge on ebb tide.
NF2	333565 E	6251423 S	South near-field turbidity monitoring location outside silt curtain. This site will be downstream of discharge on flood tide.
BG1	332960E	6251633 S	Reference turbidity monitoring location measuring background turbidity conditions in the harbour for comparison with the near-field sites.

3.3.2 Turbidity Criterion

Suspended sediment limits can be specified in terms of Total Suspended Solids (TSS) measured in mg/L, or turbidity measured in 'Nephelometric Turbidity Units' (NTU). Measurement of TSS requires laboratory analysis of water samples and is not practical for continuous monitoring in the field. Instead, optical turbidity sensors which measure light scattered by suspended sediment particles in NTU are used.

MCoA MP10_0023 condition C4.3 states that in the initial stages of the project an interim limit of 50mg/l for TSS will be applied at the monitoring locations in Darling Harbour. The same TSS limit of 50mg/l will also be applied to discharge from the water treatment plant.

To ensure compliance with TSS criteria using continuous turbidity measurement, it is therefore necessary to determine the correlation between TSS and turbidity. This correlation is site specific and depends on the size and optical properties of the suspended sediments, as well as the properties of the water itself and the expected turbidity generating mechanisms.

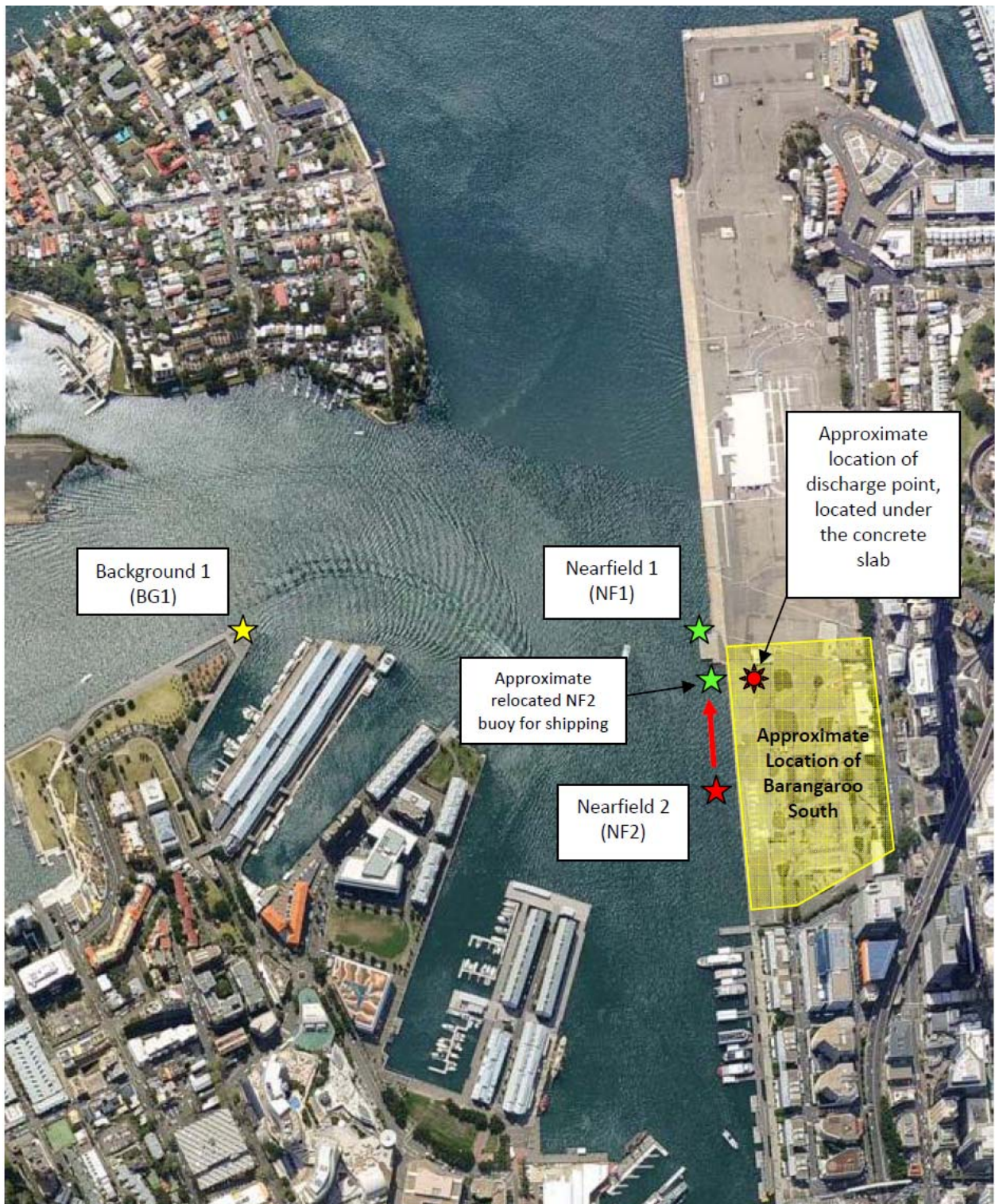


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Figure 3-1 Darling Harbour Monitoring Locations





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A TSS-turbidity relationship will therefore be developed based on sedimentation tests undertaken in accordance with recommendations outlined in the US Army Corp of Engineers guidelines “Improved Methods for Correlating Turbidity and Suspended Solids for Monitoring” (Thackston & Palmero, 2000).

The turbidity value equivalent to 50 mg/L TSS determined from these tests will be used as an indicator of the TSS limit for discharge from the water treatment plant.

Using this same turbidity value, a turbidity trigger for ambient monitoring locations NF1 and NF2 will be developed at the commencement of construction. This will be based on the turbidity value equivalent to 50 mg/L TSS (as described in the above paragraph) plus background turbidity as measured at BG1.

3.3.3 Turbidity Monitoring During Construction

Water quality within Darling Harbour will be monitored during construction for the duration of the bulk excavation and basement car park phase of the project. Measurements of turbidity will be taken by the automated stations on an almost continuous basis (every 15 minutes). Data will be logged and transmitted to a computer every 15 minutes via File Transfer Protocol (FTP) transfer over the Global Service for Mobiles (GSM) network. Data will then be placed on a web site from which remote users may view recent data via the internet. The system is capable of issuing automated alarms by text message to the construction and environmental personnel when set triggers are exceeded.

Turbidity Alarms

A “traffic light system” of alarms will be implemented comprising “amber” and “red” alarms.

The purpose of an amber alarm is to provide a warning to relevant personnel that the turbidity limit is being approached and consideration should be given to the factors that may be causing this. In the event of an amber alarm this would involve following the protocol outlined in **Section 3.3.6**.

An “amber” alarm would be triggered when two consecutive 15 minute near field turbidity values exceed 70% of the turbidity limit. The turbidity limit is the value corresponding to 50mg/L TSS as determined by correlation described in **Section 3.3.2**. This alarm will allow rapid response to sudden and sharp changes in turbidity, such as might be caused by equipment failure. Analysis of two records (i.e. the 30 minutes of data) is necessary to ensure that alarms are not triggered by erroneous measurements.

The purpose of a red alarm is to provide notification to relevant personnel that the turbidity limit has been exceeded¹. A “red” alarm is triggered when three consecutive 15 minute near field turbidity values exceed the turbidity limit. 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 in **Section 3.3.6** would be followed.

If this approach proves to provide too many false positive ‘red’ alerts, compliance will be assessed by comparing a moving average of turbidity readings (every 15 minutes) with the ambient turbidity limit, or

¹ Note that alarms are automatically issued based on raw data that is not quality controlled (and may contain erroneous data from water quality instrumentation). As such, a more detailed analysis of the data may reveal that an alarm was issued when the turbidity criterion was, in fact, not exceeded.



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increasing the number of consecutive readings above the trigger or criterion. The duration of the moving average, or number of consecutive readings, will be agreed with EPA. The advantage of using averages to assess turbidity is that it reduces the influence of short-term spikes (erroneous high readings due to weed, passing marine traffic, fish and other matter obscuring the turbidity sensor) and other short term fluctuations which can cause false alarms.

Marine Fouling

Although the turbidity monitor has a built in cleaning mechanism, data can still be affected by instrument fouling. Fouling is a build up of marine growth on the turbidity sensor and is generally characterised by a steady increase in turbidity values that remain > 20 NTU for a prolonged period of time. Where turbidity values remain > 20 NTU for a full six hour period the following investigation will be followed to determine if data has been compromised by fouling:

- Review existing turbidity data at non-affected monitoring sites to ensure that they are not experiencing similar increases in turbidity. If the data is elevated at non-affected monitoring sites the data would be considered real. If the data is not elevated the next check will be performed.
- Confirm during daylight hours that the water adjacent to the near field locations is clean by visual inspection. Where the water is clean, the elevated readings would be attributed to fouling.
- Where there had been a rain event during the period of increasing turbidity values the data would be considered real, unless the visual inspection proved otherwise.

Once these investigations have been concluded, data affected by fouling will be deemed to be invalid and removed from the data set. The full dataset will also be made available within the Monthly Water Quality Monitoring Reports.

Where fouling has been identified, inspection and maintenance of the instrument would be conducted at the earliest opportunity to ensure integrity of the data. The ongoing fortnightly maintenance program would continue as described in Section X.

Note that as a conservative approach to water quality management, the background monitoring data would be taken to be zero NTU for the sake of ensuring compliance with the water quality parameters, if it was being compromised by fouling.

3.3.4 Visual Plume Criterion

A turbidity plume is an area of apparently discoloured water caused by suspended solids within the water column and where there is a visually apparent increase or change in turbidity compared to surrounding background water quality. As such there are no quantitative criteria in terms of NTU or mg/L for a visual plume. A plume will typically spread becoming more dilute with time, due to wind, wave or tidal action.

MCoA MP10_0023 condition C4.3 states that one aim of turbidity monitoring in the harbour is to ensure there is no visual turbidity plume outside the silt curtain. Although there will be two turbidity stations located immediately outside the silt curtain it is possible that a visual plume could be missed, either because it is localised or below the trigger value set for the automated stations. Monitoring for plumes via visual observation is therefore required.



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3.3.5 Visual Plume Monitoring

In addition to the monitoring stations described in **Section 3.3.1**, daily visual inspections will be undertaken from shore for potential visual plumes outside silt curtains. The frequency of the inspections will vary from one to three per day, and more if deemed necessary - such as during commissioning of water treatment plant or during periods of higher than normal discharges from the treatment plant.

The frequency will be dependent on the nature of the works and their proximity to the harbour, as per the WSMP. These inspections will be undertaken at regular intervals for the duration of the construction activities during daylight hours to ensure that remedial actions can be implemented rapidly if required. These inspections will be carried out by the Site Superintendent or Environmental Co-ordinator (or suitable delegate) and documented in ProjectWeb diary entries

If an area of elevated turbidity is detected, it will be observed and any immediately apparent mitigation measures implemented (eg re-attaching silt curtain). If the visible area of elevated turbidity persists for greater than 15 minutes then a visual plume is deemed to have occurred and the response protocol detailed in **Section 3.3.6** is triggered.

In the event that a visual plume outside silt curtains is observed, details of the visual plume and any actions undertaken are to be documented in the *Environment Response Form*.

3.3.6 Turbidity and Visual Plume Response Protocol

In the event that harbour monitoring conducted in accordance with **Section 3.3** reveals an exceedence or occurrence of a visual plume, the procedure as summarised in **Figure 3-2** and described below will be implemented.

The response will involve the following main phases:

- Trigger;
- Assessment and evaluation – is the elevated turbidity a result of Barangaroo Project works?
- Determination of an appropriate course of action to prevent further discharge and mitigate impact;
- Instigate reactive harbour water sampling to assess impact; and
- Reporting.

TRIGGER

A 'trigger' initiates close scrutiny by the relevant officer. Triggers include:

- A visual plume;
- Complaints of a visual plume; and
- Turbidity exceedence alarms from automated near-field stations.

ASSESSMENT AND EVALUATION

Assess whether the exceedence of the turbidity criteria is due to construction activities by:

- Undertaking a visual inspection around the immediate area to determine the cause of exceedence, during daylight hours. If possible this will be completed within 30 minutes of notification of a red alert, or 60 minutes for an amber alert.



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- If considered useful, monitoring turbidity levels using hand-held instrumentation and visual checks may also be undertaken to assess the extent of any turbidity plumes and confirm that the alarm has not been falsely triggered by factors such as water quality instrumentation malfunction.

Non construction related activities such as vessel movements, storm events and significant freshwater flow events will also be investigated.

Should the exceedence be deemed a result of construction activities, then the relevant officer will implement the appropriate actions described below.

ACTIONS

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

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

- Inspection and repair of equipment associated with onsite water treatment and soil and water management;
- Reinstate or fix curtain;
- Review design/placement of the silt curtain;
- 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
- Reactive water sampling in Darling Harbour at near field (impact) and far field (reference) sample locations, to establish the level of impact or otherwise, on the water quality of Darling Harbour (refer **Section 3.3.7**);
- Deployment of an additional turbidity curtain around the extent of the turbidity plume;
- Further onsite monitoring of treated water quality, to establish that all analytes meet criteria; and
- Temporary cessation of construction works.

Contingency measures will be selected with consideration of:

- Current construction activities;
- Equipment placement and timing;
- Turbidity curtain condition and placement;
- Scale of exceedence; and
- Meteorological, tidal and hydrological conditions.

REPORTING

The Site Superintendant or Environmental Co-ordinator (or delegate) will be responsible for reporting the incident to the Environmental Manager and/or Construction Manager who will manage the incident in accordance with relevant procedures. This may include appropriate reporting to EPA.



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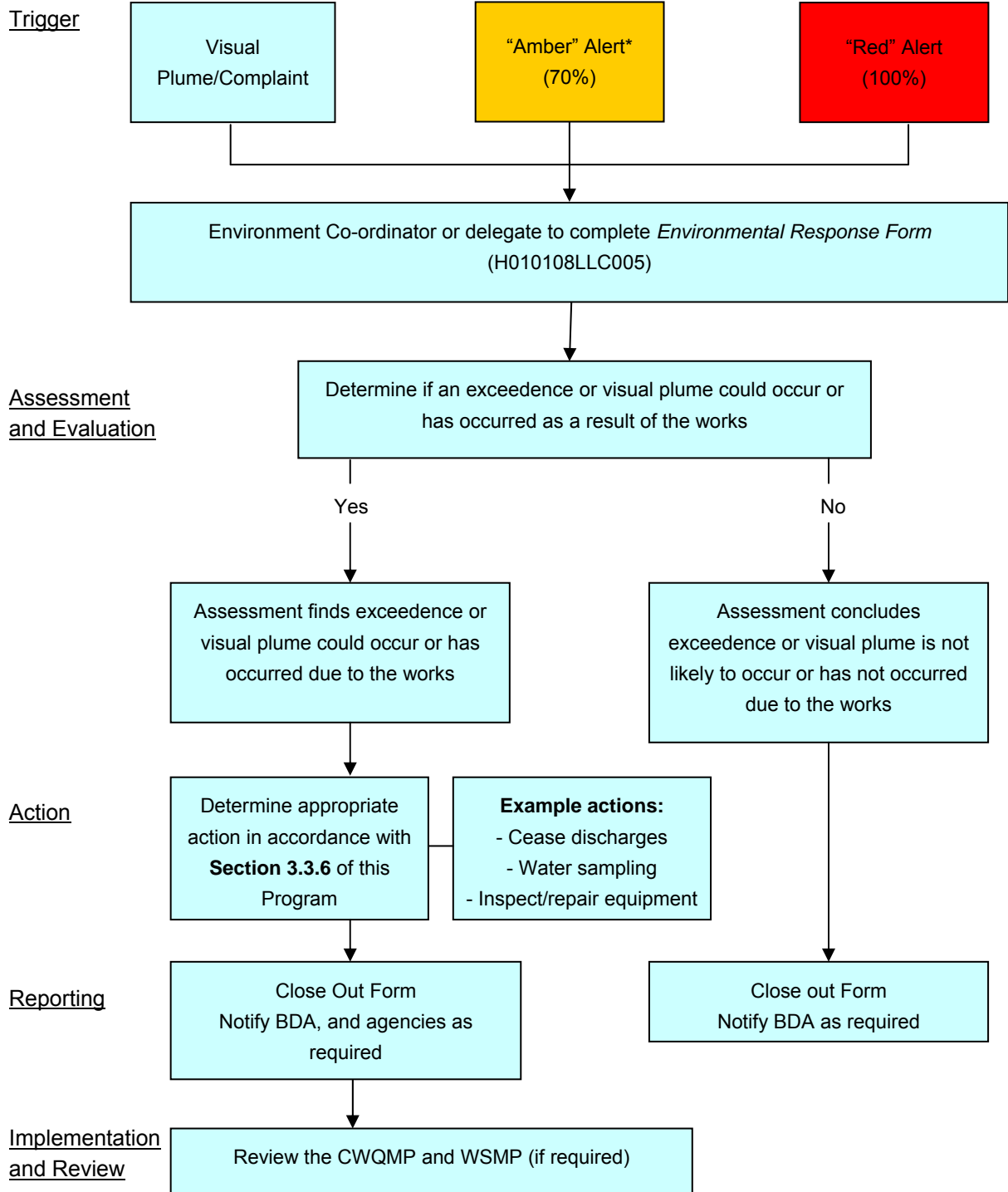


Figure 3-2 Turbidity Exceedence and Visual Plume Response Protocol



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REACTIVE HARBOUR WATER SAMPLING

Reactive water quality sampling of the harbour water can be triggered by a harbour turbidity exceedence, visual plume or exceedence of discharge limits in the onsite monitoring. In these circumstances there is a possibility that contaminated site water has been inadvertently discharged to the harbour and additional monitoring of the harbour is required to determine the extent and severity of any impact on the harbour water quality.

The monitoring may involve handheld turbidity monitoring readings taken at regular intervals to characterise the extent of the plume. The measurements from the handheld monitoring would be recorded on the Water Quality Depth Profiles & Sampling Form which is located on ProjectWeb. The monitoring may also involve the collection of water samples for laboratory analysis of the full set of analytes as described in **Section 3.2.1**. Samples taken for the full laboratory analysis would be taken from the near field (NF1 and NF2) and reference locations as a minimum. Depending on the nature of the trigger, samples may also be collected from the discharge outlet inside the silt curtain, the other background locations used in the baseline monitoring or within a visual plume.

3.3.7 Overall Water Quality Reporting

The reporting requirements specific to this CWQMP include on site and harbour water quality data reports, TSS-turbidity correlations, turbidity or discharge exceedence reporting and visual plume reporting. The water quality reports will be prepared on a regular basis and distributed as required by Lend Lease as per the Environmental Protection Licence 13336.

4. REFERENCES

ERM (2007). *Environmental Site Assessment, East Darling Harbour, Sydney, NSW*. Environmental Resources Management, Australia. June 2007.

ERM (2008). *Additional Investigation Works at Barangaroo, Hickson Road, Millers Point, NSW*. July 2008.

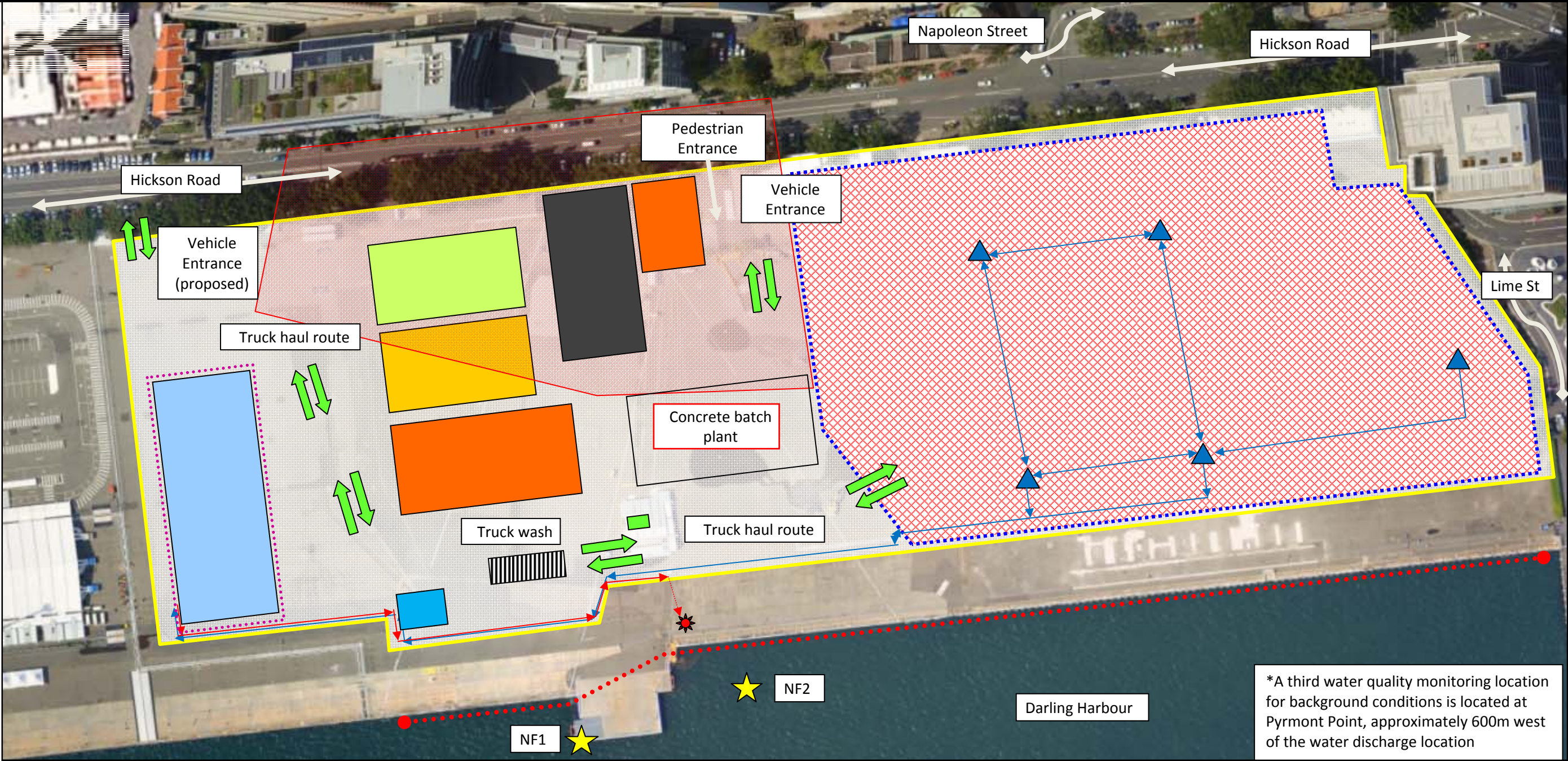
Thackston & Palmero (2000), *Improved Methods for Correlating Turbidity and Suspended Solids for Monitoring*, 2000.

WorleyParsons (2010), *Barangaroo Stage 1 – PA1 Bulk Excavation and Basement Carpark (MP10_0023) - Water Quality Monitoring Requirements*, September 2010.

WorleyParsons (2011), *Barangaroo Stage 1 – Baseline Water Quality Monitoring*, 14 February 2011.

APPENDIX 5: EROSION & SEDIMENT CONTROL PLAN

(This Plan is revised and updated as site conditions and construction works change. Additional work area specific plans may be prepared where required)



*A third water quality monitoring location for background conditions is located at Pymont Point, approximately 600m west of the water discharge location

Continuous impervious water retention barrier at site boundary	Spoil Holding Bays	Groundwater Sump (indicative)	Workshops, storage and vehicle maintenance area
EPA Declaration Area - Contamination	Site Amenities	Marine Spill Response Boom storage	Untreated Water Discharge to Treatment Plant
Water Treatment Plant area	Wheel Wash	Treated Water Discharge Point	Treated Water Discharge Line
Water transfer tanks and pre-treatment area	Extent of Perimeter Retention Wall	Water Quality Monitoring Location*	Subsurface Treated Water Discharge Line
Spoil Treatment Bays (ASS & contaminated)	Secondary water retention barrier at water treatment area	Traffic Movement	Silt Curtain and Floating Boom (as required)

**BARANGAROO SOUTH
EROSION & SEDIMENT CONTROL PLAN**

LEND LEASE

NOT TO SCALE
INDICATIVE

30/11/2012
REVISION: 06

LOCALITY: BARANGAROO SOUTH

DOC REF.: H010106LLC007