Water Quality Plan & Monitoring Program

Project Name: WestConnex New M5

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Document Approval

Rev.	Date	Prepared by	Reviewed by	Recommended by	Approved by	Remarks
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05	08/12/16	CDS-JV				
Signature:						

Details of Revision Amendments

Document Control

The Project Director is responsible for ensuring that this Plan is reviewed and approved. The Support Services Director is responsible for updating this Plan to reflect changes to the Project, legal and other requirements, as required.

Amendments

Any revisions or amendments must be approved by the Project Director before being distributed or implemented.

Revision Details

Revision	Details
00	Initial Draft for Information / Informal Review
01	Issued for consultation and review by DP&E
02	Issued for consultation and review by key stakeholders
03	Issued to DP&E approval
04	Revised to address DPI Water, Inner West Council, and DP&E comments. Issued for DP&E approval
05	Update to address additional DPI Water comments. Issued for information.

Contents

1. Introduction

1.1 Purpose and Application

The purpose of this Water Quality Plan and Monitoring Program (WQP&MP) is to describe how CPB Contractors Dragados Samsung Joint Venture (CDS-JV) will monitor the extent and nature of potential impacts to surface and groundwater quality during construction of the WestConnex New M5 Project.

This WQP&MP will be implemented to monitor the effectiveness of mitigation measures applied as part of the Project. This Plan and Program is prepared to consider Project requirements, applicable legislation and the New M5 environmental impact statement (EIS) (AECOM 2015). This WQP&MP is based on the comprehensive assessment and analysis performed as part of the New M5 EIS and SPIR, and therefore takes into consideration the environmental risks identified within it.

This WQP&MP does not apply to the Alexandria Landfill leachate collection and treatment systems. Permanent drainage, stormwater quality and flooding is considered in the Design Criteria Report – Drainage, Stormwater Quality and Flooding (M5N-AJV-TER-100-300-DR-1012).

This WQP&MP should be read in conjunction with the Construction Environment Management Plan (CEMP) and, in particular, the Construction Soil and Water Quality Sub-Plan (CSWQSP).

1.2 Context

The Project area is described in detail within the Construction Soil and Water Quality Sub Plan (CSWQSP). The CSWQSP includes specific sections on topography, soils, surface water, groundwater and groundwater dependent ecosystems. The CSWQSP should be referred to for the detailed information regarding the project environment and receiving environment.

In summary, the Project is wholly located within the Cooks River catchment. Several waterways cross the Project area or are in close proximity to the Project area. Riparian connectivity along creek lines that cross the Project footprint is minimal due to surrounding residential and industrial areas with little, if any, vegetation present along the edges of most waterways. Wolli Creek is an exception, with the Wolli Creek Regional Park located between Earlwood and Turrella. Figure 1 presents the waterways and catchments the Project lies within.

The Project's Environmental Impact Statement (EIS) (AECOM, 2015), and Submissions and Preferred Infrastructure Report (AECOM, 2016) identified that groundwater systems within the Project area are located in Quaternary age sediments; Triassic age Ashfield Shale; and Triassic age Hawkesbury Sandstone. Sixty-one bores registered by DPI Water were identified in the EIS (AECOM 2015) within a one kilometre radius of the Project area. The majority of the bores are located in the Tempe, St Peters and Alexandria area (43 bores), at or in the vicinity of Kogarah Golf Course (15 bores), with three bores located along the M5 East Motorway to the west of Arncliffe.

Groundwater dependent ecosystems (GDE) with the potential to be impacted by groundwater drawdown associated with the Project (construction and operation) have been identified in the CSWQSP and detailed in Section 6 of this plan.

Baseline water quality monitoring commenced with groundwater monitoring in March 2015 and surface water monitoring in June 2015. Appendix F contains the baseline surface water quality monitoring results. Baseline groundwater monitoring will continue until the commencement of construction, in accordance with the monitoring plan outlined in Appendix B of the Surface Water Technical Paper (Appendix N of the EIS)..

Legend

- Stations
- Railway
- Watercourse
- Water body
- Alexandria Landfill
- Wetlands
- Regional Park
- Construction Compounds

WestConnex New M5 footprints

- Above ground construction footprint
- New M5 Tunnel
- Line marking works

Catchments

- Cooks River Catchment
- Alexandra Canal Catchment
- Eastern Channel Catchment
- Bardwell Creek Sub Catchment
- Wolli Creek Catchment
- Eve St Wetlands Catchment

St Peters Interchange Site Compound

Kingsgrove North Site Compound

Kingsgrove South Site Compound

Bexley Rd South Site Compound

Kogarah Golf Course Site Compound

REV	DATE	DESCRIPTION	AUTH	REVI	APPR
0	18/11/2015	Draft for comment			

A3 scale: 1:45,000

0 0.275 0.55 km

MGA Zone 56

Sydney Motorway Corporation | WestConnex

LEIGHTON | DRAGADOS | SAMSUNG C&T

WestConnex

aurecon | JACOBS | HASSELL | Golder Associates

WestConnex Stage 2 New M5

Water Quality Plan and Monitoring Program

Issued for discussion purposes only

Waterways and catchments

Figure: 1

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1.3 Objectives and Targets

The objectives of the WQP&MP are to:

- Comply with environmental commitments in the EIS, SPIR and CoA,
- Provide a framework to help prevent pollution of surface and groundwater through appropriate management.
- Identify potential impacts to receiving waters during and after construction, identify appropriate monitoring and assessment of the impacts and provide detail of how to avoid or minimise these potential impacts.
- Detail how to appropriately treat and manage discharges from the Project.

Project targets are detailed in Table 1. A separate Water Quality Plan and Monitoring Program will be developed for the operational stages of the SSI and will be provide operational phase targets for water quality planning and monitoring for the project.

Table 1: Project targets associated with the management of water quality

Metric / measure	Target	Timeframe	Accountability	Documentation / reporting
To measure and monitor potential adverse impacts to surface water and groundwater as a result of construction of the Project	Collection and analysis of all scheduled samples in compliance with this plan.	At all times	Environment and Sustainability Manager	Water monitoring records; Annual water quality monitoring reports (refer Section 8) EPL reports.
Review, investigate and respond to identified potential adverse impacts on water quality	All exceedances of trigger values are investigated.	At all times	Environment and Sustainability Manager	Water monitoring records; Annual water quality monitoring reports (refer Section 8); EPL reports.
	Make good provisions for impacts from construction on registered bore users implemented within 3 months of an identified impact.	At all times	Environment and Sustainability Manager Project Manager	Water monitoring records; Annual water quality monitoring reports (refer Section 8); EPL reports; Consultation/ correspondence records.
Report monitoring results annually to the Secretary of DP&E, DPI Water, and the relevant councils	Annual reports submitted within one month of receiving previous 12 months monitoring data	Annually	Environment and Sustainability Manager	Annual water quality monitoring reports (refer Section 8)

2. Legal and Other Requirements

The sections below provide the Project requirements and relevant legislation that apply to water quality aspects of construction.

2.1 Legislation

Legislation relevant to water quality management for the Project includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act)
- *Protection of the Environment Operations Act, 1997* (POEO Act)
- *Water Act 1912*
- *Water Management Act 2000*
- *Water Management (General) Regulation 2011*

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in the CEMP Appendix D – Environmental Obligations Register

2.2 Planning Approval Conditions

Project approval has been granted and issued with Conditions of Approval (CoA).

Conditions of Approval that specifically address the management of water quality are identified in Table 2.

Table 2: Conditions of Approval that address management of water quality

Reference	Requirement	Where addressed
B28	A Water Quality Plan and Monitoring Program must be prepared and implemented to monitor and avoid or mitigate impacts on surface and groundwater quality and resources, during construction and operation. The Water Quality Plan and Monitoring Program must be developed in consultation with the DPI (Water), Sydney Water and relevant councils, and must include, but not be limited to:	This plan and program focus on the construction phase of the project
	(a) identification of works and activities during construction and operation of the SSI, including tunnel discharge, runoff, emergencies and spill events, that have the potential to impact on groundwater quality, levels or potentiometric pressure (in confined aquifers), and surface water quality of potentially affected watercourses and riparian land;	Section 4 Also refer to Section 6 of the Construction Soil and Water Quality Sub-plan (M5N-ES-PLN-PWD-0005)
	(b) a risk management framework for evaluation of the risks to groundwater and surface water resources and dependent ecosystems as a result of groundwater inflows to the tunnels or discharges to surface water receiving environments, including definition of trigger values for contingency and ameliorative measures;	Section 4, 5, 6, 7 and 8 Appendix B
	(c) the identification of environmental management measures that would be implemented to manage impacts to surface waters and groundwater during construction and operation, including water treatment, erosion and sediment control and stormwater management measures consistent with Water Sensitive Urban Design measures, where relevant, and consistent with the measures detailed in the documents listed in conditions A2(b) and A2(c);	Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Sections 5.7, 7 and 8 Section 6.2
	(d) details of construction water treatment plants and the operational water treatment plants, including treatment processes, discharge water quality criteria (taking into consideration any water uses and proposed rehabilitation measures downstream of the discharge locations), discharge locations and rates (and justification for their	Section 5 Appendix E Alexandria Landfill - Leachate Treatment Plant Design Report

Reference	Requirement	Where addressed
	location), treatment capacity, and any proposed on-site storage of flows;	
	(e) commitment to designing discharge points into watercourses affected by the SSI to emulate a natural stream system, where feasible and reasonable, or where emulation cannot be achieved, adequate scour protection measures are to be implemented;	Section 7
	(f) consideration of any naturalisation or rehabilitation programs occurring upstream or downstream of waterways or drainage lines intersected by the SSI, including the Wolli Creek Riparian Corridor Management Plan;	Section 4
	(g) the presentation of water quality objectives, standards, environmental values and parameters against which any changes to water quality will be assessed, based on the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council, 2000), Where alternate guidelines are used to establish water quality objectives (including the levels for protection of aquatic ecosystems in receiving waters), justification for this must be provided. In particular, justification must be provided for the classification of waterways as 'highly disturbed' versus 'slightly to moderately disturbed' receiving environments;	Section 5, 6 and 7
	(h) details on the current water quality, including at least 12 months of representative background monitoring data (including but not limited to representative data collected by the relevant councils, agencies and organisations where readily available) for surface and groundwater quality, levels and potentiometric pressures (in confined aquifers), to establish baseline water conditions prior to the commencement of construction;	Section 6 Appendix F
	(i) monitoring of the quality of discharges from construction and operational water treatment plants;	Section 5 As per Environment Protection Licence (EPL 20772 and EPL 4627) issued to Project
	(j) identification of construction and operational phase surface water and groundwater monitoring locations including watercourses and waterbodies which are representative of the potential extent of impacts from the SSI, including the relevant analytes and frequency of monitoring;	Section 6
	(k) groundwater monitoring must be able to demonstrate that groundwater discharge quality is consistent with supporting the water quality objectives defined in accordance with B28(g) and include, but not be limited to - (¡) sites in the vicinity of Bardwell Park (to confirm groundwater quality), (ii) inside and outside the cut-off wall at the Alexandria Landfill, (iii) monitoring of groundwater levels at Stotts Reserve, southern bank of Wolli Creek behind the Wolli Creek station and forested areas along Bardwell Creek to ascertain potential impacts on groundwater dependent ecosystems, and (iv) monitoring of drawdown along the alignment of the tunnels;	Section 6
	(l) details on the condition and status of licensed bores likely to be impacted by the SSI;	Appendix A

Reference	Requirement	Where addressed
	(m) commitment to a minimum monitoring period of three years following the completion of construction or until the affected waterways and/ or groundwater resources are certified by a suitably qualified and experienced independent expert as being rehabilitated to an acceptable condition, unless otherwise approved or directed by the Secretary. The monitoring must also confirm the establishment of operational water control measures (such as sedimentation basins and vegetation swales);	Section 8 This condition will be addressed in the Operational WQP&MP
	(n) details of how the potential impact of discharges on receiving waters would be avoided or minimised, including design and operational measures incorporated into the SSI to protect water quality and, where feasible and reasonable, enhance water quality over time;	Section 5, 6, 7 and 8 Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Sections 7 and 8
	(o) contingency and ameliorative measures in the event that adverse impacts to water quality or groundwater flows, levels or potentiometric pressures (in confined aquifers) are identified, with reference to the impact triggers defined in accordance with B28(b);	Section 7
	(p) identification of and commitment to 'make good' provisions for groundwater users to be implemented in the event of a decline in water supply levels, quality and quantity from existing bores associated with groundwater changes from either construction and/or ongoing operational dewatering caused by the SSI;	Section 7
	(q) procedures for monitoring of streambed fracturing;	Sections 4.4, 6.2.5 and 7
	(r) procedures for monitoring and annual reporting of extracted groundwater volumes to DPI (Water) for a minimum monitoring period of three years following completion of construction, unless otherwise approved or directed by the Secretary; and	Section 8 This condition will be addressed in the Operational WQP&MP
	(s) procedures for annual reporting of the monitoring results to the Secretary, DPI (Water), and the relevant councils;	Section 8
	The Water Quality Plan and Monitoring Program must be submitted to the Secretary for approval prior to the commencement of construction of the SSI, unless otherwise agreed by the Secretary. A copy of the Water Quality Plan and Monitoring Program must be submitted to the DPI (Water), Sydney Water and relevant councils prior to its implementation. Nothing in this condition prevents the Proponent from preparing separate Water Quality and Monitoring Programs for the construction and operational stages of the SSI. Where a separate Water Quality and Monitoring Program is prepared for the operation of the SSI, this must be submitted to the Secretary for approval at least six months prior to the commencement of operation of the SSI.	This WQP&MP relates to the construction phase of the project. A subsequent operational WQP&MP will be submitted prior to commencement of operation.

2.3 EIS Requirements

The revised environmental mitigation measures (REMMs) included in the EIS and SPIR relating to the management of water quality are included in Table 3.

Table 3: Revised environmental mitigation measures from New M5 EIS and SPIR relevant to the management of water quality

Reference	Requirement	Where addressed
Water quality		
REMM SW04.	The Soil and Water Management Plan would include: • All water generated during construction would be captured, tested (and treated if required) prior to reuse or discharge under a site specific arrangement, depending on the quality of water generated. This would target compliance with the Water Quality Reference Criteria. At the St Peters interchange site this would include transfer of some water to the leachate treatment Plant as outlined below. Varying levels of groundwater quality would also require a variation to treatment approaches;	Section 5
REMM SW05.	The water quality and outflow velocities of the water treatment Plants at the following compounds would be in accordance with the Project's Water Quality Reference Criteria and the Project's Environment Protection Licence: Kingsgrove North construction compound (C1), Commercial Road construction compound (C3), Bexley Road South construction compound (C5), Arncliffe construction compound (C7), Canal Road construction compound (C8).	Section 5 Appendix E Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005), Sections 7.1, 7.3 and 8
REMM SW06.	The Project specific water quality monitoring program would continue to collect to at least 12 months of data or to the commencement of construction (whichever is sooner) to represent pre-construction conditions for the Project. Monitoring would continue during construction of the Project as identified in Appendix A of the Technical working paper: Surface water (Appendix N). The details of this monitoring program would be contained in the Soil and Water Management Plan, and would include the following: • Sampling locations to include upstream (control) and downstream measurement locations; and • Samples taken twice a month, once in dry conditions and once in wet conditions where possible. In-situ monitoring of: • pH; • Reduction Oxidation Potential; • Dissolved Oxygen; • Temperature; • Conductivity; • Turbidity; • Colour; and • Odour. Analytical sampling of the following potential constituents of concern: • Total Recoverable Hydrocarbons; • Benzene, Toluene, Ethylbenzene, Xylene and Naphthalene; • Nutrients including: Total Nitrogen, Total Kjeldahl Nitrogen, Nitrogen Oxide, Nitrite, Nitrate;	Section 6 Appendix F

Reference	Requirement	Where addressed
	• Total Phosphorous and Reactive Phosphorous; • Heavy metals (Arsenic, Cadmium, Copper, Chromium, Lead, Mercury, Nickel, Zinc); • Manganese; and • Ferrous Iron and Total Iron.	
REMM SW07.	Water quality monitoring of the breeding ponds for Green and Golden Bell Frog near Marsh Street, Arncliffe would occur during construction by a suitably qualified scientist as part of the Green and Golden Bell Frog Plan of Management.	Green and Golden Bell Frog Plan of Management.
Water reuse		
REMM SW08.	Opportunities for reuse of treated water generated at the Arncliffe motorway operations complex would be considered during detailed design.	Sustainability Plan (M5N-ES-PLN-PWD-0020) Water Reuse Strategy (under development) Sustainability Initiatives Register and appraisal procedure
Contamination		
REMM SW11.	During landfill closure activities, surface water management measures would be implemented in accordance with The Blue Book to isolate and capture potentially contaminated water. Any such water would be transferred to the leachate treatment Plant for treatment prior to discharge to sewer under a trade waste agreement with Sydney Water.	Section 7 Landfill Closure Management Plan (M5N-GOL-TER-900-116-0012), Annexure G (Landfill EMP)
Groundwater		
REMM GW05.	Intersected shallow contaminated groundwater would be directed to the construction water treatment Plant prior to discharge. Elsewhere, collection and treatment options would be considered and releases made under relevant discharge criteria.	Section 5.2 and 6 Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005), Section 7.3
REMM GW07.	Treated waste water would be stored and re-used for Project purposes wherever possible. Groundwater reuse would be in accordance with the policies of sustainable water use of the NSW Office of Water [now DPI Water], such as dust suppression and earthworks.	Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005), Section 7.3

Reference	Requirement	Where addressed
		Water Reuse Strategy (under development) Manage Soil and Water Procedure (M5N-ES-PRC-PWD-0035), including Water Discharge Flowchart
REMM GW13.	A groundwater monitoring program would be prepared and implemented to monitor groundwater impacts during construction. This would include the monitoring of groundwater inflow into the tunnels. The program would be developed in consultation with the EPA, DPI (Fisheries), NSW DPI Water and relevant councils.	Section 6.3
REMM GW15.	In the event that the drawdown in a licensed water supply bore or irrigation bore exceeds two metres (in accordance with the Aquifer Interference Policy) or that impacts to groundwater quality alter the beneficial use of the water, measures would be taken to 'make good' the impact by restoring the water supply to pre-development levels. The measures taken would be dependent upon the location of the impacted bore and would be determined in consultation with the affected licence holder but could include, deepening the bore, providing a new bore or providing an alternative water supply.	Section 7

2.4 Project Legislative Exemptions

Section 115ZG of the EP&A Act details the approvals under NSW legislation that are not required for a Critical SSI project approved under Part 5.1 of the EP&A Act. The approvals not required under NSW legislation were identified in Section 2.3 of the EIS (AECOM 2015).

Water Management Act 2000 and Regulation

The water related approvals that are not required for the project under the *Water Management Act 2000*, are:

- Water use approvals under section 89;
- Water management work approvals under section 90; and
- Activity approvals (other than aquifer interference approvals) under section 91.

Roads authorities currently have an exemption for the short term take of groundwater required for construction and maintenance activities under Schedule 5, Part 1, clause 2 of the Water Management (General) Regulation 2011, but this exemption is limited to construction and maintenance.

Aquifer Interference Policy

The EIS notes that an aquifer interference (AI) approval may be required under the Water Management Act 2000 if construction requires the intersection of a groundwater source. Aquifer interference approvals have not yet commenced under the Act but may be required in the future.

2.4.1 EPL Conditions

The Project's construction activities are regulated by Environment Protection Licences (EPL No. 20772 and EPL No. 4627) issued by the NSW Environment Protection Authority (EPA). Refer to the Construction Soil and Water Quality Sub-Plan (M5N-PM-PLN-PWD-0005) for the conditions relevant to this water quality plan and monitoring program.

2.5 Guidelines and Relevant Documents

The main guidelines, specification and policy documents relevant to this WQP&MP include:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (October 2000).
- Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 4th Edition March 2004) and Volume 2D Main Roads Construction (DECC 2008) - the “Blue Book”;
- Department of Primary Industries (DPI) Water NSW Aquifer Interference Policy (September 2012).
- DPI Water Groundwater monitoring and modelling plans – Information for Prospective Mining and Petroleum Exploration Activities (NSW Office of Water 2014).
- DPI Water Guidelines for Controlled Activities on Waterfront Land (July 2012).
- Roads and Maritime Services Specification D&C G36 – Environmental Protection (06 August 2014).
- Roads and Maritime Services Specification D&C G38 - Soil and Water Management (04 June 2014).
- RMS Water Policy.
- RMS Code of Practice of Water Management: Road Development and Management (April 1999).
- RMS Technical Guideline: Environmental Management of Construction Site Dewatering (April 2011).

3. Consultation

This plan and program was provided to Department of Primary Industries - Water (DPI Water), Sydney Water and all relevant councils for review and comment. Comments have been received from the City of Sydney Council, Marrickville City Council (now Inner West Council) and DPI Water. Responses to comments are provided in the Consultation Comment and Response Register.

A copy of the plan and program will be submitted to DPI Water, Sydney Water and relevant councils prior to its implementation.

The final operational elements of the plan and program will be developed in consultation with DPI Water, Sydney Water, and relevant councils and a copy of the operational plan and program will be submitted to these parties prior to its implementation. The final operational elements of the plan and program shall be submitted to the Secretary for approval, at least six months prior to the commencement of operation of the Project.

4. Environmental Aspects and Impacts

4.1 Environmental Aspects

4.1.1 Surface Water

The State Government has endorsed the community's environmental values for water, known as 'Water Quality Objectives' (WQOs), for each catchment in NSW. The NSW WQOs are the environmental values and long term goals for consideration when assessing and managing the likely impact of activities on waterways (ANZECC/ARMCANZ, 2000).

Environmental values are particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health and which require protection from the effects of pollution, waste discharges and deposits. Environmental values expressed as WQOs provide goals that help in the selection of the most appropriate management options (Department of Environment and Conservation, 2006). The guiding principles are:

- Where the environmental values are being achieved in a waterway they should be protected; and
- Where the environmental values are not being achieved in a waterway, all activities should work towards their achievement over time.

The Cooks River Health Report Card 2013-2014 (2015), published by the Cooks River Alliance, remarked that while parts of the system have improved from poor to fair, it is noted that this health report does not assess the data in accordance with the ANZECC/ARMCANZ guidelines. Using the definitions of the accepted criteria (ANZECC/ARMCANZ, 2000), the Cooks River and surrounding tributaries are classified as 'highly disturbed systems' (AECOM 2015). Prior studies of water quality in the Cooks River catchment have provided the following remarks about various contaminants:

- Nutrients, phosphorus and nitrogen were found in high levels in the Cooks River. Sources include pets and birds, fertilisers, detergents, sewage discharges and golf courses.
- Faecal Coliforms – High levels found in the Cooks River, exceeding those of recreational guidelines
- Dissolved oxygen – Depleted levels found in the lower reaches of Cooks River.
- Toxicants – Elevated levels of toxicants such as organics and heavy metals have been found in high concentrations in the Cooks River. Fish kills have also been attributed to pesticide use.
- Suspended solids and turbidity – Results for all Cooks River catchments in the past have indicated results well above the ANZECC/ARMCANZ Water Quality Guidelines (ANZECC/ARMCANZ, 2000).
- pH – Results within the Cooks River have tended to indicate compliance guidelines.

Rockdale, Canterbury and Marrickville councils along with The University of New South Wales completed sediment sampling between 2008 and 2011 that showed highly contaminated river sediments. It was noted that surface sediments were less contaminated than sediments at depth, which implied that improvements in waste or discharge management in recent years had reduced the transport of contaminated materials to the river. They cited that a risk of heavy metal mobilisation would be associated with remediation activities (RCC, 2011).

Surface water monitoring has been conducted along Wolli Creek, the Cooks River and in the upper portion of Alexandra Canal. Preliminary results show that nutrients and heavy metals generally exceed the default trigger values. A baseline monitoring report (Appendix F) was completed following 12 months of surface water monitoring in May 2016.

Section 4.2 of the Technical working paper: Surface water (Appendix N of the EIS) provides a description of the waterways and catchments that have the potential to be impacted by the project. The watercourses within the project area are generalised as highly disturbed, with concrete channelisation and reconstructed rock banks dominating the waterway channels in areas directly adjacent to the project surface worksites. The technical working paper: Biodiversity assessment report (Appendix S of the EIS) described the aquatic and riparian values. The report concluded that there was no significant riparian vegetation that would be directly impacted by the project.

4.1.2 Tidal limits

The tidal limit of the Cooks River is approximately adjacent to Sando Reserve, Croydon Park (Manly Hydraulics Laboratory (MHL), 2005), shown in Figure 2. This is roughly 7.5 kilometres upstream of the Bayview Avenue Bridge and the upstream extent of any impacts related to the Project. Tidal variations will affect the surface water characteristics such as flow rates, pollutant mixing zones and water quality parameters.

Table 4 Tidal limits within the Project area

Creek	Eastings	Northings	Distance from the ocean (kms)	Comments
Alexandra Canal /Shea's Creek	332829	6246365	15.8	Tidal to a point ~100m downstream from Huntley Road bridge
Cooks River	323389	6247165	21.9	Tidal to within ~200m of Punchbowl Road bridge
Wolli Creek	327499	6243865	15.5	Tidal to vicinity of Bardwell Creek, 600m upstream from weir
Muddy Creek	328314	6240975	12.9	Tidal to vicinity of a small bridge, ~380m down from Princes Highway

4.1.3 Naturalisation and Rehabilitation Programs

An assessment has been undertaken to consider naturalisation and rehabilitation programs occurring within the waterways along the Project; Wolli Creek, Bardwell Creek, lower catchment of Cooks River, Alexandra Canal and the adjoining Shea's Creek (refer Figure 1). CDS-JV are aware of current rehabilitation programs which Sydney Water are undertaking in the upper catchment of the Cooks River and in Alexandra Canal. Project activities will not occur in these rehabilitation areas and are not anticipated to impact these programs. The Wolli Creek Riparian Corridor Management Plan, implemented by the former Sydney Metropolitan Catchment Management Authority (now Local Land Services, Greater Sydney), and the Cooks River Urban Water Initiative implemented by Local Land Services, Greater Sydney, no longer have activities directly adjacent to any project areas. CDS-JV will continue to consult with Sydney Water and the relevant councils to ensure any new rehabilitation / naturalisation programs are considered during construction.

4.1.4 Groundwater

The water table in the Project environment is heavily modified. It is locally impacted by the existing M5 East Motorway tunnels, however it is unlikely that the Airport Link tunnel impacts groundwater movement near the Project alignment. The local water table may be elevated above natural conditions by irrigation in areas such as the Kogarah Golf Course, leaky stormwater, sewer and main water infrastructures and building foundations that inhibit groundwater flow causing localised groundwater mounding (AECOM, 2015).

Assessments of the impacts on vegetation in the upper reaches of Wolli and Bardwell Creeks due to groundwater drawdown were undertaken as part of the Technical working paper: Biodiversity assessment report and assessed the significance of the impacts as low. In the lower reaches of the Cooks River, groundwater is in hydraulic connection with the Cooks River via the alluvium and changes in groundwater levels are predicted to be minimal.

Detail on groundwater levels & quality, including data from the EIS monitoring program and historic data are located in Appendix Q Groundwater Technical Report of the EIS. A baseline study of groundwater levels and quality commenced in March 2015 and will conclude prior to undertaking activities which have the potential to impact groundwater. A baseline groundwater monitoring report will be prepared within this timeframe.

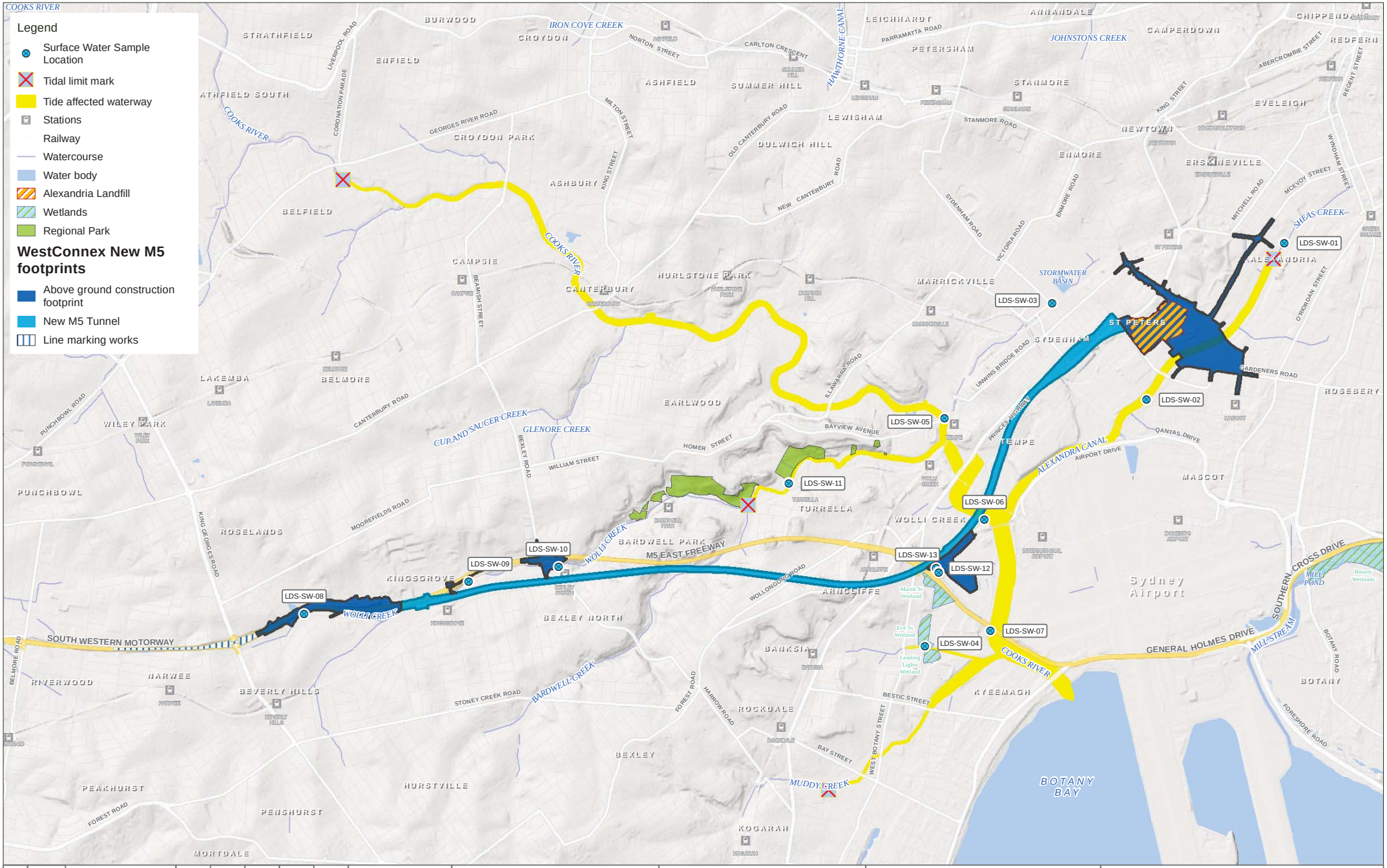
A network of groundwater monitoring wells was installed along the alignment during 2014 and 2015 (EIS (AECOM 2015)). The range of groundwater levels observed was highly variable and dependent upon the topography and locally impacted by groundwater users and infrastructure such as the M5 East Motorway. Hydrographs of the Hawkesbury Sandstone show less than one metre of fluctuation; suggesting that the formation is in equilibrium (recharge and discharge are equal). There is a clear

correlation between rainfall and an increase in water level at numerous monitoring locations, which may take up to 48 hours to respond, when rainfall exceeds 10 millimetres (EIS (AECOM 2015)).

At the Tempe Railway Station, adjacent to the Cooks River, the nested monitoring well completed in the alluvium and within the Hawkesbury Sandstone indicates that the standing water level in the alluvium is lower than in the Hawkesbury Sandstone. This suggests that there is an upward groundwater pressure gradient to the alluvium and is consistent with observations from nested monitoring wells in the Botany Sands and Hawkesbury Sandstone at Arncliffe (AECOM, 2015).

The Project tunnels will be constructed as drained tunnels, with ongoing groundwater inflow, capture and discharge. Groundwater modelling (CDM Smith, 2015) predicted model inflows of 1,115 cubic metres per day into the Project tunnels. Over a modelled length of 20 kilometres an inflow rate of 0.63 litres per second along every kilometre of east bound (shallower) tunnel and 0.67 litres per second along every kilometre of the westbound (deeper) tunnel was predicted. Groundwater modelling (CDM Smith, 2015) predicted GDE's would not experience significant drawdown over the course of the construction phase.

Groundwater will be collected treated and discharged in accordance with the surface water requirements. The Project discharge requirements have been developed in accordance with ANZECC/ARMCANZ (2000). The Alexandria Landfill actively extracts leachate, inducing groundwater to flow toward the centre of the landfill to prevent contamination from dispersing into the surrounding aquifers. This lowers the groundwater levels within the Botany Sands and Ashfield Shale and the leachate is discharged to sewer in accordance with a Trade Waste Agreement with Sydney Water.



REV	DATE	DESCRIPTION	AUTH	REVI	APPR
0	18/11/2015	Draft for comment			

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MGA Zone 56

Sydney Motorway Corporation | WestConnex

Leighton | DRAGADOS | SAMSUNG C&T

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WestConnex Stage 2 New M5

Water Quality Plan and Monitoring Program

Issued for discussion purposes only

Tidal limits within the project area

Figure: 2

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4.2 Potential Impacts and the Risk Management Framework

4.2.1 Risk Assessment and Management Framework

Potential water quality impacts caused by construction activities are summarised in Table 5 with associated risk ratings identified through a risk analysis. Environmental risk analysis was undertaken in accordance with the principles of the Australian and New Zealand standard AS/NZS ISO 31000: 2009 Risk Management – Principles and Guidelines. The likelihood and consequence criteria relevant to environment and risk rating tables are provided in Appendix B.

Initial risk ratings can be reduced through the identification and implementation of appropriate controls and management measures. The residual risk ratings are those determined after the implementation of the identified control measures.

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Table 5: Assessment of potential construction water quality impacts

Activity	Potential Aspect	Potential Impact(s)	Initial Risk Rating			Control Measure	Residual Risk Rating		
			Likelihood	Consequence	Significant (Refer to Appendix D)		Likelihood	Consequence	Significant
Potential construction water quality impacts to surface water									
Vegetation clearance / grubbing / demolition	Silt and debris	Erosion and sedimentation impacts on downstream waterways due to exposed land, inadequate controls or failure of controls	Almost certain (5)	Minor (2)	M10	Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – section 7.1 A1 - A6	Likely (4)	Negligible (1)	L4
Earthworks and excavation	Silt and debris	Erosion and sedimentation impacts on downstream waterways due to exposed land, inadequate controls or failure of controls	Almost certain (5)	Minor (2)	M10	Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – section 7	Likely (4)	Negligible (1)	L4
	Disturbance of land	Distribution of or mis-management of unexpected contamination or acid sulphate soils	Almost certain (5)	Moderate (3)	VH18	Manage Contaminated Land Procedure (M5N-ES-PRC-PWD-0036) and Manage Acid Sulfate Soils Procedure (M5N-ES-PRC-PWD-0038)	Possible (3)	Minor (2)	M8
Establishment and operation of ancillary facilities	Uncontrolled release	Failure of construction water treatment plant leads to uncontrolled discharge or discharge that doesn't meet	Unlikely (2)	Major (4)	H15	WTP Contingency Plan, WTP Permit, Plant Inspection & Checklists and Plant Maintenance	Rare (1)	Moderate (3)	M11

Activity	Potential Aspect	Potential Impact(s)	Initial Risk Rating			Control Measure	Residual Risk Rating		
			Likelihood	Consequence	Significant (Refer to Appendix D)		Likelihood	Consequence	Significant
		Infrastructure Approval or EPL conditions							
	Release of water / contamination	Contamination of soil or water from spill or leak of dangerous or hazardous materials from plant / equipment	Almost certain (5)	Minor (2)	M10	Manage Hazardous Substances Procedure (M5N-ES-PRC-PWD-0041)	Likely (4)	Minor (2)	M9
	Silt and debris	Erosion and sedimentation impacts on downstream waterways due to exposed land, inadequate controls or failure of controls	Almost certain (5)	Minor (2)	M10	Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Section 7.1, 7.2, 7.4	Likely (4)	Negligible (1)	L4
General construction activities	Uncontrolled release of water / contamination	Breach of CoA or EPL conditions, legal or client requirements leading to PINs, fines, prosecution, loss of reputation, strained relationships, contractual implications	Unlikely (2)	Major (4)	H15	CEMP (M5N-ES-PLN-PWD-0001) and sub plans	Rare (1)	Moderate (3)	M11
	Spills and leaks	Minor incidents, e.g. small leaks / spills, that do not cause or threaten material harm to the environment	Almost certain (5)	Minor (2)	M10	Manage Hazardous Substances Procedure (M5N-ES-PRC-PWD-0041)	Likely (4)	Negligible (1)	L4
	Silt and debris	Erosion and sedimentation impacts on downstream waterways due to	Almost certain (5)	Minor (2)	M10	Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-	Likely (4)	Negligible (1)	L4

Activity	Potential Aspect	Potential Impact(s)	Initial Risk Rating			Control Measure	Residual Risk Rating		
			Likelihood	Consequence	Significant (Refer to Appendix D)		Likelihood	Consequence	Significant
		exposed land, inadequate controls or failure of controls				0005) – Section 7.1, 7.2, 7.5			
	Uncontrolled release of water / contamination	Infiltration of surface water to groundwater sources or groundwater dependant ecosystems, including sediments and particles and soluble pollutants (such as acids, salts, nitrates and soluble hydrocarbons), for example through recharge activities	Possible (3)	Minor (2)	M8	CEMP (M5N-ES-PLN-PWD-0001), Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Section 7.1, 7.2, 7.5 and Manage Soil and Water Procedure (M5N-ES-PRC-PWD-0035)	Possible (3)	Minor (2)	M8
	Uncontrolled release of water / contamination / Concrete and building / demo waste	Release of Inappropriately managed/disposed uncured concrete and other building/demolition wastes.	Almost certain (5)	Moderate (3)	VH18	Manage Hazardous Substances Procedure (M5N-ES-PRC-PWD-0041) and Demolition Plan	Possible (3)	Negligible (1)	L3
Tunnel excavations	Uncontrolled release of water / contamination	Changes to groundwater level and quality leading to contamination, changes in salinity, ASS etc	Possible (3)	Moderate (3)	H13	CEMP (M5N-ES-PLN-PWD-0001), Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Section 7.1 B1 – B5, Section 7.3 and 7.6,	Rare (1)	Moderate (3)	M11

Activity	Potential Aspect	Potential Impact(s)	Initial Risk Rating			Control Measure	Residual Risk Rating		
			Likelihood	Consequence	Significant (Refer to Appendix D)		Likelihood	Consequence	Significant
						Groundwater Plan and Tunnel Plan.			
	Uncontrolled release of water / contamination	Inappropriate disposal of contaminated groundwater	Possible (3)	Moderate (3)	H13	CEMP (M5N-ES-PLN-PWD-0001), Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Section 7.1 B1 – B5, Section 7.3 and 7.6, and Manage Soil and Water Procedure (M5N-ES-PRC-PWD-0035)	Possible (3)	Minor (2)	M8
Potential construction impacts to groundwater quality and volume									
Tunnel excavations	Uncontrolled release of water / contamination	Changes to groundwater level and quality leading to contamination, changes in salinity, ASS etc	Possible (3)	Moderate (3)	H13	CEMP (M5N-ES-PLN-PWD-0001), Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Section 7.1 B1 – B5, Groundwater Plan and Tunnel Plan.	Rare (1)	Moderate (3)	M11
	Uncontrolled release of water / contamination	Inappropriate disposal of contaminated groundwater	Possible (3)	Moderate (3)	H13	CEMP (M5N-ES-PLN-PWD-0001), Construction Soil and Water Quality Sub-Plan (M5N-	Unlikely (2)	Minor (2)	L7

Activity	Potential Aspect	Potential Impact(s)	Initial Risk Rating			Control Measure	Residual Risk Rating		
			Likelihood	Consequence	Significant (Refer to Appendix D)		Likelihood	Consequence	Significant
						ES-PLN-PWD-0005) – section 7.1 B1 – B5, Section 7.3 and 7.6, and Manage Soil and Water Procedure (M5N-ES-PRC-PWD-0035)			
	Construction tunnel dewatering	Drawdown causing changes to groundwater levels.	Rare (1)	Substantial (5)	H16	CEMP (M5N-ES-PLN-PWD-0001), Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Section 7.1 B1 – B5, Groundwater Plan and Tunnel Plan.	Rare (1)	Moderate (3)	M11
	Construction tunnel dewatering	Saline intrusion / changes to salinity levels resulting from drawdown of groundwater levels	Rare (1)	Substantial (5)	H16	CEMP (M5N-ES-PLN-PWD-0001), Construction Soil and Water Quality Sub-Plan (M5N-ES-PLN-PWD-0005) – Section 7.1 B1 – B5, Groundwater Plan and Tunnel Plan.	Rare (1)	Moderate (3)	M11

4.3 Summary of impacts relative to the Aquifer Interference Policy

The NSW Aquifer Interference Policy requires that potential impacts on groundwater sources, including their users and groundwater dependent ecosystems (GDEs), be assessed against minimal impact considerations. If the predicted impacts are less than the Level 1 minimal impact considerations then these impacts would be considered as acceptable. If there are any exceedances of the criteria then they would be considered potentially adverse and mitigation and monitoring measures would be implemented.

The majority of the subject area is considered to be within a “Less Productive Groundwater Source” within fractured rock, based on the low number of registered bores in the area. The groundwater within the Botany Sands is considered to be in a “Highly Productive Groundwater Source.”

An evaluation of the risks to groundwater resources, surface water resources and GDE as a result of groundwater inflow into the tunnel is provided in Table 6 and Table 7.

Table 6: Minimal Impact Considerations for a “Less Productive Fractured Rock Aquifer”

Type of Impact	Minimal impact considerations	Summary of impacts
Water table impacts	• If more than and/or less than or equal to 10% cumulative variation in the water table allowing for typical “post-water sharing plan” variations, 40m from any high priority GDE or high priority culturally significant site listed in the schedule of the relevant water sharing plan. • A maximum of a 2m decline cumulatively at any water supply work.	• No culturally significant sites were identified within the Greater Metropolitan Regional Groundwater Water Sharing Plan. • There are no high priority groundwater dependent ecosystems listed under Schedule 4 of the Greater Metropolitan Regional Groundwater Sources Water Sharing Plan that are within the Hawkesbury Sandstone or Ashfield Shale. • The predicted long term drawdown in industrial bore GW107993 is 5.7 metres. The bore is 186 metres deep with water table depth recorded at 93 metres. Groundwater will not be drawn down to 93 metres as this is below the tunnel at this location. It is considered unlikely that drawdown in the borehole due to the tunnel will impact the sustainability of the borehole. And it is predicted that two registered bores, with only one of these bores registered for water supply purposes (industrial),within the predicted 2 m drawdown impact zone. The approach to minimising impacts are outlined below in Section 7
Water pressure impacts	• A cumulative pressure head decline of no more than 2m decline at any water supply work.	• The groundwater modelling has included the cumulative impacts of the existing M5 East Motorway tunnel. For the bores where it has been predicted that the drawdown exceeds a water level decline of more than two metres the approach to minimising impacts are outlined below in Section 7.
Water quality impacts	• Any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	• The beneficial use category of groundwater will not be changed beyond 40m of the tunnel.

Table 7: Minimal Impact Considerations for a "Highly Productive Coastal Aquifer"

Type of Impact	Minimal impact considerations	Summary of impacts
Water table impacts	• If more than and/or less than or equal to 10% cumulative variation in the water table allowing for typical "post-water sharing plan" variations, 40m from any high priority GDE or high priority culturally significant site listed in the schedule of the relevant water sharing plan. • A maximum of a 2 m decline cumulatively at any water supply work.	• No culturally significant sites were identified within the Greater Metropolitan Regional Groundwater Water Sharing Plan. • There are no high priority groundwater dependent ecosystems listed under Schedule 4 of the Greater Metropolitan Regional Groundwater Sources Water Sharing Plan. There are two wetlands within the project corridor at Tempe known as the Eve Street Wetland and Landing Lights Wetland. Groundwater modelling indicates that the water table at these wetlands is unlikely to undergo a water level decline of more than 2m. • Groundwater modelling predicted that eight water supply bores within a one kilometre radius of the tunnels that intersect alluvium are likely to be drawn down by more than two metres. Three of these bores are registered for water supply purposes, the remaining being categorised as monitoring wells or other, The approach to minimising impacts are outlined below in Section 7.
Water pressure impacts	• A cumulative pressure head decline of no more than 2m decline at any water supply work.	• The groundwater modelling has included the cumulative impacts of the existing M5 East Motorway tunnel. For the bores where it has been predicted that the drawdown exceeds a water level decline of more than two metres the approach to minimising impacts are outlined below in Section 7.
Water quality impacts	• Any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	• The beneficial use category of groundwater will not be changed beyond 40m of the tunnel.

4.4 Potential for Streambed Fracture

Streambed fracture relates to the flow of creek water over rock outcrops and the possibility of creek bed joints opening due to tunnel construction; the impact of which is potential diversion of surface water to underground. The presence of rock outcrops within the active channel of waterways is not known to occur along the Project alignment. Wolli Creek, Bardwell Creeks and Cooks River flow over alluvium infilled valleys rather than rock outcrops. There are no known observable occurrences of rock outcrops along the active channels of Bardwell and Wolli Creeks.

Streambed fracture is a potential risk where tunnelling traverses a waterway. Streambed fracturing will be monitored by:

- Assessing water inflows to the tunnel excavation; and
- Visual surveillance of waterways when tunnelling in proximity of waterways (Section 6.2.5).

5. Water Quality Performance Standards

Receiving waterways for treated groundwater discharge and temporary sediment basin discharges from the project are classified as highly disturbed ecosystems (AECOM, 2015). The following water quality discharge criteria have been developed drawing on the information and studies in the project's EIS (Appendix N Surface Water Technical Report and Appendix Q Groundwater).

Discharge water quality will be consistent with improving the water quality within the receiving environment. The validity of trigger values and discharge parameters were confirmed by completing the baseline water quality monitoring for surface waters (Appendix F).

5.1 Temporary Sediment Basins water quality discharge criteria

Water quality will be sampled at construction sediment basins prior to any controlled discharges to confirm that discharge criteria (in Table 8) are met prior to the controlled discharge. Discharge of sediment basins will occur via a permit process as described in the CSWQSP and in accordance with the Environmental Protection Licenses (EPL 20772 and 4627).

Table 8: Sediment basin discharge water quality targets

Parameter	Discharge criteria
Oil and grease	Not Visible
pH	6.5-8.5
Total Suspended Solids (TSS)	<50mg/l

5.2 Construction Water Treatment Plants water quality discharge criteria

Construction Water Treatment Plants (WTPs) are proposed for the Kingsgrove North site compound (C1), Commercial Road site compound (C3), Bexley Road North site compound (C4), Arncliffe site compound (C7), Canal Road site compound (C8). Design specifications for these WTPs have been developed based on a combination of catchment- specific and default ANZECC/ARMCANZ (2000) trigger values. The target water quality and outflow velocities of the water from these treatment plants are based on the Project's Water Quality Reference Criteria and will be in accordance with the Project's Environment Protection Licence (EPLs 20772 and 4627).

The Arncliffe site compound's construction water treatment plant will discharge into the Cooks River, via stormwater infrastructure, downstream of the Marsh Street Bridge. The Canal Road site compound's WTP will discharge into the Alexandra Canal, via stormwater infrastructure, in the vicinity of Canal Road. The receiving waters at these sites are tidally influenced and the discharge values for these two WTPs (as shown in Table 9 and Table 10) are based on the Cooks River Recommended Water Quality Trigger Values determined in the Water Quality Reference Criteria.

The Kingsgrove North, Commercial Road and Bexley Road construction water treatment plants will all discharge into Wolli Creek, upstream of Bexley Road, which is upstream of tidal influences. These sites will discharge in accordance with the recommended Water Quality Trigger Values for Wolli Creek (in Table 9 and Table 10), as listed in the Water Quality Reference Criteria.

Table 9: Construction Water Treatment Plant discharge criteria

Parameter	Discharge criteria	
	Arncliffe & Canal Road site compounds (Estuary receiving environment)	Kingsgrove North, Commercial Road & Bexley site compounds (Freshwater receiving environment)
pH*	6.5-8.5	
Total Suspended Solids *	<50mg/l	

* At all times

Table 10: Construction Water Treatment Plant discharge targets

Parameter	Measurement & Assessment		Discharge criteria	
	Percentile Concentration Limit	Sample method & frequency	Arncliffe & Canal Road site compounds (Estuary receiving environment)	Kingsgrove North, Commercial Road, & Bexley site compounds (Freshwater receiving environment)
Copper	80	Quarterly grab sample	0.008(mg/l)	0.012(mg/l)
Iron	80	Quarterly grab sample	0.3(mg/l)	0.3(mg/l)
Nickel	80	Quarterly grab sample	0.560(mg/l)	0.017(mg/l)
Zinc	80	Quarterly grab sample	0.043(mg/l)	0.059(mg/l)
Manganese	80	Quarterly grab sample	2.5(mg/l)	3.6(mg/l)
Total Nitrogen	80	Quarterly grab sample	1.7(mg/l)	2.9(mg/l)
Total phosphorus	80	Quarterly grab sample	0.2(mg/l)	0.12(mg/l)
Dissolved oxygen	80	Quarterly field sample	39.8% (lower limit)	60% (lower limit)

5.3 Leachate Treatment Plant

The St Peters Interchange site compound is an above ground structure at the Alexandria Landfill. Contaminated stormwater and landfill leachate will continue to be directed to the landfill leachate treatment plant, in accordance with the landfill's existing EPL (EPL4627), where applicable and discharged to sewer in accordance with the trade waste agreement with Sydney Water (pending transfer to CDS-JV). This Water Quality Plan and Monitoring Program does not address the Alexandria Landfill leachate collection and treatment systems. Detail on these systems is provided in the St Peters Interchange - Landfill Closure Management Plan (M5N-GOL-TER-900-116-0012).

6. Pre-construction and Construction Water Quality Monitoring Program

The following monitoring program draws and builds on the water quality reference criteria and the water quality monitoring program for surface water (Appendix N Surface Water Technical Report) and groundwater (within Appendix Q Groundwater Technical Report), described in the New M5 EIS. Baseline water monitoring for the project commenced for groundwater in April 2015, and surface water in June 2015.

The baseline water monitoring report for surface water is presented in Appendix F. A baseline water monitoring report for groundwater will be completed prior to potential impacts to groundwater.

6.1 Introduction

The Water Quality Monitoring Program will be undertaken in three key phases:

- Pre-Construction phase (baseline).
- Construction phase.
- Operational phase (three years post completion).

Monitoring in each of these phases is discussed in the following sections. Monitoring will be undertaken in accordance with Australian Standards, ANZECC/ARMCANZ (2000), the CEMP and the CSWQSP, noting that:

- Physical parameters (i.e. pH and EC) and the dissolved metals will be used to assess basic water characteristics, as they provide good indicators of overall water quality.
- Turbidity will be a key parameter in assessing indications of potential impact.
- Nutrients such as ammonia, nitrates and phosphates provide an indication of the organic load present in the water.
- Total recoverable hydrocarbons (TRH) and BTEXN provide an indication of pollution from hydrocarbons e.g. from fuels, oils, solvents and grease.

6.2 Surface Water Monitoring

6.2.1 Surface Water Monitoring Locations

Water quality monitoring will be undertaken at eleven sites as listed in Table 11 and labelled in Figure 3. Additional monitoring sites may be added during the program if necessary, beneficial or as advised. Where possible, the selection of the monitoring locations has incorporated upstream (control) sites and downstream (impact) sites. This type of monitoring allows for the assessment trends in water quality, including natural variations, and will allow sufficient data to enable assessment of any potential impacts measured during construction. The surface water quality monitoring locations are generally consistent with the ten locations identified in the New M5 EIS Water Quality Monitoring Program (Appendix N Surface Water Technical Report). Minor amendments to some monitoring locations were adopted to provide suitable access for personnel and ensure coverage in waterways where discharge is proposed.

Table 11: Surface water quality monitoring sites before and during construction

Site ID	Location relative to site compounds	Watercourse name	Sampling Address	Eastings	Northings	Freshwater or estuarine / marine
LDS-SW-01	Upstream	Sheas' Creek	Access via Euston Road, Alexandria	332938	6246524	Freshwater
LDS-SW-02	Downstream	Alexandra Canal	Access via Burrows Road or Coward Street via cycleway, Alexandria	331540	6244935	Estuarine / marine
LDS-SW-03	Downstream	Eastern Channel	Sydenham Road, Marrickville.	330581	6245909	Freshwater
LDS-SW-04	Upstream	Eve St Wetlands	Eve St Cycleway, near the entrance to the Barton Park Driving Range	329292	6242429	Estuarine / marine
LDS-SW-05	Upstream	Cooks River	Richardsons Crescent Bridge	329491	6244746	Estuarine / marine
LDS-SW-06	Downstream	Cooks River	Rockwell Avenue	329895	6243716	Estuarine / marine
LDS-SW-07	Downstream	Cooks River	Eve Street near Cooks River M5 infrastructure overpass	329955	6242591	Estuarine / marine
LDS-SW-08*	Upstream	Wolli Creek	Footbridge at portion of Beverly Grove Park located south of the M5, access via Tallawalla Street	322993	6242760	Freshwater
LDS-SW-09*	Upstream	Wolli Creek	Footbridge at the end of Kooreela Street	324663	6243087	Freshwater
LDS-SW-10	Upstream	Wolli Creek	Bexley Rd bridge, near Bexley North Station	325577	6243239	Freshwater
LDS-SW-11	Downstream	Wolli Creek	Upstream of Henderson St footbridge, near 5-9 Henderson St	327910	6244087	Freshwater

Note:*Wet weather monitoring only, as there is an inadequate volume of water in the channel during dry weather to enable sampling to occur.

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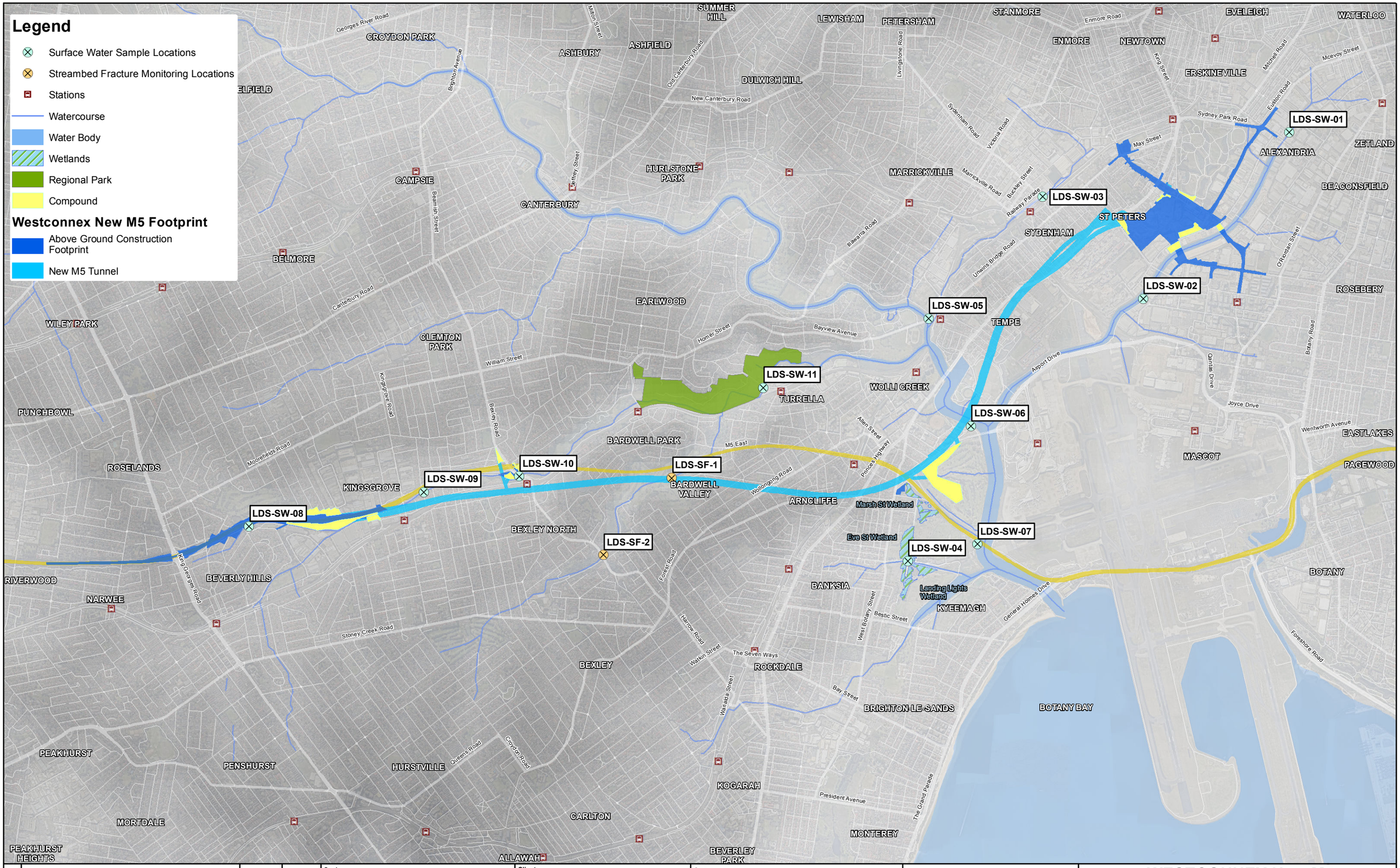

Rev	Description	Date	Approved
2	Draft for Comment	29/11/2016	
1	Draft for Comment	13/10/2016	
0	Draft for Comment	18/11/2015	■

Scale

Client: WestConnex

Status: For Information Only - NOT FOR CONSTRUCTION

Original Size	A3	Drawn	■
Coordinate System	MGA ZONE 56	Requested by	■
Height Datum	AHD	Date Printed	29-Nov-16
Filename:	Surface_Water_Sample.mxd		

WestConnex New M5

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WESTCONNEX New M5

Surfacewater Monitoring Locations

DOCUMENT NUMBER

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6.2.2 Water Quality Monitoring Parameters for surface water monitoring

The water quality monitoring parameters are drawn from the New M5 EIS Water Quality Monitoring Program (Appendix N Surface Water Technical Report) and are listed in Table 12.

Table 12: Water quality monitoring parameters for surface water monitoring

Parameter	Testing method
Total Nitrogen (includes Total Kjeldahl Nitrogen and Nitrogen oxides)	Sampled and laboratory test
Total Kjeldahl Nitrogen	Sampled and laboratory test
Nitrogen Oxide (NOx), Nitrite (NO_2), Nitrate (NO_3)	Sampled and laboratory test
Total Phosphorus	Sampled and laboratory test
Reactive Phosphorous	Sampled and laboratory test
Turbidity	Field test – probe/meter
Suspended solids	Sampled and laboratory test
Electrical Conductivity (salinity)	Field test – probe/meter
Temperature	Field test – probe/meter
pH	Field test – probe/meter
Dissolved oxygen	Field test – probe/meter
Oxygen Reduction Potential	Field test – probe/meter
Dissolved metals (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg)	Sampled and laboratory test
Additional metal (Fe and Mn)	Sampled and laboratory test
Organics, Total Recoverable Hydrocarbons (C6-C40)	Sampled and laboratory test
Iron - Ferrous (dissolved)	Sampled and laboratory test
Benzene, Toluene, Ethylbenzene, Xylene, Naphthalene	Sampled and laboratory test

6.2.3 Baseline Phase

The monitoring program during the preconstruction phase includes sampling at bi-monthly intervals (monitoring twice a month, once in dry conditions and once in wet conditions where possible) for 12 months during the preconstruction phase. Wet weather monitoring will happen once a month when more than ten millimetres of rain is received in the local catchment during a 24 hour period. For safety reasons sampling will not be undertaken during peak storm-flows. Sampling will be completed when flows are reasonably constant and safe.

Water quality monitoring parameters are as per Table 12. The baseline surface water monitoring report is provided in Appendix F.

6.2.4 Construction Phase

The monitoring program during the construction phase will continue monthly sampling during the construction phase.

Wet weather monitoring will be conducted quarterly (once every 3 months) when more than ten millimetres of rain is received in the local catchment during a 24 hour period. For safety reasons

sampling will not be undertaken during peak storm-flows. Sampling will be completed when flows are reasonably constant and safe.

Surface water quality parameters monitoring will be as per Table 12.

6.2.5 Visual surveillance procedure for potential streambed fracturing

Visual surveillance will be undertaken by the Environmental Advisor (EA) or as otherwise delegated by the Environment and Sustainability Manager. This surveillance would be in addition to monitoring of groundwater inflow to tunnels. Surveillance procedure to be implemented as follows:

1. Prior to the commencement of tunnelling, the EA will establish monitoring locations at the sites shown in Figure 3 to undertake surveillance of key waterway features, including photo points.
2. Undertake monthly baseline visual surveillance of the waterway prior to commencement of tunnelling. Identify and record key features including as a minimum:
   - Condition of banks,
   - Current water depth and relative high/low water marks.
3. Continue monthly surveillance at the monitoring sites throughout construction. Undertake a monthly review of visual surveillance between monitoring sites and relative to the baseline.
4. Commence further investigation into potential causes, where the visual surveillance identifies changes to flows in the waterway and/or key features.

6.3 Groundwater Monitoring

6.3.1 Groundwater monitoring locations

The proposed groundwater monitoring bores for preconstruction and construction phase monitoring are summarised in Table 13 and are labelled on Figure 4. This figure identifies boreholes for water quality monitoring and depth to groundwater. There is substantial site coverage both along the Project tunnels and adjacent to the alignment to monitor shallow and deep groundwater trends during the construction phase. Modelling predicts a maximum of two metres of groundwater drawdown in areas of retained Groundwater Dependent Ecosystems. This is unlikely to stress the community as the natural seasonal variation drawdown is within this parameter (CDM Smith, 2015).

The following locations and associated boreholes will be used to monitor potential impacts to Groundwater Dependent Ecosystems:

- Cooks River Castlereagh Ironbark Forest GDE at Kingsgrove
  - WCX-BH006
- Hinterland Sandstone Gully Forest GDE at Bardwell Valley Parkland and Broadford Street Reserve
  - LDS-BH-1033B and LDS-BH-1066
- Coastal Sandstone Ridgetop Woodland GDE at Stotts Reserve, Bexley North
  - LDS-BH-1044 and LDS-BH-1032
- Estuarine Fringe Forest and Mangrove Forest GDE between the southern bank of Wolli Creek and the rail line behind Wolli Creek Station
  - WCX-BH039

Groundwater quality will be monitored at the following locations:

- Cooks River adjacent to the Arncliffe construction compound
  - WCX-BH168
- Bardwell Park
  - LDS-BH-1066
- Cut-off wall for Alexandria Landfill

- LDS-BH-3045A, LDS-BH-3046A, LDS- BH- 3045A, LDS- BH- 3046A, LDS- BH- 3047A and LDS-BH-3907

Monitoring bores with screen sections at the depth of the tunnels and monitoring bores at shaft locations will closely monitor groundwater level changes due to localised dewatering through tunnel and shaft drainage. Some bores within the Hawkesbury Sandstone and the overlying alluvium are within close lateral proximity to each other to provide information on potential vertical head gradient between the alluvium and the sandstone. This is important in assessing the aquifer connectivity including recharge into deeper groundwater system intersected by the Project tunnels. Monitoring bores have also been placed at some distance to the alignment to better understand the development of a drawdown zone along the tunnel as tunnel construction progresses. Note, the final number and locations of bores are subject to access and security considerations.

Table 13: Groundwater quality and level monitoring locations

Bore ID	Hydrostratigraphic unit screened	Eastings	Northings	Water quality	Water level	Data logger
LDS-BH-1019	Alluvium	323844	6242879	✓	✓	✓
LDS-BH-1021	Hawkesbury Sst	323910	6242865		✓	✓
LDS-BH-1025A	Hawkesbury Sst	324230	6242852	✓	✓	✓
LDS-BH-1026	Hawkesbury Sst	324448	6242973	✓	✓	✓
LDS-BH-1027	Hawkesbury Sst	324475	6242852	✓	✓	✓
LDS-BH-1030	Hawkesbury Sst	325494	6243263		✓	✓
LDS-BH-1031	Hawkesbury Sst	325760	6243091		✓	✓
LDS-BH-1032	Hawkesbury Sst	326053	6243172		✓	✓
LDS-BH-1033B	Hawkesbury Sst	326949	6243223	✓	✓	✓
LDS-BH-1038	Hawkesbury Sst	329099	6243198	✓	✓	✓
LDS-BH-1041	Alluvium / Hawkesbury Sst	329465	6243437		✓	✓
LDS-BH-1044[1]	Alluvium	325714	6243233		✓	
LDS-BH-1066	Hawkesbury Sst	326531	6242873		✓	✓
LDS-BH-2001	Alluvium	329361	6243035	✓	✓	✓
LDS-BH-2003	Alluvium	329720	6242895		✓	✓
LDS-BH-2005	Alluvium / Hawkesbury Sst	329618	6243371	✓	✓	✓
LDS-BH-2007A[2]	Hawkesbury Sst	329789	6243546	✓	✓	✓
LDS-BH-2008A	Hawkesbury Sst	329891	6243883	✓	✓	✓
LDS-BH-2011A	Hawkesbury Sst	330097	6244325	✓	✓	✓
LDS-BH-2011B	Alluvium	330097	6244323	✓	✓	
LDS-BH-2015	Hawkesbury Sst	330176	6244776	✓	✓	✓
LDS-BH-2018	Hawkesbury Sst	330615	6245117	✓	✓	✓
LDS-BH-2019[3]	Hawkesbury Sst	330714	6245309		✓	
LDS-BH-2029[2]	Hawkesbury Sst	329560	6243397		✓	✓
LDS-BH-2029A[2]	Alluvium	329561	6243398		✓	✓
LDS-BH-2032[1]	Ashfield Shale	330286	6245563		✓	✓
LDS-BH-3045	Botany Sands Aquifer	331602	6245451	✓	✓	✓
LDS-BH-3045A	Ashfield Shale	331613	6245460	✓	✓	✓
LDS-BH-3046	Botany Sands Aquifer	331841	6245571	✓	✓	✓
LDS-BH-3046A	Ashfield Shale	331842	6245571	✓	✓	✓
LDS-BH-3047	Botany Sands Aquifer	332046	6245639		✓	✓

Bore ID	Hydrostratigraphic unit screened	Eastings	Northings	Water quality	Water level	Data logger
LDS-BH-3047A	Ashfield Shale	332046	6245640		✓	✓
LDS-BH-3082[4]	Botany Sands Aquifer	331437	6245751		✓	
LDS-BH-3097[4]	Botany Sands Aquifer	331822	6245596		✓	
LDS-BH-5007	Ashfield Shale	331811	6245941		✓	✓
LDS-BH-5010[1]	Ashfield Shale	331762	6245993		✓	✓
LDS-BH-5022	Botany Sands Aquifer	332211	6245657		✓	✓
WCX-BH006	Hawkesbury Sst	323555	6242880		✓	✓
WCX-BH018	Hawkesbury Sst	326717	6243422		✓	✓
WCX-BH024	Hawkesbury Sst	327222	6243306	✓	✓	✓
WCX-BH039	Hawkesbury Sst	329553	6244158		✓	✓
WCX-BH072	Hawkesbury Sst	325561	6243243	✓	✓	✓
WCX-BH088	Hawkesbury Sst	326182	6243434		✓	✓
WCX-BH093	Hawkesbury Sst	327657	6243183	✓	✓	✓
WCX-BH094	Hawkesbury Sst	327867	6243174		✓	✓
WCX-BH103	Hawkesbury Sst	330431	6245201	✓	✓	✓
WCX-BH109	Ashfield Shale	331220	6245632	✓	✓	✓
WCX-BH122	Ashfield Shale	332030	6245873		✓	✓
WCX-BH137	Hawkesbury Sst	324858	6243065	✓	✓	✓
WCX-BH153	Hawkesbury Sst	330468	6244766		✓	✓
WCX-BH157	Regentville Siltstone	331518	6245766		✓	✓
WCX-BH168	Hawkesbury Sst	329702	6243775	✓	✓	✓

Notes

1: Well destroyed

2: Well not currently accessible due to Marsh St widening construction activities

3: Due to grout infiltration during well installation, well to be used for monitoring groundwater levels only. Groundwater quality to be measured in nearby well WCX-BH-103

4: Monitoring well to be installed

6.3.2 Water Quality Monitoring Parameters for groundwater monitoring

The water quality monitoring parameters are as per the Draft Groundwater Monitoring Program as described in the New M5 EIS (Appendix Q Groundwater - Appendix E) and are listed in Table 14.

Table 14: Water quality monitoring parameters for groundwater bore monitoring

Parameter	Testing method
Turbidity	Field test – probe/meter
Electrical Conductivity (salinity)	Field test – probe/meter
Temperature	Field test – probe/meter

Parameter	Testing method
pH	Field test – probe/meter
Dissolved oxygen	Field test – probe/meter
Oxygen Reduction Potential	Field test – probe/meter
Ammonium	Sampled and laboratory test
Dissolved metals (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg)	Sampled and laboratory test
Additional metal (Fe and Mn)	Sampled and laboratory test
Organics, Total Recoverable Hydrocarbons (C6-C40)	Sampled and laboratory test
Iron - Ferrous (dissolved)	Sampled and laboratory test
Benzene, Toluene, Ethylbenzene, Xylene	Sampled and laboratory test
Polycyclic Aromatic Hydrocarbons (PAHs),	Sampled and laboratory test
Phenols	Sampled and laboratory test
Organochlorine Pesticides	Sampled and laboratory test
Organophosphorus Pesticides	Sampled and laboratory test
Polychlorinated Biphenyls	Sampled and laboratory test

6.3.3 Baseline and Construction Phase

It is proposed to collect groundwater samples for water quality monitoring purposes from up to 20 locations and also for water levels from 32 locations, refer Table 13. Groundwater quality monitoring parameters will be as given in Table 14.

The proposed frequency for sampling groundwater is presented in Table 15. The sampling frequency may be modified once an appropriate database of groundwater water quality and level data has been obtained. As part of the ongoing review of monitoring data, the requirements to increase or to decrease, the number of sampling locations and/or the analytical suites may be proposed. Alterations to monitoring locations, analytical suites, or frequencies will be reported in the biannual monitoring reports (Section 8).

Table 15: Frequency of monitoring groundwater

Project Phase	Frequency
Construction (groundwater levels)	Monthly (Datalogger)
Construction (groundwater quality)	6 monthly

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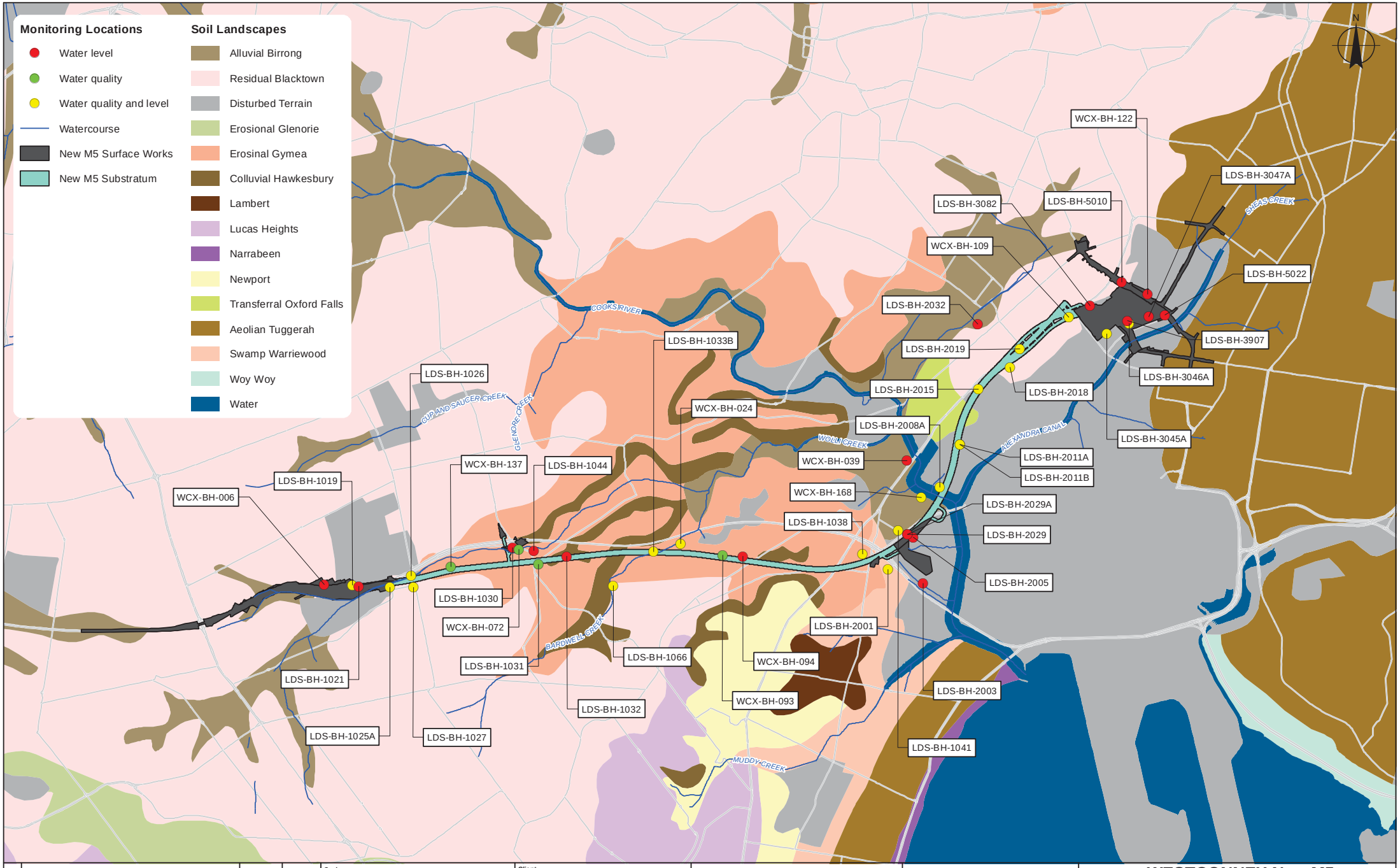

Rev	Description	Date	Approved
A	Preliminary Issue	31/05/2016	

Scales
0 1,200 m
1:35000

Imagery © Land and Property Information 2015

Client
WestConnex

Status
For Information Only - NOT FOR CONSTRUCTION

Original Size	A3	Drawn	
Coordinate System	MGA ZONE 56	Requested by	
Height Datum	AHD	Date Printed	31/05/2016
Filename:	Groundwater Monitoring Locations.mxd		

WestConnex New M5

CPB CONTRACTORS | DRAGADOS | SAMSUNG C&T

aurecon | JACOBS | HASSELL | Golder Associates

WESTCONNEX New M5

Groundwater Monitoring Locations

Figure: 4

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7. Management and Mitigation Measures

Measures to manage water quality impacts and reduce the risk of impact to water quality will be implemented prior to and during works. Elimination of the hazard is the first preference of control, followed by engineering, then administrative controls. Controls used on this Project are identified in Table 16. These controls include the relevant environmental mitigation measures identified in the New M5 EIS and the final REMMs from the WestConnex New M5 Submissions Report.

Table 16: Project controls associated with management of water quality

Reference	Control / Action	Timing	Responsibility	Source
Surface and groundwater – Water treatment				
WQ01	Measures relating to surface and groundwater during construction and operation, including water treatment, erosion and sediment control plans and stormwater management measures consistent with Water Sensitive Urban Design measures, where relevant, and consistent with the measures detailed in the documents listed in CoA A2, including the specifications and design details of the water treatment plants will be included in the Design Reports.	Design	EM,DM	B28(c)
Surface water – Incident triggers and potential responses				
WQ02	Spillage of hazardous materials: • Stop work • Activate Manage Hazardous Substances Procedure (M5N-ES-PRC-PWD-0041) and Spill Management Flowchart (M5N-ES-FLC-PWD-0003) immediately • Report the incident.	Pre-construction Construction	EM, EA, PM, SS	B28(c)
WQ03	Unanticipated discovery of contaminated soil/water: • Stop work • Activate the Manage Contaminated Land Procedure (M5N-ES-PRC-PWD-0036) and Unexpected Discovery of Contaminated Land Flowchart (M5N-ES-FLC-PWD-0001) immediately • Report the incident.	Pre-construction Construction	EM, EA, PM, SS	B28(c)
WQ04	Fish kill in receiving waters: • Stop work • Implement the Incident Response Plan (M5N-HS-PLN-PWD-0003) • Report and investigate the incident.	Construction	EM, PM	B28(c)
WQ05	Exceptional rainfall event • Restrict works in open areas, where appropriate • Inspect erosion controls (i.e. source controls) to ensure effectiveness • Maintain/manage erosion and sediment control devices, including sediment basins • Conduct ongoing monitoring and maintenance of controls.	Pre-construction Construction	PM, SS	B28(c)

Reference	Control / Action	Timing	Responsibility	Source
Surface water – Ambient surface water quality triggers – Using trigger values				
WQ06	Water Quality triggers will be used to identify potential Project impacts on the receiving waters, and to inform an appropriate response. A management response (refer to WQ08) will be instigated if any of the following occurs: • If, in the downstream monitoring location(s) there are exceedances of one or more of the trigger values for that catchment for three consecutive monthly sampling events and the upstream monitoring does not show the same exceedances. • If, in the downstream monitoring location(s) there are exceedances of one or more of the trigger values for that catchment for more than six sampling events in any one year and the upstream monitoring does not show the same exceedances. • If, in a downstream monitoring location there is a single exceedance of the trigger values for that catchment by more than 50% and the upstream monitoring location does not show the same exceedance. • An NTU result at a downstream location is more than 20% above that measured in the associated upstream location and is attributable to site works.	Pre-construction Construction	EM	B28(o)
Surface water – Site discharge triggers - Sediment basins				
WQ07	Water will not be actively discharged from a sediment basin unless it meets the EPL targets in Section 5.1. Rainfall events that exceed the design event may cause overtopping of a sediment basin. Such unconditional discharges are not subject to the same water quality targets or monitoring, but their date, time and duration will be documented.	Pre-construction Construction	EM	B28(c)
Surface Water – Management responses				
WQ08	Within two business days of receiving any round of surface water monitoring results, a review will be conducted against the agreed trigger values, and between comparison sites (i.e. upstream vs downstream). In the event that one or more of the triggers in section 5 (Table 8, Table 9, Table 10) was exceeded, and one or more of the scenarios listed in WQ06 applies, an investigation would be immediately commenced to determine the significance of the exceedance(s) and possible causes. If the exceedance is attributable to Project works, the project's Incident Response Plan (M5N-HS-PLN-PWD-0003) would be implemented. An investigation would be conducted and actions that	Pre-construction Construction	EM, EA	B28(o)

Reference	Control / Action	Timing	Responsibility	Source
	recommend any additional management measures, amelioration or monitoring required would be identified.			
Groundwater quality – Groundwater chemical triggers and management response				
WQ9	Monitoring to-date shows that some groundwater quality parameters currently exceed the default ANZECC/ARMCANZ 2000 water quality trigger values for slightly to moderately disturbed ecosystems. Therefore, site-specific groundwater trigger values will be developed using the baseline data. This data will provide a project-specific baseline for assessing potential impacts of the project on groundwater quality. A management response would be initiated if any of the following occurs: • There is an identified negative trend in any of the analytes measured over a period of any two sampling events; or • There is a peak in any single analyte which is more than 20% above the previous reading; or • An analyte result deviates negatively more than 20% from the rolling 80th percentile of all previous results. In the event that one or more of the above groundwater chemical triggers are observed, a review will be conducted against the trigger values, and against the results from surrounding monitoring bores. An investigation would be conducted to determine the significance of the exceedance(s) and possible causes. If the exceedance is determined to be attributable to Project works, an investigation would be conducted to determine any additional management measures required to be implemented. Groundwater quality monitoring data will be assessed and reported according to Section 8.	Pre-construction Construction	EM, EA	B28(o)
Groundwater quality – Groundwater elevation triggers				
WQ10	Identification of a groundwater decline (including a decline in quality and/or quantity) in a water supply bore (beyond seasonal fluctuations in nearby monitoring bores) will be assessed to determine whether the decline is attributable to dewatering from the project. The assessment will include a review of groundwater levels and groundwater quality in the relevant bore and surrounding monitoring bores. Where such an impact is confirmed, 'make good' provisions for the relevant groundwater users will apply. ['Make good' will only apply to registered bore users.]	Pre-construction Construction	EM, EA	B28(p)
WQ11	Implement measures identified in the Hydrogeological Design Report (M5N-GOL-DRT-100-200-GT-1525) to manage/mitigate identified potential groundwater impacts. Where groundwater drawdown is identified to occur beyond the modelled predictions of the Hydrogeological Design Report, an assessment will be conducted to determine whether the decline is attributable to	Construction	PM	B28(o)

Reference	Control / Action	Timing	Responsibility	Source
	dewatering from the project. Where the drawdown is determined to be project-related, a review and update of the groundwater model would be undertaken, and further consultation would be undertaken with DPI Water to determine an appropriate management response, where required.			
Groundwater Treatment and Discharge				
WQ11	Refer to Section 5 for details of treatment and discharge of tunnel inflows. Discharge points into watercourses will be designed to emulate a natural stream system where feasible and reasonable, or where emulation cannot be achieved, adequate scour protection measures are to be implemented.	Pre-construction Construction	EM, EA	B28(c) – (e)
Streambed Monitoring				
WQ12	Flow in-tunnel monitoring when operating in the vicinity of Wolli Creek, Bardwell Creek and Cooks River.	Construction	EM, PM	B28(q)
WQ13	Identification of risk and undertake visual surveillance (refer Section 6.2.5) for potential streambed fracture (beyond seasonal fluctuations in stream depth) and required mitigation measures associated with tunnelling works in the vicinity of Wolli Creek, Bardwell Creek and Cooks River.	Construction	EM, PM	B28(q)

CRM Community Relations Manager; DM – Design Manager; EA – Environmental Advisor; EM – Environmental Manager; PE – Project Engineer; PM – Project Manager; SS – Site Supervisor

8. Reporting

Reporting of the monitoring results to the Secretary, DPI Water and the relevant council is required as part of this Water Quality Plan & Monitoring Program. Table 17 details the proposed reporting schedule.

Table 17: Reporting schedule

Project Phase	Report Timing	Report Requirements
Prior to Construction	Within 3 months of completion of baseline monitoring	Surface water and groundwater data collected and tabulated. Progressive trends and rolling means to be identified as they emerge.
		A report on results obtained from the baseline monitoring period. This data will be used to confirm the site-specific water quality criteria/targets.
During Construction	Annual	Raw surface and groundwater data to be collected and tabulated. Progressive trends to be identified. Trigger exceedances to be highlighted.
		A brief report on the validation of groundwater modelling (once only, in the initial reporting period).
		Report on water quality results obtained during construction. Trigger values to be used and triggers and management responses to be documented. Determine the need for adjustments to the Water Quality Monitoring Program, if necessary.
		Detail and justification for any alterations to monitoring locations or frequencies.
		Document rainfall data

The operational elements of the Water Quality Plan and Monitoring Program will be submitted to the Secretary for approval six months prior to the commencement of operation of the Project, unless otherwise agreed by the Secretary. A copy of the Plan and Program shall be submitted to the DPI Water, Sydney Water and relevant councils prior to its implementation.

9. References

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Appendix A – Registered Groundwater Bores

A.1. Groundwater Users

Groundwater users within a one kilometre radius of the Project area were identified in the New M5 EIS (AECOM 2015).

Sixty-one bores registered by DPI Water within a one kilometre radius of the Project area were idenfitied. The majority of the bores are located in the Tempe, St Peters and Alexandria area (43 bores), at or in the vicinity of Kogarah Golf Course (15 bores) and along the M5 East Motorway to the west of Arncliffe (three bores).

Refer to Figure 5 for an overview of the licensed bores within one kilometre of the Project. Table 18 provides the predicted drawdown at bores within 1km of the main tunnel alignments.

Table 18: Predicted drawdown at bores within 1 km of the main tunnel alignments

Bore_ID	Depth of Bore (m)	SWL	Purpose	From (mBGL)	To (mBGL)	Geology Screened	Easting	Northing	Location relative to M5 Alignment	Predicted drawdown (m)
GW013331	14.9	7.9-14.8	Industrial	0	1.52	Sand (yellow)	332767.30	6245196.24	King Georges Rd to Alexandria - Within alignment boundary, North of Gardener's Road	0.0
GW015954	20.1	6.7-19.2	Industrial	0	0.3	Sand	332869.39	6245175.85	King Georges Rd to Alexandria - North and East of alignment boundary, North of Gardener's Road	0.0
GW023191	3.7	1.20	Water Supply - Domestic	0	3.65	Sand	329042.25	6242522.89	South of Alignment - South East of Princes Highway, North of Spring St	0.4
GW023194	4.9	3.3	Water Supply - Domestic	0	0.91	Sand	329157.21	6242813.39	South of Alignment - South East of Princes Highway, North of Spring St	6.7
GW024109	2.1	2.1	Water Supply - Domestic	0	2.13	Sand	329430.77	6243539.39	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway	2.2
GW024673	4.3	Not Available	Water Supply - Domestic	0	4.26	Loam	323239.13	6243337.24	King Georges Rd to Alexandria - North of alignment, West of Princes Highway	0.3
GW027248	4.9	2.4	Industrial	0	1.21	sand	332256.63	6244787.87	King Georges Rd to Alexandria - South of alignment, near Coward Street	0.0
GW027664	6.1	0.7	Irrigation	0	0.3	Sand	329534.65	6243419.23	King Georges Rd to Alexandria - within alignment boundary, East of Princes Highway	2.4

Bore_ID	Depth of Bore (m)	SWL	Purpose	From (mBGL)	To (mBGL)	Geology Screened	Easting	Northing	Location relative to M5 Alignment	Predicted drawdown (m)
GW040219	0	Not Available	Commercial and Industrial	-	-	Not Available	332130.36	6245129.53	King Georges Rd to Alexandria - South of Gardeners Road	0.0
GW072161	90.5	14	Other	0	16	Sandstone (grey, shale bands)	329636.13	6243432.15	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway	1.0
GW072643	12	Not Available	Unknown	0	2	Shale (grey, clay bands)	331955.90	6245581.26	King Georges Rd to Alexandria - Within alignment boundary, South East of Princes Highway, North	0.1
GW100053	7	1	Other	0	0.95	Sand (white)	332163.64	6245862.27	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway, North of	0.1
GW100209	108	42.00-43.00	Water Supply - Domestic	0	31	Sandstone (white)	329944.54	6243249.10	King Georges Rd to Alexandria - South east of alignment, East of Princes Highway	0.3
GW101533	20	4.4	Domestic	0	2	Sand	333060.41	6245356.71	King Georges Rd to Alexandria - North of alignment, North of Gardeners Road	0.0
GW103504	6.1	Not Available	Monitoring	0	0.5	Sand	333095.44	6245468.26	King Georges Rd to Alexandria - North of alignment, North of Gardeners Road	0.0
GW103505	6	Not Available	Monitoring	0	0.16	Sand	333095.64	6245457.17	King Georges Rd to Alexandria - North of alignment, North of Gardeners Road	0.0
GW103506	6	Not Available	Monitoring	0	0.17	Sand	333095.64	6245457.17	King Georges Rd to Alexandria - North of alignment, North of Gardeners Road	0.0

Bore_ID	Depth of Bore (m)	SWL	Purpose	From (mBGL)	To (mBGL)	Geology Screened	Easting	Northing	Location relative to M5 Alignment	Predicted drawdown (m)
GW103507	6	Not Available	Monitoring	0	0.16	Sand	333095.64	6245457.17	King Georges Rd to Alexandria - North of alignment, North of Gardeners Road	0.0
GW103508	6	Not Available	Monitoring	0	0.16	Sand	333095.64	6245457.17	King Georges Rd to Alexandria - North of alignment, North of Gardeners Road	0.0
GW104448	0	Not Available	Monitoring	-	-	Not Available	331717.68	6244933.63	King Georges Rd to Alexandria - South East of Princes Highway	0.0
GW104449	0	Not Available	Monitoring	-	-	Not Available	331680.31	6244955.16	King Georges Rd to Alexandria - East of Alexandra Canal, South of Ricketty Street	0.0
GW104450	0	Not Available	Monitoring	-	-	Not Available	331635.06	6244898.89	King Georges Rd to Alexandria - South East of Princes Highway	0.0
GW104988	7	Not Available	Domestic	0	7	Sand	333079.61	6244791.29	King Georges Rd to Alexandria - South East of alignment, West of Botany Road	0.0
GW106830	7	Not Available	Water Supply - Domestic	0	7	Sand	323793.20	6242382.39	King Georges Rd to Alexandria - South of alignment, West of Princes Highway	0.4
GW107993	13.6	1.95	Other-Test Bore	0	0.3	Sandstone (brown)	328239.95	6243429.15	King Georges Rd to Alexandria - North of alignment, West of Princes Highway	11.5
GW108104	Not	Not Available	Industrial	-	-	Not Available	333033.46	6245311.86	King Georges Rd to Alexandria - North of alignment, North of Gardeners Road	0.0

Bore_ID	Depth of Bore (m)	SWL	Purpose	From (mBGL)	To (mBGL)	Geology Screened	Easting	Northing	Location relative to M5 Alignment	Predicted drawdown (m)
GW108295	8	Not Available	Water Supply - Domestic	0	8	Sand	328904.61	6242464.94	Southern Alignment - South East of Princes Highway, near Coward St	0.2
GW108406	8	Not Available	Water Supply - Domestic	0	8	Sand	329506.32	6243452.00	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway	2.4
GW108439	8	Not Available	Water Supply - Domestic	0	8	Sand	328895.17	6242475.86	Southern Alignment - South East of Princes Highway, near Coward St	0.3
GW108497	8	Not Available	Recreation	-	-	Not Available	332751.80	6245550.95	King Georges Rd to Alexandria - East of Alexandra Canal, North of Orchard Road	0.0
GW108588	8	Not Available	Water Supply - Domestic	0	8	Sand	329442.01	6243428.66	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway	2.7
GW109191	186	93	Other	0	1	Sandstone (brown)	325257.73	6243186.07	King Georges Rd to Alexandria - North of alignment, West of Princes Highway	5.7
GW109821	35	14.5	Monitoring	0	2.2	Shale	331820.76	6245900.57	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway, North of	0.0
GW109822	10.45	3	Monitoring	0	2.6	Sand	331807.77	6245589.73	King Georges Rd to Alexandria - Within alignment boundary, South East of Princes Highway, North	0.2
GW109823	29	12.5	Monitoring	0	3	Sand	331817.02	6245589.90	King Georges Rd to Alexandria - Within alignment boundary, South East of Princes Highway, North	0.2

Bore_ID	Depth of Bore (m)	SWL	Purpose	From (mBGL)	To (mBGL)	Geology Screened	Easting	Northing	Location relative to M5 Alignment	Predicted drawdown (m)
GW109824	20.7	4.51	Monitoring	0	4.5	Sandstone (brown)	331390.74	6245637.80	King Georges Rd to Alexandria - Within alignment boundary, South East of Princes Highway, North	0.0
GW109825	22	14.9	Monitoring	0	4.5	Shale	331692.11	6245853.92	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway, North of	0.1
GW109963	8	Not Available	Water Supply - Domestic	0	8	Sand	329442.41	6243406.48	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway	2.7
GW109964	8	Not Available	Water Supply - Domestic	0	8	Sand	329423.72	6243417.24	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway	2.8
GW109965	8	Not Available	Water Supply - Domestic	0	8	Sand	329487.63	6243462.76	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway	2.4
GW109966	3	Not Available	Water Supply - Domestic	0	3	Clay	329376.71	6243460.76	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway	4.5
GW110456	3.6	2.3	Monitoring	0	0.3	Sand	332780.77	6246006.28	King Georges Rd to Alexandria - North of alignment, West of Princes Highway/North of Gardeners	0.0
GW110457	3.6	1.7	Monitoring	0	0.25	Sand	332818.92	6245940.40	King Georges Rd to Alexandria - North of alignment, West of Princes Highway/North of Gardeners	0.0
GW110458	2.8	2.3	Monitoring	0	0.7	Sandstone	332910.60	6245986.38	King Georges Rd to Alexandria - North of alignment, West of	0.0

Bore_ID	Depth of Bore (m)	SWL	Purpose	From (mBGL)	To (mBGL)	Geology Screened	Easting	Northing	Location relative to M5 Alignment	Predicted drawdown (m)
									Princes Highway/North of Gardeners	
GW110735	0	Not Available	Water Supply - Domestic	-	-	Not Available	328931.14	6242531.97	South East of Princes Highway, near Coward St	0.4
GW111316	162	4.000	Monitoring	0	37	Sandstone (brown)	329328.57	6242539.14	South East of Princes Highway, near Coward St	0.4
GW111320	5.2	2.52	Monitoring	0	0.18	Sand	332302.72	6245842.54	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway, North of	0.0
GW111321	5	2.64	Monitoring	0	0.18	Sand	332322.98	6245743.06	King Georges Rd to Alexandria - Within alignment boundary, East of Princes Highway, North of	0.0

Legend

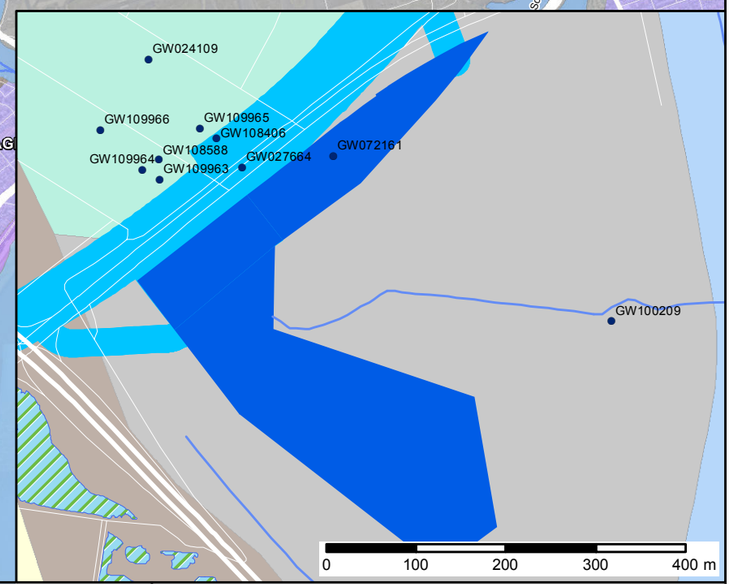
- Licensed Bores Within 1km of the Project
- Stations
- Watercourse
- Water Body
- Wetlands

Westconnex New M5 Footprint

- Above Ground Construction Footprint
- New M5 Tunnel

Soils Landscapes

- BIRRONG
- BLACKTOWN
- DISTURBED TERRAIN
- GLENORIE
- GYMEA
- HAWKESBURY
- LAMBERT
- LUCAS HEIGHTS
- NARRABEEN
- NEWPORT
- OXFORD FALLS
- TUGGERAH
- WARRIEWOOD
- WOY WOY



Rev	Description	Date	Approved
1	Draft for Comment	11/10/2016	
0	Draft for Comment	18/11/2015	■

Scale: 0 500 1,000 1,500 m

Imagery © Nearmap 2016

Client: WestConnex

Status: For Information Only - NOT FOR CONSTRUCTION

Original Size	A3	Drawn	■
Coordinate System	MGA ZONE 56	Requested by	■
Height Datum	AHD	Date Printed	11-Oct-16
Filename:	Licensed Boreholes.mxd		

WestConnex New M5

CPB CONTRACTORS | DRAGADOS | SAMSUNG C&T

aurecon | JACOBS | HASSELL | Golder Associates

WESTCONNEX New M5

Licensed Groundwater Bores Within 1km of the Project

DOCUMENT NUMBER

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Appendix B – Risk Assessment

The following details the method in which the risk assessment in Section 4 of this plan was undertaken. The risk analysis involved:

- Ranking the risk of each identified potential impact by identifying the consequences of the impact and the likelihood of each impact occurring.
- Considering the probable effectiveness of the proposed mitigation measures to determine the likely residual risk of each impact.

The likelihood of the event occurring is detailed in Table 19 and the consequence in Table 20, Table 21 provides the risk rating.

Table 19: Likelihood criteria

Probability (likelihood)	Description (1)	Description (2)	Description (3)
Almost certain (5)	Common /Frequent Occurrence	Can be expected to occur 75% – 99%	More than 1 event per month
Likely (4)	Is known to occur or “It has happened regularly”	Can quite commonly occur 50% - 75%	More than 1 event per year
Possible (3)	Could occur or “I’ve heard of it happening”	May occasionally occur 25% - 50%	1 event per 1 to 10 years
Unlikely (2)	Not likely to occur very often	May infrequently occur 10% - 25%	1 event per 10 to 100 years
Rare (1)	Conceivable but only in exceptional circumstances	May occur in exceptional circumstances 0% - 10%	Less than 1 event per 100 years

Table 20: Consequence criteria relevant to environment and heritage

Consequence (impact)	Description
Negligible (1)	Short term ecological damage
Minor (2)	Limited but medium term ecological damage
Moderate (3)	Major but recoverable ecological damage
Major (4)	Heavy ecological damage, costly restoration
Substantial (5)	Permanent widespread ecological damage

Table 21: Risk rating

		Consequence				
		Negligible (1)	Minor (2)	Moderate (3)	Major (4)	Substantial (5)
Likelihood	Almost certain (5)	Low (5)	Moderate (10)	Very High (18)	Extreme (23)	Extreme (25)
	Likely (4)	Low (4)	Moderate (9)	Very High (17)	Very High (20)	Extreme (24)
	Possible (3)	Low (3)	Moderate (8)	High (13)	Very High (19)	Very High (22)
	Unlikely (2)	Low (2)	Low (7)	High (12)	High (15)	Very High (21)
	Rare (1)	Low (1)	Low (6)	Moderate (11)	High (14)	High (16)

Appendix C – Surface Water Sampling Methodology

Grab samples will be collected manually from the sampling locations identified in Table 11 of the Water Quality Plan and Monitoring Program. The volume of sample collected will be of sufficient volume for the required analyses, including any repeat analyses and will be collected into sampling battles and jars provided by the NATA accredited testing laboratory.

C.1 Sample Labeling

All samples will be clearly labeled with unique sampling identification nomenclature consisting of the sample date, location and sampler initials. All samples will be kept cool prior to dispatch to the NATA registered laboratory under chain of custody procedures.

C.2 Decontamination

Generally, sampling equipment will not require specific cleaning from rinsing the equipment well on return to the lab at the end of each sampling trip. The Field Sampling Guidelines (Department of Water, Western Australia 2009) suggest that where a sample site is particularly dirty (i.e. there is an algal bloom, or the site smells strongly of hydrocarbons, sewage or something else) equipment will need to be cleaned thoroughly. In addition, equipment will need to be cleaned periodically to prevent a build-up of dirt. To do this:

- Rinse the equipment well in tap water;
- Clean with De-Con 90 (a phosphate free detergent), or equivalent;
- Rinse well with tap water;
- Rinse three times with de-ionised water, and finally;
- Allow to dry.

De-ionised and tap water will be available for washing equipment in the field, in case a particularly dirty site is encountered during a sampling event.

C.3 In Situ Measurements

Field water quality parameters including temperature, electric conductivity (EC), pH, dissolved oxygen (DO) and redox potential (redox) will be measured at each sampling location with a multi-probe field water quality meter. Other observations including odour and colour will also be recorded.

The multi-probe field water quality meter will be calibrated against known standards, as supplied by the manufacturer, at the start and completion of each day of water quality sampling. Calibration records will be maintained in accordance with the appropriate standard.

C.4 Laboratory Analytical Program

A NATA accredited laboratory will be used for analyses of all grab samples. (the ALS laboratory in Smithfield, NSW has been nominated as the primary reporting laboratory for baseline samples).

C.5 General

Quality Assurance / Quality Control (QA/QC) samples are collected to ensure the quality of the investigation procedures and sampling program. QA/QC samples provide analytical information that may be used to investigate anomalous results.

QA/QC sampling will be undertaken in accordance with AS 5667.1:1998. Only NATA registered laboratories will be used to undertake analysis.

C.6 Replicate Samples

Replication is the collection and analysis of separate samples from the same sample site at the same time. This provides the experimental sampling error and thus a measure of the sampling precision.

Replicate samples will be collected at random at a rate of approximately 1 in 10 total samples collected.

C.7 Internal Laboratory Procedures

The Project laboratory (ALS Pty Ltd is currently used for baseline investigation) will undertake their normal internal QA/QC testing in accordance with their NATA registration and industry standards. ALS will provide evidence of the following QA/QC procedures:

- Sample receipt and registration documentation
- Instrument blank analyses
- Surrogate spike and matrix spike analyses
- Laboratory duplicates

Appendix D – Groundwater Sampling Methodology

D.1 Overview

The methodology for monitoring groundwater includes:

- Assessment of groundwater elevation (measurement prior to purging, if purging required by sampling method);
- Sampling of groundwater (sampling after purging, if sampling method requires purging) by qualified personnel; and
- Implementation of quality control plan including chain-of-custody for laboratory sampling and maintaining appropriate documentation.

D.2 Elevation Assessment and Purging

Groundwater monitoring is to be overseen by personnel with appropriate qualifications and experience, with field sampling undertaken by trained personnel using appropriate personal protective equipment (PPE) (note that gloves are to be changed for each sampling site to prevent cross-contamination).

The static groundwater elevation within each groundwater monitoring well will be measured prior to purging (if required) or sampling. The water level will be measured using a groundwater level dip metre from the Top of Casing (TOC) to the nearest millimetre.

Bottom of Casing (BOC) will be measured to the nearest millimetre as well by lowering the meter to the base of the well until it touches the bottom. These levels will be recorded.

Following measurements of water level, the monitoring well will be purged using a low flow pump prior to sampling to remove stagnant water within the well casing and ensure a representative sample can be collected. If use of Hydrosleeve sampling method is adopted purging will not be required.

Field water quality parameters will be measured using calibrated equipment including temperature, dissolved oxygen, pH, oxidation and reduction potential and electrical conductivity) during purging (if applicable).

The groundwater monitoring well will be considered to be purged when one of the following criteria is achieved (whichever occurs first):

- Three well volumes of water have been purged; or
- The well is purged until no more water can be removed (considered dry); or
- The water quality parameters are stabilised within 10% over three consecutive recorded measurements.

In the event that any water level logger is removed from the bore, it will be checked and maintained as necessary before being re-calibrated and then returned to the monitoring bore and at the known distance from the measuring point, but so as to not sit on the bottom of the bore.

D.3 Sample Collection

At the completion of purging (if relevant), groundwater samples will be collected into dedicated laboratory-supplied sampling bottles with sufficient volume to satisfy the requirements for all analytes.

The samples will be placed into a chilled ice-chest for transport to the nominated laboratory(s). Where required for some laboratory containers (metal analysis), the water sample will also be field filtered using a dedicated 0.45 µm water filter to remove fine suspended particles.

Cross-contamination of samples will be prevented through either dedicated tubing at the pump, dedicated Hydrosleeve sampling devices or by decontamination with phosphate-free detergent and clean water between sampling locations.

D.4 Quality Assurance and Documentation

As part of sampling, quality assurance and control samples during sampling will be undertaken to ensure the integrity of the dataset. These are to include:

- Rinsate blanks (one per sampling event only);
- Blind duplicates (at a rate not less than 20% of total samples); and
- Split duplicates (at a rate not less than 20% of total samples).

All containers are to be clearly labelled with the location, date/time, method, name and duplicate details, with the same documented on dedicated field sheets.

Samples are to be transported to a laboratory under documented chain-of-custody protocols.

Appendix E – Construction Water Treatment Plant Technical Details

Five construction water treatment plants have been initially designed for this project. The operational water treatment plant is still in concept design and details are not provided in this plan. The design of the five construction water treatment plants shall be based on the feed flow rates outlined below. The design (and flow process) will include:

- Hydrocyclone and grit separation in pre-treatment,
- Chemical dosing,
- Clarification,
- pH correction, and
- Media filtration.

For the solid waste products, sludge dewatering will be employed.

The flow rates provided below are peak flows (maximum instantaneous rates). The detailed design process for these plants is continuing at the time of writing this plan. Typical general arrangement drawings are provided as part of this appendix. This plant layout is typical or each of the 5 water treatment plants, but is subject to alteration during detailed design.

- Kingsgrove North Water Treatment Plant (12L/s)
- Commercial Road Water Treatment Plant (12L/s)
- Bexley Water Treatment Plant (25L/s)
- Arncliffe Water Treatment Plant (36L/s)
- Canal Road Water Treatment Plant (25L/s)

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Appendix F – Baseline Surface Water Monitoring Report

Surface Water Quality Baseline Monitoring Report

Project Name: WestConnex New M5

Project number:	15.7020.2597
Document number:	M5N-ES-RPT-PWD-0005
Revision date:	20/07/2016
Revision:	01

Document Approval

Rev.	Date	Prepared by	Reviewed by	Recommended by	Approved by	Remarks
00	08/06/16	CDS-JV				
01	20/07/16	CDS-JV				
Signature:						

Purpose of Report

A Water Quality Plan and Monitoring Program has been prepared to address condition B28 of Infrastructure Approval SS6788. This Surface Water Quality Baseline Monitoring Report specifically addresses condition B28(h) which requires details on the current water quality, including at least 12 months of representative background monitoring data (including but not limited to representative data collected by the relevant councils, agencies and organisations where readily available) for surface water to establish baseline water conditions prior to the commencement of construction. A separate baseline report will be prepared for groundwater quality, levels and potentiometric pressures (in confined aquifers). Baseline groundwater monitoring will continue, and a baseline report will be submitted prior to construction works that have potential to impact or disturb groundwater.

Contents

1. Introduction

Baseline surface water quality monitoring has been undertaken along Wolli Creek, the Cooks River and Alexandra Canal since June 2015. Samples have been collected from locations described in the New M5 EIS Surface Water Technical Paper (Appendix N of the EIS). The parameters that have been assessed are listed in Appendix B (Water Quality Monitoring Program) of the above mentioned technical paper.

A Water Quality Plan and Monitoring Program (WQPMP: M5N-ES-PLN-PWD-0027) has been prepared and includes detail on previous water quality. This Baseline Monitoring Report has been prepared in accordance with the WQPMP with the specific objective of establishing baseline water quality conditions prior to the commencement of construction. This is achieved (in accordance with the WQPMP) by:

- Tabulating baseline surface water quality data;
- Identifying means and trends;
- Confirming site specific water quality criteria and targets

Section 2 of this document contains the tabulated data and summaries identifying means and trends, to establish the existing surface water quality conditions. Section 3 contains an assessment of the water quality criteria and targets and confirmation of appropriate targets.

2. Baseline Surface Water Quality Data

Surface water quality was sampled at locations in Wolli Creek, Alexandra Canal and the Cooks River (refer to Figure 2 of the Water Quality Plan and Monitoring Program). Sampling was also undertaken at the eastern stormwater channel at Sydenham, and in an unnamed channel near Muddy creek. During construction, water quality monitoring will also be undertaken at the Green and Golden Bell Frog habitat (the RTA ponds).

Data collected over the 12 month period from June 2015 to May 2016 is presented in Tables 1-4 for each discrete area and presented with trigger values from the Water Quality Reference Criteria from Appendix A of the Surface Water Technical Paper from the New M5 EIS. Where mean values over the 12 month period exceed the trigger values, these are highlighted. Summaries are provided for each discrete area, identifying significant trends.

2.1. Wolli Creek

Sampling was conducted from the four nominated sites along Wolli Creek (Table 1). Whilst exceedances of the established trigger values were recorded for many parameters on several occasions, the mean values for each parameter over the 12 month period were generally within the established trigger values. Notable exceptions include:

- Total suspended solids was consistently higher at the sampling location furthest upstream (SW08) and had a mean value of 27.8 (max 49) mg/l, which is above the established trigger value of 22.0.
- Turbidity was also elevated at the site furthest upstream (mean of 40.2NTU, trigger of 29.0NTU).
- Elevated levels of copper were detected and the mean values at each of the Wolli Creek sample locations were above the trigger value (refer to Table 1).
- Zinc was detected above the trigger value at each site, with the mean concentration of zinc for two of the four sites above the trigger value.
- Total nitrogen was detected above the trigger value at each location (more than 5 times the established trigger value). However, no exceedances for total nitrogen were recorded at the Bexley Road location.
- The pH at each of the sampling locations was elevated with a range from 6.22-10.58, with the mean for each site above the upper trigger limit of 7.7.

2.2. Sheas Creek/Alexandra canal

Sampling locations in the St Peters area include Sheas Creek, near the Huntley Road bridge, which is a concrete lined channel upstream of the Alexandra Canal, and a sampling location downstream of works which is in the tidally influenced Alexandra Canal (Table 2). Trigger values from the Water Quality Reference Criteria in the EIS were based on limited sampling for these areas.

Of the trigger values available, the trigger value for zinc was exceeded by a mean value of 0.044mg/l over the 12 month period (the trigger was 0.031mg/l). Whilst trigger values were not available, nutrient concentrations were comparatively elevated in Sheas Creek including levels for ammonia, nitrite, nitrate, nitrogen and phosphorous. Total nitrogen was also elevated within Alexandra Canal, and conductivity was above the trigger value (25.906ms/cm with trigger of 21.410ms/cm).

2.3. Cooks River

Water quality within the Cooks River was measured at three sites within the general vicinity of Tempe and Arncliffe (Table 3). Suspended solids were highest at the site furthest downstream. Total suspended solids ranged from near 0 to 437mg/l, with a mean value of 55mg/l at the sampling location downstream of the future Arncliffe site (no trigger was presented for this parameter in the Water Quality Reference Criteria). This trend was not observed for turbidity.

Large variation of detected levels and concentrations for a number of parameters were observed, particularly for nutrients and metals, with trigger levels exceeded on several occasions. However the mean values over the baseline period generally stayed within the trigger values. Total nitrogen peaked

at levels above the trigger value at each sampling location (max of 4.7mg/l, trigger of 1.04mg/l), and similar variations were identified with nitrite and nitrate.

2.4. Additional monitoring

Monitoring was undertaken at the Eastern Stormwater Drain at Sydenham, adjacent to Sydenham Road and Sydenham Station, and at Muddy Creek in Banksia (Table 4).

The Sydenham site is located near the western extent of the road widening works that will be associated with the St Peters Interchange. The waterway is highly variable in flow, but is predominantly stormwater from the adjacent industrial and commercial areas, without tidal influence. The list of chemical toxicants are the only applicable trigger values for this location from the EIS. High levels of copper (0.012mg/l mean, 0.0025 trigger value), lead (0.016mg/l mean, 0.009 trigger value) and zinc (0.031 mg/l, 0.044 trigger value) were recorded on several occasions. Nutrient levels were high, including levels of total nitrogen up to 12.4mg/l. Comparatively elevated levels for nitrite, nitrate and phosphorous were also detected. pH was measured between 7.3 and 8.6 which is also elevated for an urban catchment.

The unnamed tributary to Muddy Creek in Banksia was monitored during the baseline period near the intersection with West Botany Street. This is a concrete lined channel that is within the tidal reach of Muddy Creek. Nutrient levels including nitrate, nitrogen and phosphorous were all elevated in this waterway, as was pH (7.5 and 9.0).

Table 1. Wolli Creek baseline water quality data. Where the mean value over the 12 month period exceeds the established trigger, the value is in bold.

Wolli Creek Sampling Locations		SW08			SW09			SW10			SW11		
Upstream freshwater trigger from Water Quality Reference Criteria (New M5 EIS)		Upstream of Kingsgrove compounds			Between Kingsgrove and Bexley compounds			Immediately downstream of Bexley compounds			Downstream of Bardwell Creek		
Parameter	**Trigger***	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Suspended Solids (TSS: mg/l)	22.0	**27.8**	0.0	49.0	13.0	6.0	24.0	4.8	0.0	10.0	7.2	0.0	13.0
Arsenic (mg/l)	0.360	0.001	0.000	0.004	0.001	0.000	0.002	0.001	0.000	0.002	0.000	0.000	0.002
Cadmium (mg/l)	0.0008	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0002
Chromium (mg/l)	0.040	0.000	0.000	0.002	0.000	0.000	0.002	0.000	0.000	0.002	0.000	0.000	0.001
Copper (mg/l)	0.0025	**0.006**	0.000	0.012	**0.011**	0.005	0.018	**0.006**	0.000	0.017	**0.004**	0.000	0.012
Lead (mg/l)	0.0094	0.003	0.000	0.015	0.002	0.000	0.013	0.002	0.000	0.014	0.002	0.000	0.005
Manganese (mg/l)	3.600	0.080	0.009	0.273	0.009	0.001	0.030	0.039	0.000	0.264	0.043	0.004	0.087
Nickel (mg/l)	0.017	0.002	0.000	0.004	0.001	0.000	0.002	0.002	0.000	0.004	0.001	0.000	0.003
Zinc (mg/l)	0.031	0.026	0.000	0.093	**0.037**	0.009	0.082	0.029	0.000	0.105	**0.033**	0.000	0.065
Iron (mg/l)	-	0.48	0.00	2.62	0.39	0.00	1.88	0.45	0.00	2.01	0.72	0.00	1.90
Mercury (mg/l)	0.0054	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0001	0.0000	0.0010	0.0000	0.0000	0.0001
Ferrous Iron (mg/l)	-	0.19	0.00	0.83	0.08	0.00	0.22	0.29	0.09	0.69	0.25	0.08	0.77
Ammonia (mg/l)	2.300	No data			0.083	0.037	0.128	0.017	0.000	0.052	No data		
Nitrite as N (mg/l)	-	0.019	0.000	0.060	0.021	0.000	0.060	0.021	0.000	0.156	0.048	0.010	0.214
Nitrate as N (mg/l)	17.000	0.505	0.000	0.920	0.624	0.000	1.750	0.273	0.000	0.770	0.455	0.180	1.070
Total Kjeldahl Nitrogen as N (mg/l)	-	0.65	0.00	1.60	1.27	0.04	9.50	0.76	0.09	1.72	1.12	0.43	2.80
Total Nitrogen as N (mg/l)	1.90	1.18	0.00	2.30	**1.93**	0.60	10.00	1.11	0.68	1.80	1.68	0.94	3.90
Total Phosphorus as P (mg/l)	0.120	0.098	0.000	0.330	0.117	0.020	0.650	0.080	0.020	0.250	0.085	0.012	0.250
Reactive Phosphorus as P (mg/l)	-	0.037	0.000	0.160	0.062	0.000	0.400	0.000	0.000	0.000	0.017	0.000	0.050
C6 - C10 Fraction (µg/l)	-	0	0	0	29	0	190	0	0	0	0	0	0
>C10 - C16 Fraction (µg/l)	-	0	0	0	2362	0	30300	0	0	0	29	0	440
>C16 - C34 Fraction (µg/l)	-	0	0	0	1917	0	21800	15	0	190	52	0	780
>C34 - C40 Fraction (µg/l)	-	0	0	0	115	0	1500	0	0	0	0	0	0
Benzene (µg/l)	-	0	0	0	0	0	0	0	0	0	0	0	0
Toluene (µg/l)	-	0	0	0	0	0	0	1	0	10	0	0	0
Ethylbenzene (µg/l)	-	0	0	0	0	0	0	0	0	0	0	0	0
Total Xylenes (µg/l)	-	0	0	0	1	0	14	0	0	0	0	0	0
Naphthalene (µg/l)	-	0	0	0	0	0	5	0	0	0	0	0	0
pH	6.5 - 7.7	**8.41**	6.22	9.59	**9.31**	8.89	10.58	**8.24**	6.55	9.63	**7.78**	7.14	8.93
ORP	-	82.6	0.1	163.9	48.9	0.1	165.8	39.8	0.1	188.5	53.2	0.1	209.4
Dissolved Oxygen (% Sat)	60.	97.3	69.0	123.9	125.9	103.2	166.5	110.5	87.3	140.1	**47.4**	19.5	67.3
Temperature (°C)	12.1 - 23.2	22.2	18.7	25.0	**25.7**	19.3	32.3	**24.5**	19.3	27.3	22.7	17.0	26.0
Conductivity (µS/cm)	310-1660	1503.8	3.0	4028.0	1152.0	201.0	1516.0	1269.1	1095.0	1684.0	774.1	305.6	1671.0
Turbidity (NTU)	29.0	**40.2**	0.0	161.0	10.1	0.0	43.7	7.9	0.0	19.8	6.6	0.0	12.3

* Trigger values sourced from the Water Quality Reference Criteria (New M5 EIS). Blank cells indicate that no trigger value was provided for the parameter.

Table 2. Sheas Creek/Alexandra Canal baseline water quality data. Where the mean value over the 12 month period exceeds the established trigger, the value is in bold.

Sheas Creek and Alexandra Canal Sampling Locations	SW01 Sheas Creek (near Huntley Road). Upstream of project area (freshwater)				SW02 Alexandra Canal (near Coward Street) Downstream of project area (estuarine)			
Parameter	**Trigger***	**Mean**	**Min**	**Max**	**Trigger***	**Mean**	**Min**	**Max**
Suspended Solids (TSS: mg/l)	-	33.9	0.0	186.0	-	10.8	6.0	21.0
Arsenic (mg/l)	0.360	0.001	0.000	0.002	-	0.001	0.000	0.003
Cadmium (mg/l)	0.0008	0.0000	0.0000	0.0004	0.0360	0.0000	0.0000	0.0000
Chromium (mg/l)	0.040	0.000	0.000	0.002	0.085	0.000	0.000	0.001
Copper (mg/l)	0.0025	0.008	0.000	0.022	0.008	0.005	0.000	0.054
Lead (mg/l)	0.009	0.003	0.000	0.022	0.012	0.003	0.000	0.030
Manganese (mg/l)	3.600	0.016	0.000	0.051	-	0.028	0.000	0.059
Nickel (mg/l)	0.017	0.001	0.000	0.002	0.560	0.000	0.000	0.002
Zinc (mg/l)	0.031	**0.044**	0.000	0.152	0.043	0.025	0.000	0.097
Iron (mg/l)	-	0.25	0.00	1.05	-	0.21	0.00	1.38
Mercury (mg/l)	0.0054	0.0000	0.0000	0.0000	0.0014	0.0000	0.0000	0.0002
Ferrous Iron (mg/l)	-	0.05	0.00	0.46	-	0.04	0.00	0.26
Ammonia (mg/l)	2.300	0.170	0.102	0.288	1.7	No data		
Nitrite as N (mg/l)	-	0.161	0.020	0.408	-	0.016	0.000	0.030
Nitrate as N (mg/l)	17	2.094	0.400	2.870	-	0.623	0.004	4.690
Total Kjeldahl Nitrogen as N (mg/l)	-	1.08	0.31	1.90	-	0.80	0.00	2.40
Total Nitrogen as N (mg/l)	-	3.16	1.10	4.90	1.38	**1.43**	0.00	5.40
Total Phosphorus as P (mg/l)	-	0.102	0.040	0.260	0.14	0.073	0.007	0.210
Reactive Phosphorus as P (mg/l)	-	0.050	0.010	0.110	-	0.009	0.000	0.030
C6 - C10 Fraction (µg/l)	-	0	0	0	-	0	0	0
>C10 - C16 Fraction (µg/l)	-	7	0	110	-	0	0	0
>C16 - C34 Fraction (µg/l)	-	0	0	0	-	0	0	0
>C34 - C40 Fraction (µg/l)	-	0	0	0	-	0	0	0
Benzene (µg/l)	-	0	0	0	-	0	0	0
Toluene (µg/l)	-	0	0	0	-	0	0	0
Ethylbenzene (µg/l)	-	0	0	0	-	0	0	0
Total Xylenes (µg/l)	-	0	0	0	-	0	0	0
Naphthalene (µg/l)	-	0	0	0	0	0	0	0
pH	-	8.30	7.84	9.09	7.3-7.9	7.61	7.38	8.04
ORP	-	60.7	0.1	201.8	-	80.1	0.1	259.7
Dissolved Oxygen (% Sat)	-	102.7	82.3	150.2	39	87.4	36.7	110.2
Temperature (°C)	-	22.7	19.3	25.9	14.3-23.0	**23.9**	20.0	26.6
Conductivity (µS/cm)	-	381.9	5.0	717.0	490-2140	**25906.0**	30.0	39266.0
Turbidity (NTU)	-	10.2	0.0	34.0	10.0	6.0	0.0	11.8

* Trigger values sourced from the Water Quality Reference Criteria (New M5 EIS). Blank cells indicate that no trigger value was provided for the parameter.

Table 3. Cooks River baseline water quality data. Where the mean value over the 12 month period exceeds the established trigger, the value is in bold.

Cooks River Sampling Locations		SW05			SW06			SW07		
Cooks River Lower Catchment estuarine triggers from Water Quality Reference Criteria (New M5 EIS)		Tempe - Upstream of Wolli Creek and Project Area			Near the Giovanni Brunetti Bridge, adjacent to Alexandra Canal and near the Arncliffe compound			Upstream of Muddy Creek, downstream of all sites		
Parameter	**Trigger***	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Suspended Solids (TSS: mg/l)	-	2.7	0.0	14.0	1.2	0.0	7.0	55.0	5.0	437.0
Arsenic (mg/l)	-	0.001	0.000	0.013	0.002	0.000	0.028	0.008	0.001	0.010
Cadmium (mg/l)	0.036	0.000	0.000	0.000	0.000	0.000	0.006	0.001	0.000	0.001
Chromium (mg/l)	0.085	0.000	0.000	0.002	0.002	0.000	0.022	0.000	0.000	0.000
Copper (mg/l)	0.008	0.001	0.000	0.015	0.007	0.000	0.107	0.001	0.000	0.007
Lead (mg/l)	0.012	0.001	0.000	0.015	0.003	0.000	0.036	0.000	0.000	0.003
Manganese (mg/l)	-	0.012	0.000	0.044	0.012	0.000	0.049	0.009	0.000	0.049
Nickel (mg/l)	0.560	0.000	0.000	0.001	0.001	0.000	0.016	0.000	0.000	0.000
Zinc (mg/l)	0.043	0.004	0.000	0.062	0.010	0.000	0.120	0.005	0.000	0.030
Iron (mg/l)	-	0.08	0.00	0.56	0.14	0.00	0.74	0.06	0.00	0.24
Mercury (mg/l)	0.0014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
Ferrous Iron (mg/l)	-	0.02	0.00	0.11	0.04	0.00	0.24	0.02	0.00	0.26
Ammonia (mg/l)	1.700	0.034	0.000	0.158	0.041	0.000	0.190	0.032	0.000	0.063
Nitrite as N (mg/l)	-	0.005	0.000	0.020	0.003	0.000	0.014	0.086	0.008	0.196
Nitrate as N (mg/l)	-	0.238	0.015	1.780	0.386	0.005	4.430	0.082	0.008	0.167
Total Kjeldahl Nitrogen as N (mg/l)	-	0.41	0.04	0.90	0.45	0.05	1.20	0.35	0.10	1.00
Total Nitrogen as N (mg/l)	1.04	0.65	0.00	2.40	0.82	0.00	4.70	0.49	0.19	1.10
Total Phosphorus as P (mg/l)	0.2	0.052	0.000	0.100	0.049	0.000	0.090	0.058	0.000	0.140
Reactive Phosphorus as P (mg/l)	-	0.023	0.000	0.060	0.018	0.000	0.041	0.021	0.000	0.038
C6 - C10 Fraction (µg/l)	-	0	0	0	0	0	0	0	0	0
>C10 - C16 Fraction (µg/l)	-	0	0	0	0	0	0	0	0	0
>C16 - C34 Fraction (µg/l)	-	0	0	0	0	0	0	0	0	0
>C34 - C40 Fraction (µg/l)	-	0	0	0	0	0	0	0	0	0
Benzene (µg/l)	-	0	0	0	0	0	0	0	0	0
Toluene (µg/l)	-	0	0	0	0	0	0	0	0	0
Ethylbenzene (µg/l)	-	0	0	0	0	0	0	0	0	0
Total Xylenes (µg/l)	-	0	0	0	0	0	0	0	0	0
Naphthalene (µg/l)	-	0	0	0	0	0	0	0	0	0
pH	7.0-8.5	7.65	7.14	7.99	7.81	7.70	7.94	7.80	7.43	8.04
ORP	-	75.0	0.1	280.0	42.6	0.1	230.2	51.6	0.1	228.2
Dissolved Oxygen (% Sat)	39.8	84.4	68.0	95.3	89.5	71.4	118.5	91.7	74.7	119.3
Temperature (°C)	15-23	**23.5**	20.9	25.3	**23.8**	20.7	25.8	**23.7**	21.2	25.9
Conductivity (µS/cm)	17540-54200	32192.5	23163.0	48713.0	29194.3	23576.0	44503.0	32474.0	23461.0	49028.0

Cooks River Sampling Locations	SW05				SW06			SW07		
Turbidity (NTU)	15.0	4.9	0.0	11.8	6.1	0.0	10.0	2.7	0.0	4.8

* Trigger values sourced from the Water Quality Reference Criteria (New M5 EIS). Blank cells indicate that no trigger value was provided for the parameter.

Table 4. Additional baseline water quality data. Where the mean value over the 12 month period exceeds the established trigger, the value is in bold.

Additional water monitoring will also occur at the RTA ponds (GGBF habitat) during construction	SW03 Eastern stormwater drain, Sydenham, adjacent to road widening project area (freshwater catchment)				SW04 Unnamed tributary to Muddy Creek (estuarine).			
Parameter	**Trigger***	**Mean**	**Min**	**Max**	**Trigger***	**Mean**	**Min**	**Max**
Suspended Solids (TSS: mg/l)	-	17.9	0.0	68.0	-	9.6	0.0	30.0
Arsenic (mg/l)	0.140	0.004	0.000	0.011	-	0.001	0.000	0.003
Cadmium (mg/l)	0.0008	0.0000	0.0000	0.0001	0.0360	0.0000	0.0000	0.0002
Chromium (mg/l)	0.040	0.001	0.000	0.004	0.085	0.000	0.000	0.000
Copper (mg/l)	0.0025	**0.012**	0.003	0.039	0.008	0.001	0.000	0.005
Lead (mg/l)	0.009	**0.016**	0.000	0.163	0.012	0.000	0.000	0.002
Manganese (mg/l)	3.600	0.036	0.000	0.069	-	0.017	0.000	0.050
Nickel (mg/l)	0.017	0.003	0.001	0.004	0.560	0.000	0.000	0.000
Zinc (mg/l)	0.031	**0.044**	0.006	0.267	0.043	0.008	0.000	0.040
Iron (mg/l)	-	0.75	0.00	4.11	-	0.02	0.00	0.13
Mercury (mg/l)	0.0054	0.0000	0.0000	0.0001	0.0014	0.0000	0.0000	0.0000
Ferrous Iron (mg/l)	-	0.12	0.00	0.45	-	0.08	0.00	0.25
Ammonia (mg/l)	2.300	0.049	0.000	0.103	1.700	0.325	0.192	0.470
Nitrite as N (mg/l)	-	0.181	0.000	0.900	-	0.025	0.000	0.043
Nitrate as N (mg/l)	17	0.738	0.000	1.530	-	1.815	0.060	5.610
Total Kjeldahl Nitrogen as N (mg/l)	-	2.52	0.04	10.00	-	1.31	0.00	2.90
Total Nitrogen as N (mg/l)	-	3.39	0.41	12.40	-	3.14	0.91	7.00
Total Phosphorus as P (mg/l)	-	0.089	0.024	0.300	-	0.087	0.039	0.151
Reactive Phosphorus as P (mg/l)	-	0.024	0.000	0.110	-	0.039	0.000	0.110
C6 - C10 Fraction (µg/l)	-	0	0	0	-	0	0	0
>C10 - C16 Fraction (µg/l)	-	0	0	0	-	0	0	0
>C16 - C34 Fraction (µg/l)	-	0	0	0	-	0	0	0
>C34 - C40 Fraction (µg/l)	-	0	0	0	-	0	0	0
Benzene (µg/l)	-	0	0	0	-	0	0	0
Toluene (µg/l)	-	0	0	0	-	0	0	0
Ethylbenzene (µg/l)	-	0	0	0	-	0	0	0
Total Xylenes (µg/l)	-	0	0	0	-	0	0	0
Naphthalene (µg/l)	-	0	0	0	-	0	0	0
pH	-	8.06	7.34	8.61	-	8.00	7.53	9.02
ORP	-	52.8	0.1	181.7	-	63.4	0.1	183.4
Dissolved Oxygen (% Sat)	-	95.6	59.3	127.3	-	102.6	78.1	129.0
Temperature (°C)	-	24.5	18.3	31.1	-	24.0	17.5	28.6
Conductivity (µS/cm)	-	852.5	79.0	1182.0	-	18949.9	177.0	43788.0
Turbidity (NTU)	-	7.5	2.2	13.7	-	6.7	0.0	18.4

* Trigger values sourced from the Water Quality Reference Criteria (New M5 EIS). Blank cells indicate that no trigger value was provided for the parameter.
NB. SW03 is a concrete lined stormwater drain. SW04 is a concrete lined stormwater drain that is tidally influenced by Muddy Creek.

3. Confirmation of water quality criteria and targets

Water Quality Reference Criteria within Appendix A of the Surface Water Technical Paper (New M5 EIS) were used to assess the data collected for the baseline monitoring program (Section 2). The criteria listed in the Technical Paper, for both the lower catchment of the Cooks River and the upper catchment of Wolli Creek, were based on long term monitoring programs and were confirmed broadly as suitable trigger values for these areas (in Section 2). The trigger values adopted in the Technical Paper for Alexandra Canal were based on limited data and the baseline monitoring program revealed some adaption is required for this catchment. Trigger values for Sheas Creek, Eastern Stormwater Drain (Sydenham) and the tributary to Muddy Creek (Banksia) were incomplete.

Due to the applicability of the trigger values established for Wolli Creek (freshwater) and the Cooks River (estuarine) areas, it is proposed to use these values more broadly. An assessment was completed that confirmed that the Wolli Creek triggers (with minor amendments) were suitable for application as project specific freshwater criteria (Table 6). These will be applied during construction to all freshwater sampling sites including Wolli Creek, Sheas Creek and Eastern Stormwater Drain. Triggers for total suspended solids (50mg/l) and pH (6.5-8.5) were adapted to be consistent with conditions associated with the Project's Environmental Protection Licences (EPLs). Modifications to the existing Wolli Creek criteria are proposed for copper, zinc, and total nitrogen due to consistent exceedances of these values during the baseline period at freshwater sampling sites. Suggested amendments to trigger values are provided in bold text in Table 6, and are based on the 80% percentile of samples collected during the period June 2015 to May 2016. A trigger value for ferrous iron of 0.3mg/l has been adopted from the Australian Drinking Water Guidelines (published by the National Health and Medical Research Council in 2011). Rolling means will be used during construction to further assess this parameter. Measured levels of conductivity, turbidity and dissolved oxygen also exceeded the criteria frequently during the baseline monitoring period; however the triggers adopted from the EIS will remain as the 80% value calculated from the data set was similar to the existing trigger.

An assessment of the Cooks River criteria for application as project specific estuarine triggers confirmed the suitability to apply these (with minor amendments in bold text in Table 7) to the Cooks River, Alexandra Canal, and tributary to Muddy Creek. Triggers for total suspended solids (50mg/l) and pH (6.5-8.5) were adopted to be consistent with conditions associated with the Project's (EPLs). A trigger value for ferrous iron of 0.3mg/l has been adopted from the Australian Drinking Water Guidelines (published by the National Health and Medical Research Council in 2011). Rolling means will be used to further assess this parameter during construction. Modification to the existing Cooks River criteria are proposed only for Total Nitrogen, which will be based on the 80% percentile of samples collected during the period June 2015 to May 2016 from estuarine sampling locations. New criteria are suggested for arsenic, manganese and total phospohorous, where triggers were not previously available. These are also based on the 80% percentile of samples collected during from estuarine sampling locations.

A number of additional parameters assessed during the baseline program do not have corresponding trigger values (Table 5). It is not appropriate to list trigger values for these as the majority of samples collected were below the limits of detection available from the laboratory, with some spikes in individual samples providing outliers and affecting reliability of data. No triggers are proposed for these parameters. Instead, rolling means will be used to assess results and assess any emerging trends for sites and locations.

Table 5: List of parameters where rolling means will be used in the absence of trigger values.

Parameters to be assessed against rolling means	
Reactive Phosphorus as P	Toluene
C6 - C10 Fraction	Ethylbenzene
>C10 - C16 Fraction	Total Xylenes
>C16 - C34 Fraction	Naphthalene
>C34 - C40 Fraction	Oxidation-reduction potential (ORP)
Benzene	

Table 6. Confirmation of water quality criteria and targets for freshwater sampling locations.

	Freshwater mean, criteria and targets						
Parameter	**Trigger**	**Mean**	**Min**	**Max**	**N**	**% trigger exceeded**	**Adopted trigger**
Suspended Solids (TSS: mg/l)	-	19.2	0.0	186.0	38	-	**50**
Arsenic (mg/l)	0.360	0.001	0.000	0.011	85	0	0.360
Cadmium (mg/l)	0.0008	0.0000	0.0000	0.0004	85	0	0.0008
Chromium (mg/l)	0.040	0.000	0.000	0.004	85	0	0.040
Copper (mg/l)	0.0025	0.008	0.000	0.039	85	88	**0.012**
Lead (mg/l)	0.0094	0.005	0.000	0.163	85	13	0.0094
Manganese (mg/l)	3.600	0.036	0.000	0.273	85	0	3.600
Nickel (mg/l)	0.017	0.001	0.000	0.004	85	0	0.017
Zinc (mg/l)	0.031	**0.037**	0.000	0.267	85	40	**0.059**
Mercury (mg/l)	0.0054	0.0000	0.0000	0.0010	85	0	0.0054
Ferrous Iron (mg/l)	-	0.17	0.00	0.83	83	-	**0.3**
Ammonia (mg/l)	2.3	0.081	0.000	0.288	14	0	2.3
Nitrate as N (mg/l)	17	0.820	0.000	2.870	82	0	17
Total Nitrogen as N (mg/l)	1.90	**2.12**	0.00	12.40	85	31	**2.89**
Total Phosphorus as P (mg/l)	0.12	0.095	0.000	0.650	85	21	0.12
pH	6.5 – 7.7	**8.31**	6.22	10.58	46	78	**6.5 – 8.5**
Dissolved Oxygen (% Sat)	60	95.1	19.5	166.5	46	15	60
Conductivity (µS/cm)	310-1660	953.2	3.0	4028.0	46	26	310-1660
Turbidity (NTU)	29	12.2	0.0	161.0	42	10	29

Table 7. Confirmation of water quality criteria and targets for estuarine sampling locations.

	Estuary mean, criteria and targets						
Parameter	**Trigger**	**Mean**	**Min**	**Max**	**N**	**% trigger exceeded**	**Adopted trigger**
Suspended Solids (TSS: mg/l)	-	16.3	0.0	437.0	41	-	**50**
Arsenic (mg/l)	-	0.003	0.000	0.028	66	-	**0.004**
Cadmium (mg/l)	0.036	0.0002	0.0000	0.0055	66	0	0.036
Chromium (mg/l)	0.085	0.000	0.000	0.022	66	0	0.085
Copper (mg/l)	0.008	0.003	0.000	0.107	66	5	0.008
Lead (mg/l)	0.012	0.002	0.000	0.036	66	5	0.012
Manganese (mg/l)	-	0.016	0.000	0.059	66	-	**0.026**
Nickel (mg/l)	0.56	0.000	0.000	0.016	66	0	0.56
Zinc (mg/l)	0.043	0.011	0.000	0.120	66	10	0.043
Mercury (mg/l)	0.0014	0.0000	0.0000	0.0002	66	0	0.0014
Ferrous Iron (mg/l)	-	0.04	0.00	0.26	66	-	**0.3**
Ammonia (mg/l)	1.7	0.108	0.000	0.470	20	0	1.7
Nitrate as N (mg/l)	-	0.538	0.004	5.610	66	-	**0.38**
Total Nitrogen as N (mg/l)	1.04	**1.16**	0.00	7.00	66	30	**1.7**
Total Phosphorus as P (mg/l)	0.2	0.062	0.000	0.210	66	2	0.2
pH	7.0-8.5	7.77	7.14	9.02	39	3	**6.5-8.5**
Dissolved Oxygen (% Sat)	39.80	91.1	36.7	129.0	39	3	39.80
Conductivity (µS/cm)	17540-54200	27706.1	30.0	49028.0	39	64	54200
Turbidity (NTU)	15	5.2	0.0	18.4	35	10	15

Appendix G – Glossary of Terms

Term / abbreviation	Definition
ANZECC/ARMCANZ	Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council)
AHD	Australian Height Datum
As	Arsenic
BOC	Bottom of casing
BOD	Biochemical oxygen demand
BTEXN	Benzene, toluene, ethylbenzene, xylenes and naphthalene.
CCS	Community Communication Strategy
Cd	Cadmium
CEMP	Construction Environmental Management Plan
Chl-a	Chlorophyll a
CIP	Community Involvement Plan
CoA	Minister's Condition of Approval (to be obtained with Infrastructure Approval)
Construction Area	A separable portion of work that is identified early in construction planning to help drive early definition of construction methodology and alignment of design activities. Work Areas should be listed in the overall construction methodology. The planning document for a work area is called a Construction Area Plan
Construction Area Plan (CAP)	The main document prepared during the construction planning for that work area. Includes construction methodology, risk assessment, constructability reviews and Work Pack listing
Critical State Significant Infrastructure (CSSI)	Since finalisation of the Environmental Impact Statement, the Project has been declared by Ministerial Order to be State significant infrastructure and critical State significant infrastructure under sections 115U(4) and 115V of the Environmental Planning and Assessment Act 1979.
Cr	Chromium
Cr(V)	Hexavalent chromium
Cu	Copper
D&C	Design and Construction
Deed	As appropriate to the defined scope of the WestConnex New M5 D&C Deed
DO	Dissolved Oxygen
DP&E	Department of Planning and Environment

Term / abbreviation	Definition
DPI	Department of Primary Industries
EC	Electrical conductivity
EIS	Environmental Impact Statement
EMM	Environmental management measures (proposed in the Environmental Impact Assessment)
EMS	Environmental Management System
Environmental aspect	Element of an organisation's activities, products or services that can interact with the environment
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999.*
EPL	Environment Protection Licence
ER	Environmental Representative
EWMS	Environmental Work Method Statement – a component of the environmental management system that addresses environmental management issues relevant to a specific site and/or activity
GDE	Groundwater Dependant Ecosystem
Hg	Mercury
IC	Independent Certifier
Infrastructure Approval	Approval under the *Environmental Planning & Assessment Act 1979* for SSI-6788 signed by the Minister for Planning on 20 April 2016
kms	kilometres
CDS-JV	CPB Contractors Dragados Samsung Joint Venture (Contractor)
mbtoc	metres below top of casing
mg/L	Milligrams per litre
mL	millilitre
MPN	Most probable number
mS/cm	milli Siemens per centimetre
NH_3	Ammonia
Ni	Nickel

Term / abbreviation	Definition
NO_x	Oxides of nitrogen
NOW	NSW Office of Water, now DPI Water
NTU	nephelometric turbidity unit
NUDLC	National Uniform Drillers Licensing Committee
OCP	Organochlorine pesticides
OEH	Office of Environment and Heritage
OEMP	Operational Environmental Management Plan
OPP	Organophosphate pesticides
Pb	Lead
POEO Act	*Protection of the Environment Operations Act 1997*
PPE	Personal Protective Equipment
Project	WestConnex New M5 Project
Project Company	WCX New M5 Pty Limited
Project requirements	The project requirements include all CoA (pursuant to Infrastructure Approval), REMMs, EMMs, SWTC and EPL.
REMM	Revised Environmental Management Measure (from the SPIR)
RMS, Roads and Maritime	Roads and Maritime Services
SMC	Sydney Motorway Corporation (formerly WestConnex Delivery Authority – WDA)
SP	Sustainability Plan
SPIR	Submission [and Preferred Infrastructure] Report
SVOC	Semivolatile organic compounds
SWL	Standing Water Level
CSWQSP	Construction Soil and Water Quality Sub-Plan
SWTC	As appropriate to the defined scope of the Scope of Works & Technical Criteria defined under the New M5 Main Works D&C Deed
TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen
TOC	Top of casing
TP	Total phosphorus

Term / abbreviation	Definition
TPH	Total petroleum hydrocarbons
TRH	Total recoverable hydrocarbons
TSS	Total suspended solids
VOC	Volatile organic compounds
WCX	WestConnex
WDA	WestConnex Delivery Authority now Sydney Motorway Corporation (SMC)
WHS	Work Health and Safety
WQP&MP	Water Quality Plan and Monitoring Program
CWRSP	Construction Waste and Resource Sub Plan
Work Pack	Assembly of documents that contain relevant information for the field delivery team to undertake a specific package of works. Inputs include safety, environment, design, temporary works, Project control, approvals/permits and community notices.
Work Procedure	A document that provides a detailed step-by-step description for how work activities will be carried out. May document Risks & Controls associated with each step
Zn	Zinc