4.0 Existing environment

The project extends from Beverly Hills to St Peters and Mascot, covering a distance of around nine kilometres, following roughly the alignment of the existing M5 East Motorway. The project crosses a number of waterways draining to the Cooks River. These waterways include the Cooks River, Wolli Creek and Alexandra Canal. At the eastern end of the project, in St Peters, the project also drains to the Eastern Channel, a trunk drainage line with a relatively large catchment.

The existing environment across the surface water study area consists of highly altered land, impacted by land clearing and subsequent urbanisation. The topography ranges from relatively flat to steep banks through parts of Lower Wolli Creek. The climate is temperate with average annual rainfall of roughly 1080 millimetres spread relatively evenly throughout the year.

The existing surface water environment is described in the following sections in relation to:

- Soil landscapes
- Catchments and watercourses
- Catchment land use
- Geomorphology
- Hydrology and flooding
- Water quality
- Sensitive receiving environments.

4.1 Soil landscapes

The *Soil Landscapes of the Sydney 1:100,000 Sheet 9130* (1989) indicates that the study area in underlain by seven soil landscape groupings. The Gymea soil landscape covers the majority of the project corridor in the west, along with smaller areas of the Hawkesbury, Blacktown, Birrong, Warriewood and Oxford Falls soil landscapes. The eastern extent of the project corridor is largely covered by land identified as being disturbed terrains, associated with Alexandra Canal and industrial land uses. Soil landscapes within the study area are shown in Figure 2, and the key characteristics of relevant soil landscapes are summarised in Table 8.

Table 8 Soil landscapes found in the surface water study area

Soil Landscape Grouping	Soil Landscape	Characteristics	Erosional nature
Residual	Blacktown	- Occurs on gently undulating rises on Wianamatta Group Shales - Poorly drained, moderately reactive soil	No appreciable erosion occurs on this unit as most of the surface is covered by tiles, concrete, bitumen or turf.
Alluvial	Birrong	- Occurs on level to gently undulating alluvial flood plan draining the Wianamatta Group Shales - High soil erosion hazard, saline soils, seasonal waterlogging and localised flooding	Most drainage lines have been artificially lined with concrete preventing most erosion. Minor streambank erosion has occurred along remaining natural drainage lines.
Erosional	Gymea	- Occurs on undulating to rolling rises and low hills on Hawkesbury Sandstone - Localised steep slopes - High soil erosion hazard	Severe sheet erosion occurs following bushfires which destroy or damage stabilising vegetative cover. Minor gully erosion occurs along unpaved roads and fire trails especially those frequented by four wheel drive vehicles and trail bikes

Soil Landscape Grouping	Soil Landscape	Characteristics	Erosional nature
Colluvial	Hawkesbury	- Occurs on rugged, rolling to very steep hills on Hawkesbury Sandstone - Extreme soil erosion and mass movement hazard.	Severe sheet erosions often occur during storms and after ground cover has been destroyed by bushfires. Minor gully erosion occurs along unpaved tracks and fire trails, especially those used regularly by four wheel drive vehicles, motorcycles and horses.
Swamp	Warriewood	- Occurs on level to gently undulating swales, depressions and infilled lagoons in Quaternary sands - High water tables and localised flooding, highly permeable soils, compressible soils.	No appreciable erosion occurs where slopes are low and a vigorous ground cover is maintained. Isolated blowouts caused by wind erosion occur in exposed area where cover has been removed.
Disturbed Terrain	Disturbed Terrain	- Terrain extensively disturbed by human activity, including complete disturbance, removal or burial of soil. Variable relief and slopes	Erosion varies markedly according to site characteristics including slope, aspect and exposure. In general, severe sheet and rill erosion often occur at quarries, gravel pits and places where unconsolidated or disturbed material remains without a protective cover of vegetation, asphalt or concrete

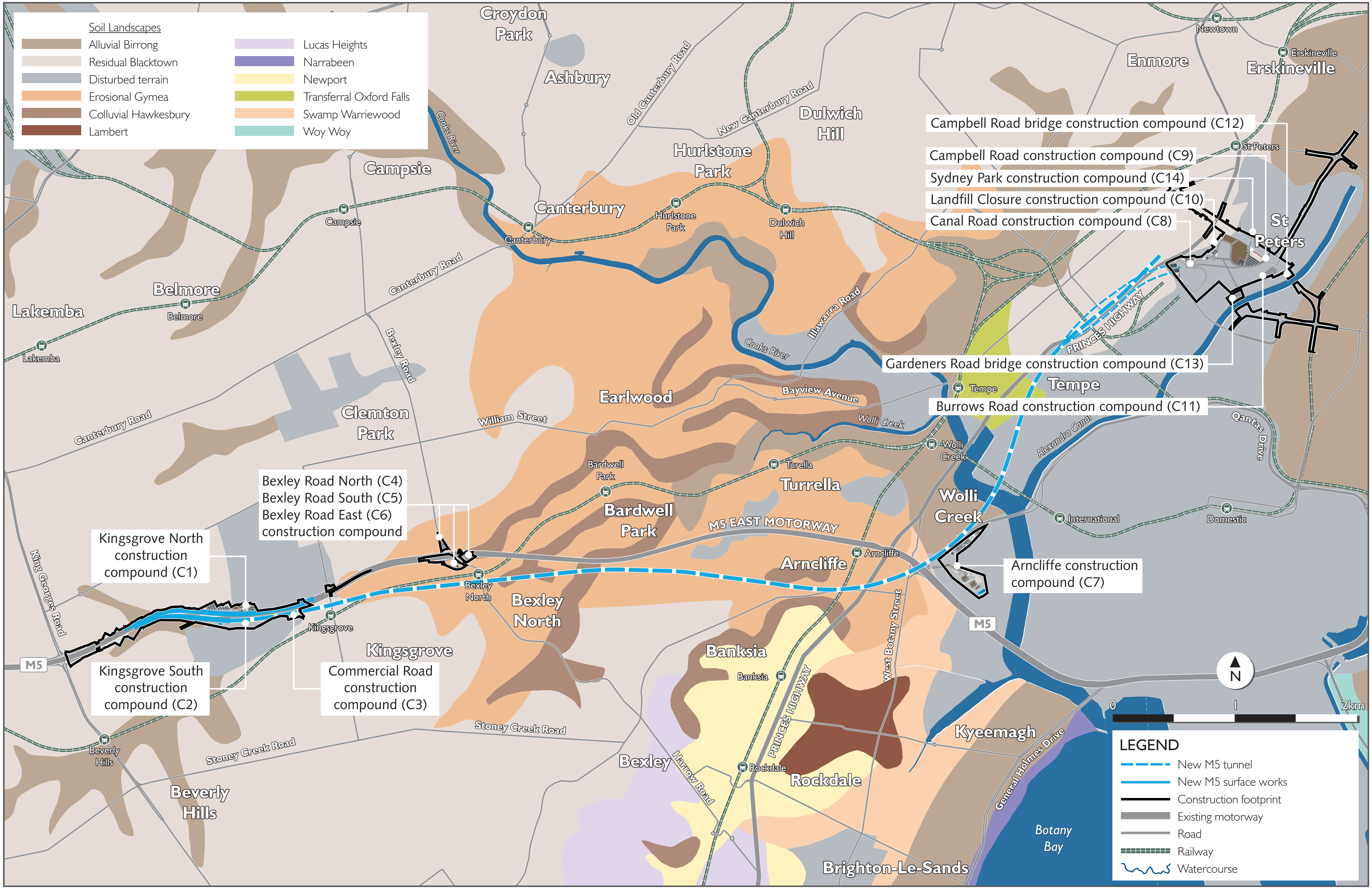

Figure 2 Soil landscapes

This page has been left blank intentionally.

4.2 Catchments and watercourses

The project corridor is located within the Cooks River catchment. The Cooks River catchment extends from Botany Bay in the south east to Randwick in the north east, Strathfield in the north west and Hurstville in the south west forming part of the greater 116,500 hectare Botany Bay catchment (SMCMA, 2011). The Cooks River catchment is fed by nine tributaries:

- Greenacre Creek
- Cox's Creek
- Cup and Saucer Creek
- Fresh Water Creek
- Bardwell Creek
- Wolli Creek
- Muddy Creek
- Alexandra Canal, which includes Sheas Creek
- Eastern Channel.

Of these nine tributaries, the Wolli Creek, Alexandra Canal and Eastern Channel are located within the study area. There are several channels that drain Kogarah Golf Course that discharge into the Cooks River. For the purposes of this assessment, these drainage channels are considered as part of the overall Cooks River catchment.

The catchment boundaries and watercourses in the study area are shown on Figure 3 and Figure 4.

4.2.1 Cooks River catchment

The Cooks River catchment covers an area of around 10,000 hectares in south western Sydney, discharging to Botany Bay at Mascot. The catchment was stripped of its natural vegetation during early European settlement and has been subject to long term anthropogenic degradation. The Cooks River catchment is highly urbanised and has a history of intensive land use ranging from residential to heavy industry. The catchment has very little remaining bushland, and a small amount of parkland (SMCMA, 2011).

Residential land use is the predominant zoning within the catchment. The major portion of industrially zoned land is concentrated in the Port Botany area, along Alexandra Canal within Tempe and the southern portion of the Strathfield local government area. Thin corridors of open space line the Cooks River and many of its tributaries. (RCC, 2011)

The landscape and natural function of the catchment and waterways has been impacted by urbanisation within the catchment and the density of the built environment. As a result, the majority of watercourses within the Cooks River catchment are anthropogenically modified channels. Generally the artificial modifications have included dredging, widening, re-alignment and various forms of armouring such as concrete linings and rock revetments. The development of impervious surfaces within the catchment has increased the volume and rate of runoff, which has in turn necessitated flood mitigation measures primarily in the mid and upper catchment, and bank stabilisation works in the lower catchment (Earth Tech, 2007). Semi-natural channel morphology exists as small laterally discontinuous reaches where bedrock controls on confinement have negated the need for channel stabilisation initiatives or the watercourse abuts natural floodplain or parkland.

Partly confined and alluvial unconfined reaches exist in the lower catchment only in relatively low energy environments (Earth Tech, 2007). In most instances channel modification has masked or removed in-channel geomorphic units and the built environment masks the floodplain thereby making it problematic to determine historic channel morphology (Earth Tech, 2007).

Within the catchment it is estimated that roughly 89 per cent of stormwater travels through a combination of pit and pipe networks, open concrete channels, metal sheet piled channels and rock armoured channels. Around 71 per cent of the stream reaches in the Cooks River catchment have no vegetation or are used for flood control (SMCMA, 2011).

The Cooks River flows for roughly 23 kilometres from Graf Park in Bankstown into Botany Bay at Kyeemagh (CRA, 2013). The Cooks River is so highly modified that it functions more like a stormwater drainage system than a river system. The river in the study area is largely lined with steel sheet pilings, concrete walls or stone/block revetments, though with some rehabilitated, naturalised sections. The Cooks River is almost uniformly 50 metres wide upstream of Cahill Park, Tempe where it widens to roughly 150 metres until its discharge through training walls into Botany Bay.

The tidal limit of the Cooks River is estimated to be adjacent to Sando Reserve, Croydon Park (Manly Hydraulics Laboratory (MHL), 2005). This is roughly 7.5 kilometres upstream of the Bayview Avenue Bridge and the upstream extent of any impacts related to the project.

Most of the river bank was built between the late 1940s to the early 1950s as part of the river diversion and land reclamation works associated with the construction of the Sydney Airport. The mouth of the Cooks River was relocated 1.6 kilometres west to its current position during these works (PPK, 1999).

A number of authorities are responsible for the management of the Cooks River and its catchment, including the local councils located within the Cooks River catchment, the Local Land Services Board, the Environment Protection Agency and Sydney Water.

4.2.2 Wolli Creek catchment

The Wolli Creek catchment has an area of about 2,100 hectares and includes the suburbs of Narwee, Beverly Hills, Kingsgrove, Canterbury, Bexley, Bardwell Park, Earlwood, Turrella, Arncliffe and Tempe. The area consists primarily of residential development with some industrial and remnant bushland areas.

This catchment has been significantly altered by urbanisation, as well as the existing M5 East Motorway and the East Hills Railway line. Open areas include the Canterbury Golf Course, the M5 Linear Park (established as part of the M5 East Motorway, incorporating open spaces such as Beverly Grove Park), and around fifty hectares of natural bushland within the suburbs of Earlwood and Bardwell Valley. Part of the natural bushland has been declared as a regional park (the Wolli Creek Regional Park), managed by the National Parks and Wildlife Service. Remaining sections of bushland are managed by local councils.

Wolli Creek is the largest tributary of the Cooks River. The creek begins in the suburb of Beverly Hills and runs through the Wolli Creek Valley in a north-easterly direction from Kingsgrove in the west, flowing towards the east until joining the Cooks River near Tempe.

The upper section of Wolli Creek, from Bevery Hills to Bexley Road, is generally anthropogenically modified with hard engineered lining with the majority consisting of a concrete-lined trapezoidal channel (refer to photographic example in Figure 5). This upper section is owned and managed by Sydney Water as part of its trunk drainage system. Sydney Water owns and manages the creek from its beginning until Bexley Road where it enters Crown Land.

The upper section consists of a mix of open concrete-lined trapezoidal channels, reconstructed semi-natural watercourse channel, underground concrete channels, piped channels and rock-lined channels. Given the channel protection material, the channels here are devoid of geomorphic features, apart from the occasional sediment deposition slug that forms around / behind a channel intrusion, such as a bridge pier, or debris blockage. The susceptibility for in-channel erosion is minimal.

The reconstructed semi-natural watercourse channel extends for around 400 metres near The Crescent, Kingsgrove. The 400 metre reach of formed, but unlined, earthen channel is constructed of grouted rock rip-rap and vegetation (refer to Figure 6). Although naturalised, this reach is heavily degraded with sedimentation and infested with weeds. However, the grouted rock-rip rap means that the channel at this point is generally stable, with the bed and banks likely to be resistant to erosion. Downstream of The Crescent, the channel then returns to a constructed concrete-lined trapezoidal channel. Through the M5 Linear Park a number of water treatment measures are present; notably a Gross Pollutant Trap (GPT) operated by Sydney Water near Beaumont Street, Kingsgrove. The GPT filters low flows, resulting in some hydraulic head loss, particularly when partially blocked, though is bypassed in high flows.

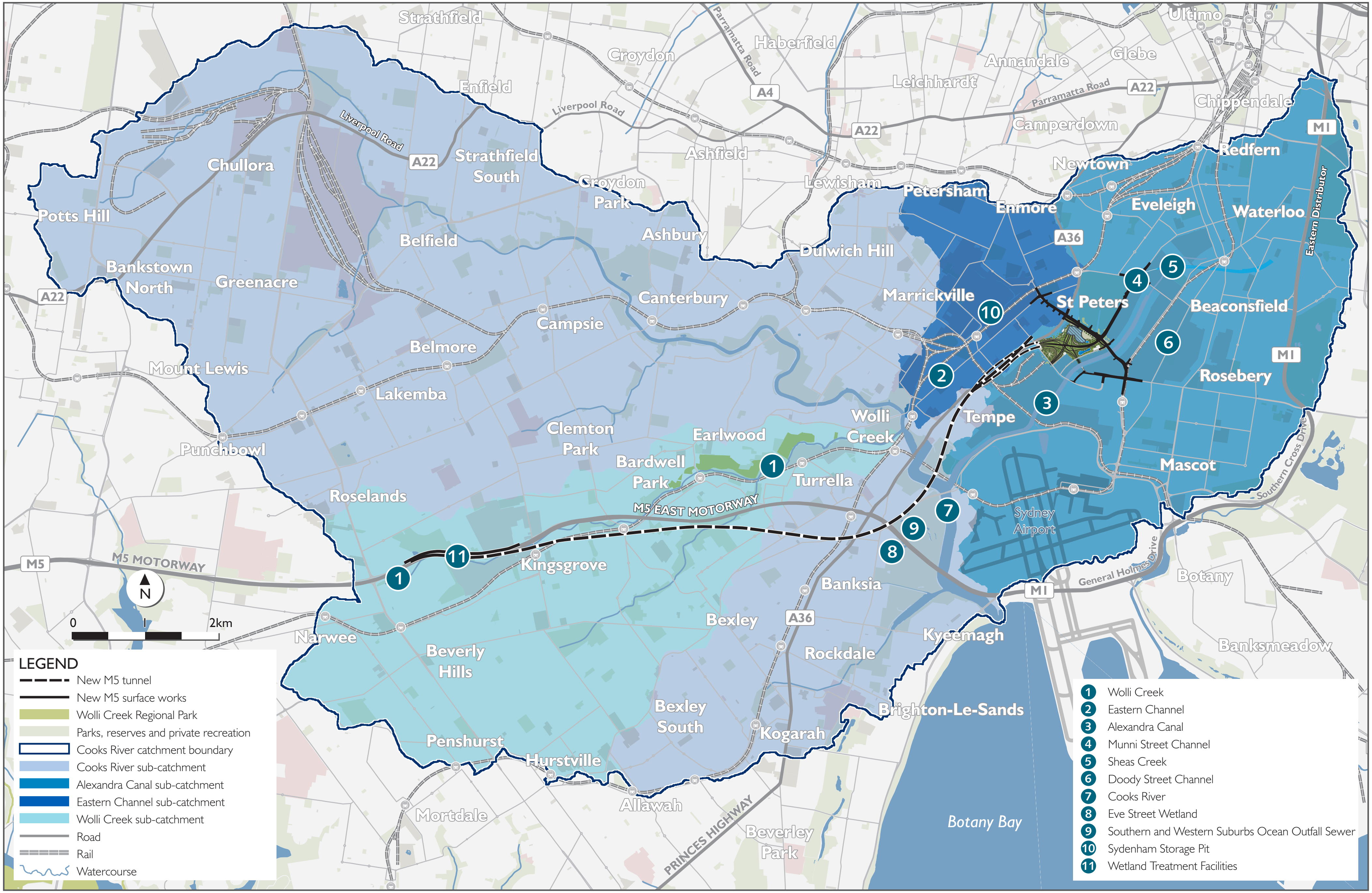

Figure 3 Catchments within the study area

This page has been left blank intentionally.

Figure 4 Watercourses within the study area

This page has been left blank intentionally.

At Bexley Road the creek passes through a box culvert before flowing into a modified (shaped), but more natural, channel (the lower section) (refer to Figure 7). Downstream of Bexley Road, the creek features alluvial banks within a confined valley setting containing a number of modifications to accommodate the railway line, urban development, bridge crossings or recreational sports fields. This section of the creek is densely vegetated, predominately with weed species. The channel traverses through a short, confined valley setting with floodplain pockets before transitioning into a partly confined meandering, platform controlled setting.

This section includes the following categorisations: the 'Confined Channel with Alternating Discontinuous Floodplain Pockets'; 'Partly Confined – Meandering', 'Platform Controlled', 'Discontinuous Floodplain'; and 'Anthropogenic Shaped Channel'.

The watercourse travels through the Wolli Creek Regional Park and is joined by Bardwell Creek on the northern side of the passenger rail line at Bardwell Park. Treated groundwater from the existing M5 East Motorway tunnel is discharged into the creek near Turrella Station (refer to Figure 8). A weir and associated fishway (refer to Figure 9) at Turrella Park, near Henderson Street regulates flow before reaching its confluence with the Cooks River adjacent to Wentworth Park, Wolli Creek.

Based on the vegetation present it is expected that the majority of the tidal limit is roughly at the Turrella (Henderson Street) weir, with the upper extent (i.e. king tide) in the vicinity of the confluence of Bardwell Creek (MHL, 2005).

The in-stream, lower bank and riparian zone of the lower section of Wolli Creek is dominated by weeds that have historically, and continue to cause sedimentation and minor bank erosion where the banks are exposed. Much of the geomorphic units within this semi-natural system are smothered by weed growth and difficult to define. The channel geometry generally consisted of a flattened U-shaped channel with a steep 1(vertical):1(horizontal) to sub-vertical low-flow bank, of an approximate height range between one to three (3) metres. The creek banks in many places illustrated signs of minor scour, slumping and fretting erosion, likely to be caused by a combination of tidal fluctuations, coupled with weed infestations providing no deep-rooted stability and intense storm flow events. At the downstream extent this erosion was less evident where mangroves were present (refer to Figure 9), which provide additional protection against the storm flows, tidal fluctuations and encourage sediment accumulation.

Generally there appeared to be minimal in-stream geomorphic or large wood habitat features, however the water turbidity at the time of the site investigation did impair visibility.

The locations of photographs shown in Figure 5 to Figure 10 are shown in Figure 11.

4.2.3 Alexandra Canal catchment

The Alexandra Canal catchment (including Sheas Creek) has an area of about 2,300 hectares and includes the suburbs of Alexandria, Rosebery, Erskineville, Beaconsfield, Zetland, Waterloo, Redfern, Newtown, Eveleigh, Surry Hills and Moore Park. The catchment is heavily altered, predominantly covered by commercial, industrial and residential development with a small amount of parkland such as Sydney Park and Moore Park.

Alexandra Canal is a constructed canal, originally a natural watercourse named Sheas Creek. It flows into the Cooks River near the north-western corner of Sydney Airport. Dredging and canalisation of Sheas Creek started in the 1880s to make the creek navigable in order to attract industries to the area. By 1896 the creek was excavated by about three metres and spoil was used to fill banks by up to 1.8 metres to reclaim the low lying swampy areas surrounding the creek.

The canal was substantially complete by 1900. As it was originally built for navigation by boat for transportation purposes it is much larger than technically required to convey stormwater from the catchment area draining to it (roughly 16 square kilometres). Due to its size in relation to its inflows as well as tidal action, the canal accumulates sediment. Dredging was regularly undertaken up to the 1950's to remove sediment build up. By that time, road and rail had made boat navigation in the canal superfluous for goods transportation. The last major works on the canal, including backfilling and dredging, were carried out in the 1970's when the north-south runway for Sydney Airport was built (DPWS, 2004).

Figure 5 Wolli Creek concrete-lined trapezoidal channel upstream of Kingsgrove Road

Figure 6 Constructed 400 m reach of grouted rock rip-rap and vegetation near The Crescent

Figure 7 Wolli Creek downstream of Bexley Road, near Illoura Park (looking upstream)

Figure 8 The existing M5 East Motorway ventilation outlet and groundwater treatment plant discharge location near Turrella Station

Figure 9 Wolli Creek Turrella Weir fishway at Henderson Street

Figure 10 Downstream extent of Wolli Creek, looking from Waterworth Park to the mangroves on the southern bank

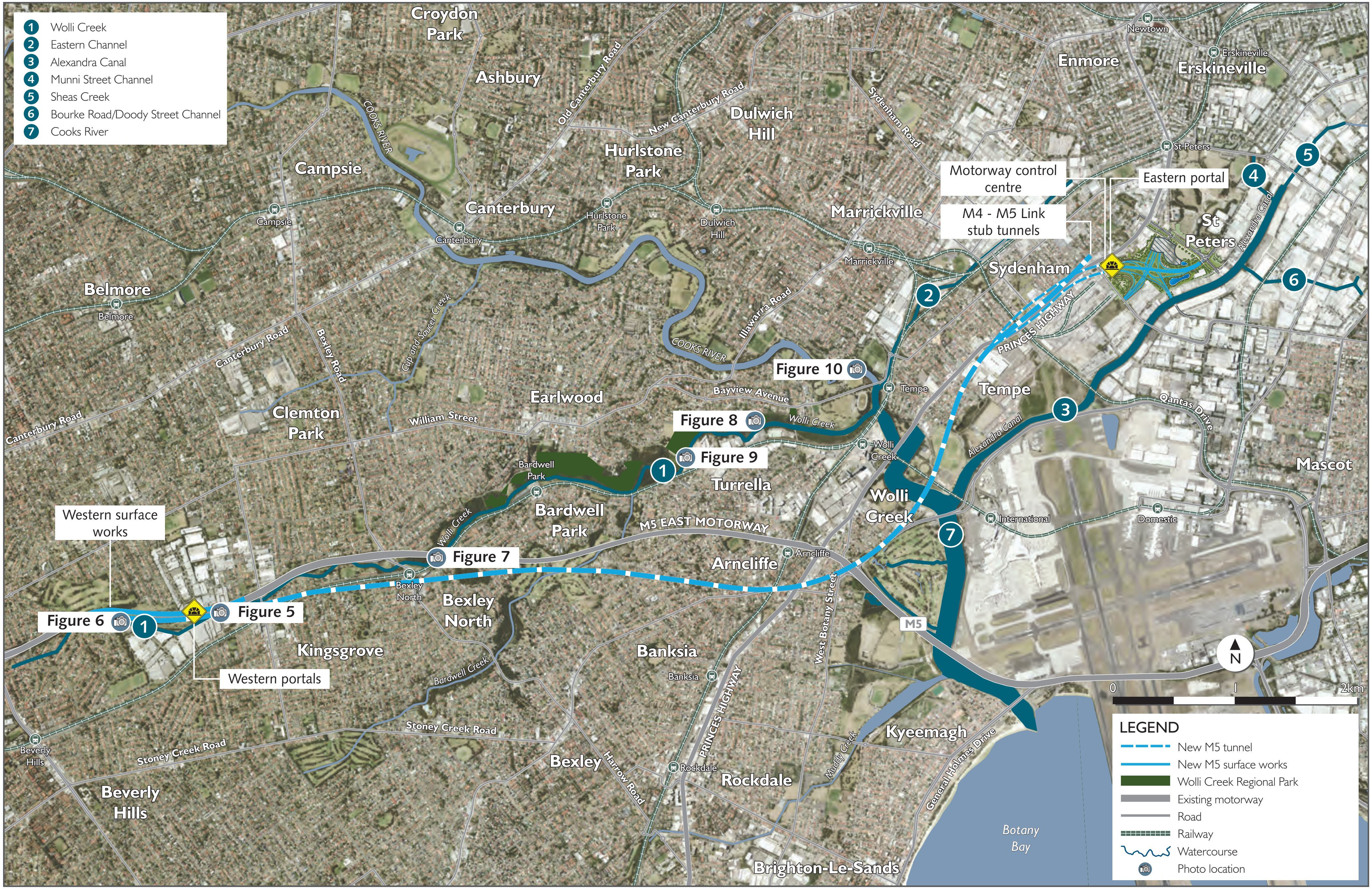

Figure 11 Location of photos shown in Figures 5 - 10

This page has been left blank intentionally.

The canal bank walls were originally constructed from sandstone blocks forming a 1:1 sloping bank from roughly 0.5 metres below low water mark to about 1.5 metres above high water mark on each side with rubble ballast as a footing. The condition of these walls is highly variable, with numerous slumps some having required remediation / restoration. Lower reaches have been rebuilt in a variety of 20th century materials including concrete block, shotcrete over rubble and fabricon and range from good to poor condition (SW, 2014). The bottom of the canal is mainly earth except where Sheas Creek enters the canal near Huntley Street, where a base has been laid in sandstone (DPWS, 2004).

The majority of the canal is devoid of geomorphic units, due to the rock-lined banks and dredged canal base. The canal contains a scour hole at the headwaters of the canal and a number of sediment deposition material (slugs), particularly at the extents of the waning flow energy, channel edges, tidal influence, and in-stream structures. These sediment slugs are remobilised when larger events pass through the system, eventually overtime entering the Cooks River.

Alexandra Canal is tidally dominated through its connection to the Cooks River. It is around 3.9 kilometres long and 60 metres at its' widest. The tidal influence from the Cooks River extends to the head of the canal. A University of Queensland study (UoQ, 2002) indicated that the flows pushing in from the Cooks River can trap the catchment flows in the canal, indicating that "*the residence time of waters conveyed into the canal from the catchment is long*".

Peak flow velocities vary little along the canal, with average velocities generally between 0.5 and 0.8 metres per second with maximum localised velocities of up to 1.2 metres per second. The existing velocities where the Sheas Creek channel enters the canal near Huntley St are fairly high, in the order of 4.8 metres per second under high tide conditions and 6.5 metres per second under low tide conditions. These high velocities dissipate very quickly in the canal, but explain a big scour hole visible at the head of the canal (AAJV, 2014).

The canal is owned and operated by Sydney Water as are the major trunk drainage lines discharging into it. Numerous minor drains in the Alexandra Canal sub-catchment are managed by South Sydney, Marrickville and Botany Councils.

Three channels discharge into Alexandra Canal: Munni Street Stormwater Channel, Sheas Creek and the Botany Road to Doody Street Channel. These are discussed below and shown in Figure 4.

Munni Street Stormwater Channel

The Munni Street Stormwater Channel drains an urban catchment of Enmore and Eveleigh into Alexandra Canal. Sections of the Local Roads Upgrades drain into this channel. The channel is concrete lined U-shape and passes under Sydney Park Road, Sydney Park, Euston Road and Burrows Street until its confluence roughly 150 metres from the head of Alexandra Canal. Stormwater in harvested from the channel by a sump near Euston Road which pumps 500-1,000 litres per second into the Sydney Park Stormwater Harvesting ponds to the south-west (Turf Design 2011).

Sheas Creek

Sheas Creek is now a shortened concrete-lined channel upstream of Alexandra Canal. Sections of the Local Roads Upgrades drain into this creek. The creek services the piped drainage system of the upper Alexandra Canal catchment. As previously mentioned a scour patch exists in the base of Alexandra Canal due to the discharge of Sheas Creek. Sydney Water owns roughly a 360 metre section of the creek / channel with the rest belonging to the City of Sydney Council.

Botany Road to Doody Street Channel

The Botany Road to Doody Street channel is a brick lined channel conveying stormwater from the parts of the Alexandria, Beaconsfield and Rosebery pipe drainage system to Alexandra Canal roughly 900 metres downstream of its head. Sections of the Local Roads Upgrades drain into this channel. The catchment is named SW_031 and Sydney water owns the final 630 metres of channel to its discharge point. A moderate amount of vegetation grows alongside the creek in Alexandria. At its discharge point with the canal, there has been some slumping of the channel / canal walls and a prominent patch of weeds exists.

4.2.4 Eastern Channel Catchment

The Eastern Channel catchment includes the suburbs of Tempe, Sydenham, Enmore and Newtown and is about 500 hectares in area. The catchment is heavily urbanised and altered by a relatively even mix of commercial and residential property. The catchment has a very small proportion of open space in the form of recreational parklands.

The Eastern Channel (SWC 66) runs along the Sydenham to Tempe railway line, discharging into the Cooks River. The channel conveys stormwater as a trapezoidal-shaped concrete-lined open channel with 1 to 4 slopes. The main open section is roughly 2.3 kilometres from near Murray Street, Marrickville to its confluence with the Cooks River adjacent to Tempe Station. Part of the channel is tidal due to its connectivity with the Cooks River.

4.3 Catchment land use

The geomorphology and water quality of the watercourses in the study area are closely linked to the land use in each of the catchments. Details of the four catchments considered in this assessment, including size and current land use, are outlined in Table 9.

Table 9 Catchments relevant to the project categorised by land use (per cent)

Land use	Catchment/Sub-catchment							
	Cooks River catchment		Alexandra Canal sub-catchment		Wolli Creek sub-catchment		Eastern Channel sub-catchment	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Commercial	3,343	31	1,409	63	327	16	218	45
Residential	6,389	58	609	27	1,513	72	242	49
Open space	1,169	11	248	10	255	12	30	6
Total sub-catchment area	**10,901**	**100**	**2,266**	**100**	**2,095**	**100**	**490**	**100**

4.4 Geomorphology

Waterways within each catchment consist of a mix of concrete lined and modified watercourses that convey stormwater to the Cooks River. The network of open and partially open channels within the study area, and their geomorphological characteristics, is shown in and Figure 12.

The characteristics of the watercourses in the study area are explained previously in Section 4.2 and Section 4.4. However, in summary, the geomorphology characteristics of the watercourses are primarily categorised as having no potential for lateral or vertical adjustment (concrete channel, piped channel, rock-lined channel, shaped channel and underground concrete channel). The geomorphic characteristics of the watercourses reflect their urban and anthropogenic nature.

Conversely, slopes in part of the study area are greater than ten per cent. This combined in an R factor (rainfall erosivity) of 3000 to 3500 for this area of Sydney presents a high erosion hazard.

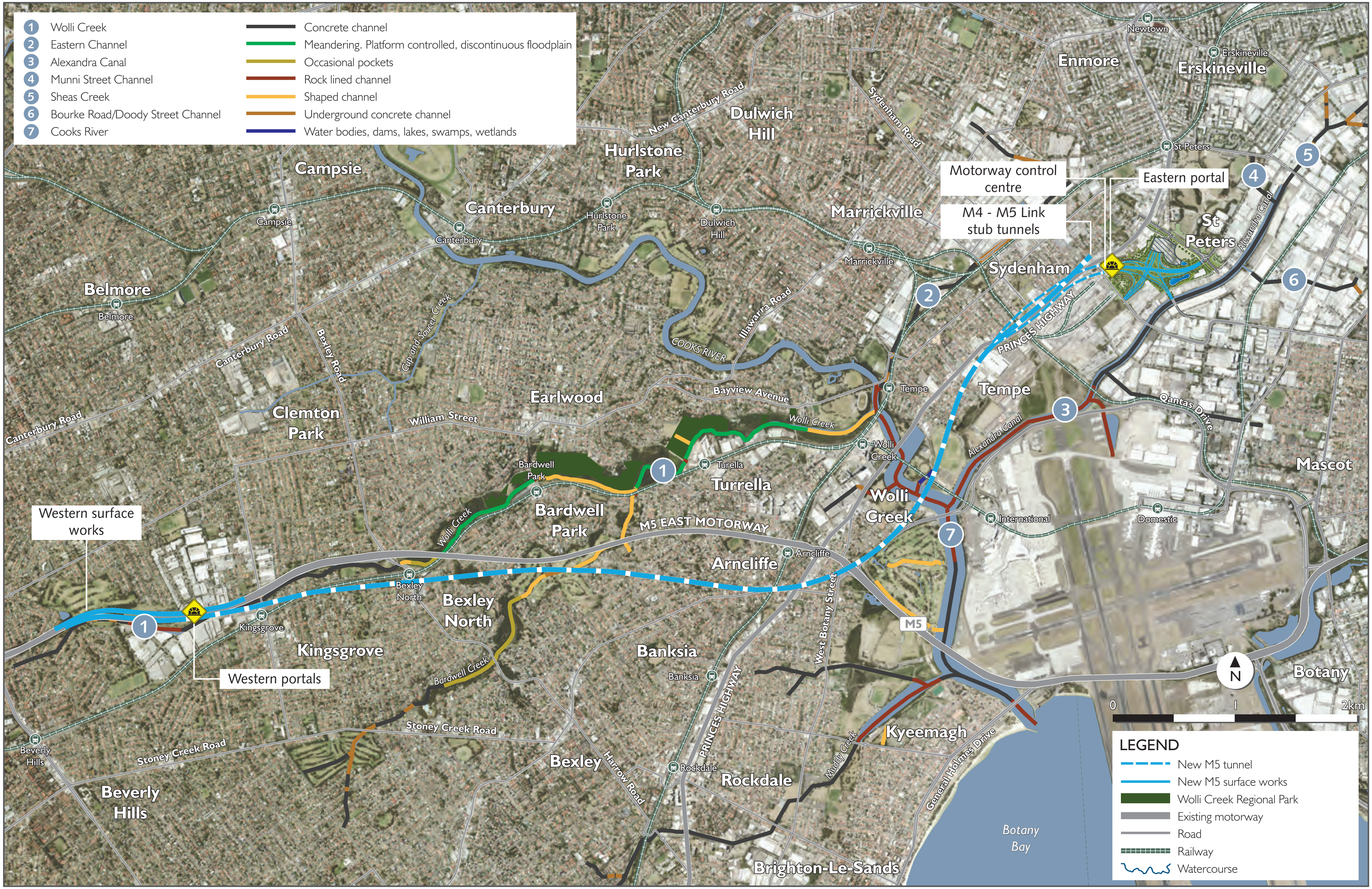

Figure 12 Geomorphology within the surface water study area

This page has been left blank intentionally.

Table 10 Surface water study area Riverstyles® categorisation (Earth Tech, 2007)

River Style Categorisation	Length (metres)	Percentage of study area (%)
Concrete channel	10,230	50
Partly confined channel - Meandering, planform controlled, discontinuous floodplain	2,690	13
Occasional pockets - Confined channel with alternating discontinuous floodplain pockets	270	1
Piped channel	220	1
Rock-lined channel	3,700	18
Shaped channel	1,540	8
Underground concrete channel	1,880	9

4.5 Hydrology and flooding

As discussed in Section 4.2, the study area is located within the Cooks River, Wolli Creek, Alexandra Canal and Eastern Channel catchments. The Wolli Creek catchment is underlain by clay soils and sandstone contributing to low soil permeability. In contrast, the Alexandra Canal and the Eastern Channel catchments are underlain by sandy soils, allowing greater soil permeability and reduced run-off from unsurfaced areas.

Development within the study area is typically well established with a high proportion of residential and commercial land use. Land within the surface water study area is also predominantly of urbanised nature with small pockets of open space, notably along some of the watercourses. Flood risk in the study area has increased since the onset of urbanisation, leading to catchments with a high percentage of impermeable land resulting in increased runoff during rainfall events. In addition, concrete drainage lines, relatively low infiltration and reduced flood storage capacity within the catchments also result in a quick response to rainfall events. This is particularly significant in small, frequent storm events and results in high peak flows which can cause flooding in parts of the study area.

4.5.1 Mainstream flooding

For this assessment, the 20 year, 100 year ARI and PMF flooding conditions within each catchment was considered. Flood extents for these events under present day conditions in the context of surface disturbances areas are shown on Figure 14 to Figure 16.

A detailed description of mainstream flooding of Upper Wolli Creek, Alexandra Canal and the Lower Cooks River under present day conditions is contained in Technical Working Paper: Flooding (Lyall and Associates, 2015). The Eastern Channel has been shown to have sufficient capacity to convey flows up to and including the 100 year ARI flood though not the PMF (WMA, 2011).

4.5.2 Localised flooding and drainage

Localised flooding could occur anywhere in the study area. Localised flooding issues could be further exacerbated by:

- The geological nature of the contributing catchment for example the Wolli Creek catchment is underlain by clay soils and sandstone contributing to low soil permeability
- The topographical nature of the contributing catchments, for example parts of the Local Road Upgrades which are situated in low, flat terrain
- High proportion of impermeable surfaces caused by roofs and hardstand such as roads, car parks and pavements which causes runoff to concentrate rapidly
- Limited capacity in existing piped drainage systems
- Lack of maintenance which could lead to blocked culverts and gully pits, sedimentation build-up within drainage systems and /or collapsed drainage infrastructure
- Backing-up effects into the local drainage system when main watercourses are flooded.

Details and/or observations for each catchment are discussed further below.

Cooks River Catchment

The Cooks River catchment is highly urbanised, with extensive subsurface pit and pipe networks. All of these networks within the study area are located within one of the subcatchments described in this section of the report.

Wolli Creek Catchment

The upper Wolli Creek catchment is completely urbanised with a drainage system comprising extensive pit and pipe networks.

Hyder Consulting prepared the design of the M5 East Motorway and its drainage system, including the transverse drainage lines which convey runoff into Wolli Creek from areas north of the road. The transverse drainage system was designed to convey flows up to the 100 year ARI magnitude. There are no records of major flood events along the existing M5 East Motorway between King Georges Road and Bexley Road (Roads and Maritime, 2015).

Alexandra Canal Catchment

The section of the project within the Alexandra Canal catchment lies on flat terrain of low elevation. The drainage systems are hence placed under pressure during relatively small events. A number of areas within the catchment are known to experience localised flooding including the following within the study area:

- The low points of Euston Road and Burrows Road
- Industrial development bordering Munni Street Channel downstream of Euston Road (Cardno, 2014)
- The intersection of Campbell Road with Euston Road and Burrows Road currently subject to localised flooding (Preliminary stormwater advice for WestConnex St Peters and Alexandra Canal, Sydney Water, 2015).

Eastern Channel Catchment

Stormwater runoff is presently generated by a significant catchment along Campbell Road. From beyond the Princes Highway in the east, the catchment drains towards the intersection of Campbell Street and May Street. The existing piped drainage system at the intersection directs runoff into a 1200 millimetre diameter pipe running to the north-west under Bedwin Road, which in turn discharges into a 1550 by 870 millimetre box culvert that crosses under the adjacent rail line. This box culvert connects into the Eastern Channel on the northern side of the rail line. In larger storm events, stormwater ponds in the intersection before surcharging into an existing detention basin located at the western end of Camdenville Park. The existing basin cannot drain via gravity, and is dewatered by two pumps that direct stormwater into the above-mentioned box culvert.

The intersection of Campbell Street and May Street is frequently flooded as a result of lack of street drainage in areas, limited local inlet capacity in existing piped drainage network and a limited hydraulic capacity in the downstream trunk drainage system (Golder, 2010).

A flooding investigation entitled *EC East Sub-catchment Management Plan Volume 2 – Flood Study* undertaken by Golder Associates (2010) for Marrickville Council provided some further, limited details of existing drainage arrangements, capacity constraints and local flooding behaviour in this area.

4.6 Surface water quality

Results from 2012-13 River Health monitoring for the Cooks River have been presented as the River Health Report Card. The report card rates river health (A^+ = excellent, A-B^+ = Good, B-C^- = Fair, D^+ - F^- = Poor). The River Health Report Card from 2013 that the Cooks River freshwater sites have an ecological condition rated as 'Poor' (D). Estuary conditions the Cooks River were 'Fair" (B) (CRA, 2013). This is consistent with previous studies (PPK, 1999), which showed that the Cooks River catchment is regarded as one of the most polluted urban river catchments in Australia. Water quality in the catchment has been affected historically by stormwater pollution, industrial and domestic wastewater discharge, rubbish dumping and modifications of the waterway. Present levels of pollutants, including nutrients, sediments, toxicants and faecal coliforms make the Cooks River unsafe for swimming, unsuitable for many aquatic species and a health risk for commercial fishing.

A number of past studies were used in generating an understanding of the base case water quality condition in the watercourses that would be subject to impact from the project. Previously collected water quality data was available at a number of locations as outlined in Figure 12. A Water Quality Monitoring Program specific for the project commenced in June 2015 and is ongoing (refer to Appendix B). Where historical data was not available from existing sources, results from the Water Quality Monitoring Program were also used to supplement the data set. Locations of these sites are shown in Appendix B.

The existing water quality data has been provided in tables in the following section, including default ANZECC trigger values for each parameter. The values provided for physical and chemical stressors are those for south-east Australia for slightly to moderately disturbed ecosystems. For toxicants – the trigger for 80 per cent protection of species was chosen for comparison, due to the disturbed water quality of the waterways. As ANZECC guidelines do not set trigger values for highly disturbed ecosystems, a comparison to these trigger values has been made to determine if the waterways within the study area do or do not meet the definition of a slightly to moderately disturbed ecosystem.

Comparison of both historical and recent samples with the ANZECC triggers for slightly to moderately ecosystems shows that the water quality generally does not meet these values. Samples from both historical and recent sampling failed to meet these trigger values for a number of parameters.

The ANZECC Water Quality Guidelines (ANZECC, 2000) guidelines define waterways classified as highly disturbed systems as "*measurably degraded ecosystems of lower ecological value. Examples of highly disturbed systems would be … urban streams receiving road and stormwater runoff….*" (ANZECC, 2000). This supports this assessment that the watercourses are highly disturbed ecosystems. As such, project specific trigger values have been generated by forming a reference data set. This reference data set has been developed to provide guidance on the quality of water that must be produced by water treatment plants to make that water suitable for discharge into the receiving environment. The reference data set has been prepared with the objective to improve water quality of the receiving environment, which is consistent with the objectives of the Botany Bay and Catchment Water Quality Improvement Plan. The method is explained in more detail in Appendix A.

A general comparison of water quality in Wolli Creek, Alexandra and the Cooks River was provided in the Sydney Water Environmental Indicators Compliance Report Volume 3 and measured in 2000/2001 is shown in Table 11. The table provides a summary of measurements taken at a range of locations throughout each watercourse.

This page has been left blank intentionally.

Table 11 Summary of water quality data for 2000/2001 (Woodlots, 2004)

Site	Condition	Wolli Creek		Alexandra Canal		Cooks River		ANZECC (2000) default trigger values*
		Mean	SD	Mean	SD	Mean	SD	
Dissolved Oxygen (per cent Saturation)	Dry	62	16	108	47	119	36	80-110
	Wet	73	28	86	34	95	17	
pH	Dry	7.5	0.2	7.8	0.4	8.1	0.4	7.0-8.5
	Wet	7.2	0.3	7.3	0.2	7.8	0.7	
Faecal coliforms (CFU/100 mL)	Dry	60	1000	46	506	2,058	6,499	<1,000 for secondary contact
	Wet	190,788	193,907	10,954	31464	55,857	60,000	
Faecal enterococci (CFU/100 mL)	Dry	66	754	28	509	296	33,985	< 230
	Wet	65,269	77,460	21,909	25,923	53,066	62,929	
Total Phosphorus (mg/L)	Dry	0.068	0.029	0.139	0.153	0.281	0.175	0.03
	Wet	0.34	0.19	0.13	0.01	0.315	0.183	
Total Nitrogen (mg/L)	Dry	0.86	0.57	1.38	0.99	1.81	1.26	0.3
	Wet	3.46	2.63	1.11	0.44	2.48	1.43	
Chlorophyll ‘a’ (mg/L)	Dry	0.012	0.018	0.096	0.213	0.134	0.131	0.004
	Wet	0	0	0	0	0	0	

Shading indicates that recorded data is outside of the respective guidelines

**ANZECC (2000) default trigger values for physical and chemical stressors for south-east Australia for slightly to moderately disturbed ecosystems in estuaries*

4.6.1 Wolli Creek

In 2014, The City of Rockdale Water Quality Monitoring Study (Equatica, 2014) was released and this included four monitoring sites within the study area (refer Figure 13). Three locations along Wolli Creek, namely:

- Bonalbo Street, Kingsgrove (WC1)
- Roughly 150 metres downstream of Bexley Road, near Slade Road, Bardwell Valley (WC2)
- Henderson Street, Turrella (WC3)
- At a small mangrove wetland between Marsh Street and Levey Street, Wolli Creek, roughly 200 metres from the Cooks River at Marsh Street Bridge (LS 1).

A summary of the parameters analysed during the study is shown Table 12 . The report concluded that Wolli Creek showed:

- Dissolved oxygen (DO) levels higher than guidelines range at the upstream location (Bonalbo Street) and low dissolved oxygen the other locations
- pH levels were generally acceptable, though above the guidelines on one instance at Bonalbo Street and below the threshold on four instances at Henderson Street
- Median turbidity generally falling within the guidelines but exceedance occurs at most sites
- Elevated levels of nutrients (Total Nitrogen (TN), Nitrates (nitrogen oxides, NO_x) and Total Phosphorous (TP) at all sites on the majority of samples. Nitrogen at its highest after the confluence of Bardwell Creek
- High levels of copper at all sites, decreasing downstream where the majority of samples showed acceptable levels
- High levels of zinc at all sites, increasing downstream
- Faecal coliforms (Enterococci) exceeded the guidelines for secondary recreational contact at times at all sites.

The mangrove site near Marsh Street is poorly flushed and was observed to have suspected iron bacteria covering the surface and lower branches of mangroves. Samples showed:

- Dissolved oxygen below the guideline range
- Low pH during some tests
- Turbidity above the guidelines
- Nutrients (TN, NO_x and TP) above the guidelines
- Zinc levels above the threshold
- Faecal coliforms (enterococci) were found above the guidelines for secondary recreational contact.

Sydney Water monitors the intertidal communities at Wolli Creek. In 2007-08 the estuarine health at the Wolli Creek site continued to improve from 'Mild impact or disturbed' in 2004-2005, approaching 'Clean or not disturbed' in 2005-2006. This improved situation was maintained into 2007. In 2008-09 the community structure of intertidal organisms in 2008-09 at Wolli Creek was comparable to that at control locations having a biological community dominated by oysters and gastropods and can both be regarded as 'Healthy' (Marrickville Council, 2009).

4.6.2 Cooks River

The 2011 Annual Water Quality Study by the Cooks River Valley Association (2010/2011) reported on a range of water quality parameters measured by Streamwatch at locations in the Cooks River catchment. Sampling at Younger Road, Earlwood (CR1), Wardell Road, Marrickville (CR2), Bruce Street, Marrickville (CR3) and Richardson Crescent, Tempe (CR4) gave an indication of water quality in the Cooks River, upstream of the project (refer Figure 13). The results of their reporting are summarised in Table 13.

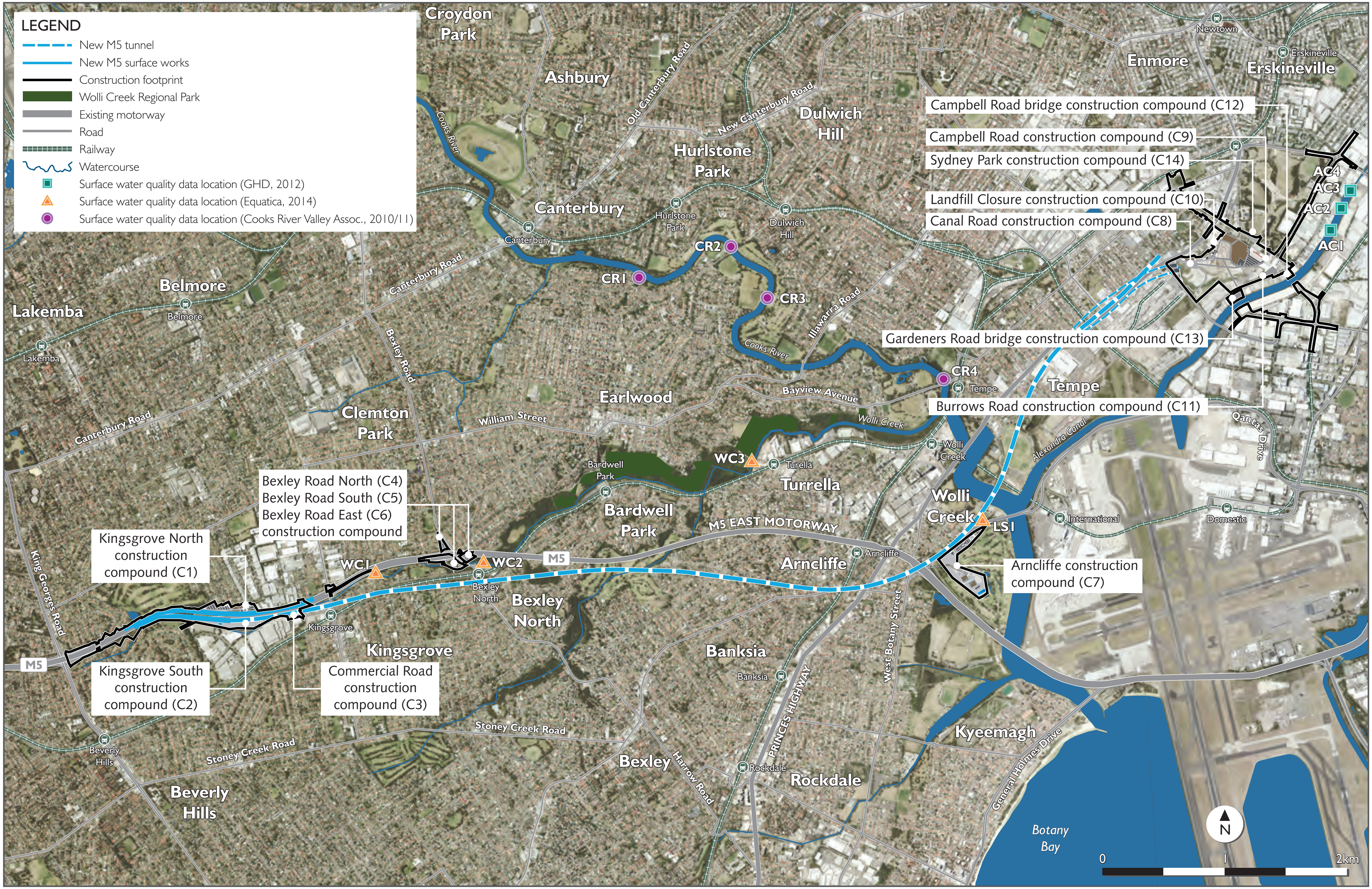

Figure 13 Water quality data locations

The study concluded that water quality at a number of locations in the Cooks River is generally poor with frequent occurrences of test results outside the ANZECC Water Quality Guidelines (ANZECC, 2000). The following were noted at through the four sites

- DO was below the suggested lower threshold at all sites
- Turbidity was above the threshold during all tests at all four sites
- Filterable Reactive Phosphorus was found well above the guidelines at all sites
- E.coli was predominantly above the guideline at all sites
- Faecal coliforms (E.coli) were found at levels above the trigger for secondary contact at Younger Avenue and Wardell Avenue. Test sites further downstream contained fewer coliforms, particularly at Richardsons Crescent where the median of tests were acceptable for primary contact
- pH fell within the guideline range for a majority of samples.

To inform an understanding of metal concentrations in the river, recent samples taken have also been included in Table 14. These show high levels of nutrients as well as copper and zinc. Details of the sample sites are provided in Appendix B.

Prior studies of water quality in the Cooks River catchment have provided the following remarks about various contaminants (CRSMP, 2011):

- Nutrients – Phosphorus and Nitrogen – Found in high levels in the Cooks River. Sources include pets and birds, fertilisers, detergents, sewage discharges and golf courses
- Chlorophyll-a – High levels, at or approaching bloom status
- 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 or Turbidity – Results for all Cooks River catchments in the past have indicated results well above the ANZECC Water Quality Guidelines (ANZECC, 2000)
- pH – Results of testing the Cooks River have tended to indicate compliance with pH guidelines.

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

Table 12 Water quality in Rockdale LGA (City of Rockdale Water Quality Monitoring Study (Equatica, 2014))

Parameter	Wolli Creek: Bonalbo St, Kingsgrove (WC1) (Lowland Freshwater River)		Wolli Creek: Slade Rd, Bardwell Valley (WC2) (Lowland Freshwater River)		Levey St Wetland: Henderson St, Turrella (WC3) (Estuary/Marine)		Levey St Wetland: Levey St, Wolli Creek (LS1) (Estuary/Marine)		ANZECC (2000) default trigger values*	
	Range	Median	Range	Median	Range	Median	Range	Median	Lowland rivers	Estuaries
Dissolved oxygen (% Sat)	91-182	135.5	9-109	75.5	15-151	53	13-50	17.5	85-110	80-110
Temp (°C)	12.1-27.5	21.4	9.4-22.8	18.8	10.8-23.6	19.45	15.5-26	21.5	-	-
pH	6.63-8.52	7.205	6.52-7.93	6.865	6.02-7.86	6.65	6.2-7.5	6.965	6.5-8.0	7.0-8.5
Turbidity (NTU)	1.5-290	8.05	2-64	6.7	2.5-23	5.55	15-370	110	6-50	0.5-10
Total suspended solids (TSS) mg/L	5-200	13	5.5-52	16.5	6-13	11	8.5-110	51		
EC (µS/cm)	70-3030	1340	220-4600	725	*	*	*	*	125-2200	n/a
NOx (µg/L)	20-2200	190	20-940	420	170-1900	785	120-210	165	40	15
TKN (µg/L)	300-1800	700	200-3800	750	400-9000	1000	300-2200	1200		
TP (µg/L)	20-130	60	20-320	70	30-230	55	20-320	125	50	30
BOD (mg/L)	2-7.1	2.8	2.3-9.3	4.3	2.4-5.2	2.95	3.4-11	6.9		
Chl - a (ug/L)	< 0.2-< 0.2	< 0.2	< 0.2-< 0.2	< 0.2	< 0.2-< 0.2	< 0.2	< 0.2-< 0.2	< 0.2	5	4
Parameter	**ANZECC (2000) trigger value for protection of 80% of marine species**								**Freshwater**	**Marine Water**
As (µg/L)	<1-2	2	1	1	1-2	1.5	2	2	360 (III) 140 (V)	ID
Cd (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.8	36
Cr (µg/L)	<1	<1	<1	<1	<1	<1	<1	<1	40 (VI)	90.6 (III) 85 (VI)

Parameter	Wolli Creek				Levey St Wetland					
	Bonalbo St, Kingsgrove (WC1) (Lowland Freshwater River)		Slade Rd, Bardwell Valley (WC2) (Lowland Freshwater River)		Henderson St, Turrella (WC3) (Estuary/Marine)		Levey St, Wolli Creek (LS1) (Estuary/Marine)		ANZECC (2000) default trigger values*	
	Range	Median	Range	Median	Range	Median	Range	Median	Lowland rivers	Estuaries
Cu (µg/L)	4-8	5.5	3-7	3.5	1-7	2	<1-3	2.5	2.5	8
Pb (µg/L)	<1-2	1.5	<1-1	1	<1-2	2	<1	<1	9.4	12
Ni (µg/L)	<1-1	1	1-3	1	<2-2	1	<3-2	2	17	560[3]
Zn (µg/L)	<5-46	15	9-60	23.5	6-52	33	14-82	51	31	43
Water quality guidelines for recreational waters										
Enterococci (MPN/100 mL)	20-16000	170	74-20000	470	10-9200	114	20-9200	390	35[1]	230[2]

** ANZECC (2000) default trigger values for physical and chemical stressors for south-east Australia for slightly to moderately disturbed ecosystems. Trigger values for toxicants are for 80 per cent protection of marine species.*

1 = Maximum for any one sample for primary contact associated with recreational purposes.

2 = Maximum for any one sample for secondary contact associated with recreational purposes.

3 = Figure may not protect key test species from acute toxicity (and chronic).

ID = Insufficient data. DO = dissolved oxygen, TSS = Total Suspended Solids, EC = Electrical conductivity, NOx = Nitrate + Nitrite, TKN = Total Kjeldahl Nitrogen, TP = Total Phosphorus, FRP = Filterable Reactive Phosphorus, BOD = Biological Oxygen Demand, Chl-a = Chlorophyll a, As = Arsenic, Cd = Cadmium, Cr = Chromium, Cu = Copper, Pb = Lead, Ni = Nickel, Zn = Zinc.

Shading indicates that recorded data is outside of the respective guidelines.

Table 13 Water quality in the Cooks River (CRVA, 2011)

Parameter	Cooks River: Younger Ave, Earlwood (CR1)		Wardell Rd, Marrickville (CR2)		Bruce St, Marrickville (CR3)		Richardsons Cr Marrickville (CR4)		ANZECC (2000) Default Trigger Values*
	Range	Median	Range	Median	Range	Median	Range	Median	
DO %	11-98	40	16-67	32	30-82	55	38-68	56	80-110
Temp (ºC)	12-24	19	14-19	19	14-25	20	12-29	21	-
pH	7.5-9.0	8.5	8	8	8.0-9.0	8.5	8.0-9.0	8	7.0-8.5
TURB (NTU)	15-30	18	<10-20	10	10-15	15	10-20	15	0.5-10
FRP (µg P^{-1})	0-390	180	80-270	160	40-540	130	90-280	140	30
E.coli	100-70,000	2,500	200-6,800	2,000	100-7,300	400	<100-900	<100	1,000*

**ANZECC (2000) default trigger values for physical and chemical stressors for south-east Australia for slightlyto moderately disturbed ecosystems (estuaries)*
DO = dissolved oxygen, TURB = Turbidity, FRP = Filterable Reactive Phosphorus, EC = Electrical conductivity
Shading indicates that recorded data is outside of the respective guidelines

Table 14 Water quality in the Cooks River (AECOM, 2015)

Parameter	Site 3 - Cooks River- Levey Street, Wolli Creek &		Site 4 – Cooks River - Riverine Park, Arncliffe		ANZECC (2000) default trigger values*
	Range	Median	Range	Median	Estuaries
NOx (µg/L)	130-290	155	90-870	125	15
TN (µg/L)	500-1300	800	300-1400	700	300
TP (µg/L)	60-90	75	40-140	70	30
Parameter	**ANZECC (2000) trigger value for protection of 80% of marine species for marine water**				
As (µg/L)	10-28	10	1-10	10	ID
Cd (µg/L)	1-5.5	1	0.1-1	1	36
Cr (µg/L)	10-22	10	1-10	10	90.6 (III) 85 (VI)
Cu (µg/L)	10-107	10	7-10	10	8
Pb (µg/L)	10-36	10	4-10	10	12
Ni (µg/L)	10-16	10	1-10	10	560[3]
Zn (µg/L)	50-120	50	21-52	50	43
Mn (µg/L)	10-49	19.5	10-49	11.5	N/A
Fe (µg/L)	440-470	500	240-640	500	N/A

** ANZECC (2000) default trigger values for physical and chemical stressors for south-east Australia for slightly to moderately disturbed ecosystems. Trigger values for toxicants are for 80 per cent protection of marine species.*

3 = Figure may not protect key test species from acute toxicity (and chronic).

ID = Insufficient data. NOx = Nitrate + Nitrite, TN = Total Nitrogen, TP = Total Phosphorus, As = Arsenic, Cd = Cadmium, Cr = Chromium, Cu = Copper, Pb = Lead, Ni = Nickel, Zn = Zinc, Mn=Manganese

Shading indicates that recorded data is outside of the respective guidelines.

4.6.3 Alexandra Canal

Alexandra Canal is a heavily polluted waterway, impacted by a past and present discharges and runoff. A range of studies conducted within the catchment indicated the following main sources of pollution:

- Stormwater pollution including runoff from roads, industrial, commercial and residential premises
- Seeps and overflows form the sewer system.
- Discharges from industry.
- Contaminated land within the catchment combined with porous soils allowing leachate to migrate via stormwater or groundwater into the canal.
- Release of chemicals from contaminated sediments in the canal into the water column.
- Contaminated groundwater input (DPWS, 2004).

Older sediments are known to be highly contaminated, and these are overlain by more recent less contaminated sediments (UoQ, 2002).

In 2012 Sydney Water engaged GHD to undertake a Review of Environmental factors for the Alexandra Canal (6a Huntley Street, Stormwater Renewal Program). The study included water quality testing at four locations in the upper 350 metres of Alexandra Canal. Sampling locations are shown in Figure 13.

A summary of the parameters analysed during the study in relation to the ANZECC Water Quality Guidelines (ANZECC, 2000) for 80 per cent protection of marine water quality is shown in Table 15.

Table 15 Water sampling results in upper Alexandra Canal (GHD, 2012)

Parameter	Site AC1	Site AC2	Site AC3	Site AC4	ANZECC (2000) trigger value for protection of 80% of marine species
As ($\mu g\ L^{-1}$)	3	3	2	2	ID
Cd ($\mu g\ L^{-1}$)	0.2	0.1	<0.1	<0.1	36
Cr ($\mu g\ L^{-1}$)	<1	<1	<1	<1	85
Cu ($\mu g\ L^{-1}$)	1	3	3	<1	8
Pb ($\mu g\ L^{-1}$)	<1	<1	<1	<1	12
Ni ($\mu g\ L^{-1}$)	28	<1	<1	1	560
Zn ($\mu g\ L^{-1}$)	36	43	50	68	43
Hg ($\mu g\ L^{-1}$)	<0.1	<0.1	<0.1	0.2	1.4
Ammonia as N (µg/L)	540	470	410	-	1,700

Shading indicates that recorded data is outside of the respective guidelines.

The GHD study concluded that metal concentrations in the upper reaches of Alexandra Canal were below the ANZECC Water Quality Guidelines (ANZECC, 2000) for cadmium, chromium, Lead, nickel and mercury and Ammonia. Copper concentrations were greater than the 95 per cent though below the 80 per cent protection level at two sites. Zinc concentrations were greater than the 95 per cent trigger value at all test locations, and the 80 per cent value at other two test sites.

To supplement the data from the GHD study, results from four samples collected in 2015 are shown in Table 16. Details of the site are provided in Appendix B

Table 16 Water quality in Alexandra Canal (AECOM, 2105)

Parameter	Site 1- Alexandra Canal- Via Alexandra Cycleway, near Coward St		ANZECC (2000) default trigger values*
	Range	Median	Estuaries
Dissolved oxygen (% Sat)	34-53	45.5	80-110
Temp (°C)	9.5-19.8	14.6	-
pH	7.27-7.92	7.41	7.0-8.5
Turbidity (NTU)	2.3-256	9.6	0.5-10
EC (µS/cm)	11483-39060	24714	n/a
NOx (µg/L)	270-4710	1285	15
TN (µg/L).	900-5400	2600	300
TP (µg/L)	10-110	55	30

** ANZECC (2000) default trigger values for physical and chemical stressors for south-east Australia for slightly to moderately disturbed ecosystems. Trigger values for toxicants are for 80% protection of marine species.*

DO = dissolved oxygen, EC = Electrical conductivity, NOx = Nitrate + Nitrite, TN = Total Nitrogen, TP = Total Phosphorus

Shading indicates that recorded data is outside of the respective guidelines.

This data shows elevated levels of nutrients in the canal, almost always above the trigger values for slightly to moderately disturbed ecosystems.

Sydney Water monitors the intertidal communities at the confluence of Alexandra Canal with the Cooks River. From 2007 to 2009 the intertidal communities in Alexandra Canal were considered disturbed, and the canal was found to be poorly flushed with consistently elevated concentrations of chlorophyll-a (Marrickville Council, 2009).

4.6.4 Eastern Channel

Water quality within the Eastern Channel has recently been sampled near Murray Street Marrickville. The results are provided in Table 17 (AECOM, 2015). Details of the site are provided in Appendix B.

Table 17 Water Quality in the Eastern Channel (AECOM, 2015)

Parameter	Site 10- Eastern Channel- Murray St, Marrickville		ANZECC (2000) default trigger values*
	Range	Median	Estuaries
Dissolved oxygen (% Sat)	63-133	75	80-110
Temp (°C)	13.5-19	16.7	-
pH	8-8.8	8.3	7.0-8.5
Turbidity (NTU)	20-249	93.5	0.5-10
EC (µS/cm)	291-765	529	n/a
NOx (µg/L)	150-1580	1070	15
TN (µg/L)	1200-3200	2100	300
TP (µg/L)	30-140	80	30
	ANZECC (2000) trigger value for protection of 80% of marine species in marine water		
As (µg/L)	1-5	3	ID
Cd (µg/L)	0.1-1	<0.1	36
Cr (µg/L)	0.001-0.002	0.0015	90.6 (III) 85 (VI)
Cu (µg/L)	5-20	14	8

Parameter	Site 10- Eastern Channel- Murray St, Marrickville		ANZECC (2000) default trigger values*
	Range	Median	Estuaries
Dissolved oxygen (% Sat)	63-133	75	80-110
Temp (°C)	13.5-19	16.7	-
pH	8-8.8	8.3	7.0-8.5
Turbidity (NTU)	20-249	93.5	0.5-10
EC (µS/cm)	291-765	529	n/a
NOx (µg/L)	150-1580	1070	15
TN (µg/L)	1200-3200	2100	300
TP (µg/L)	30-140	80	30
	ANZECC (2000) trigger value for protection of 80% of marine species in marine water		
Pb (µg/L)	2-13	7.5	12
Ni (µg/L)	2-4	2.5	560[3]
Zn (µg/L)	30-61	42.5	43
Mn (µg/L)	53-64	56	N/A
Fe (µg/L)	600-1950	630	N/A

** ANZECC (2000) default trigger values for physical and chemical stressors for south-east Australia for slightly to moderately disturbed ecosystems. Trigger values for toxicants are for 80% protection of marine species.*

3 = Figure may not protect key test species from acute toxicity (and chronic).

ID = Insufficient data. DO = dissolved oxygen, EC = Electrical conductivity, NOx = Nitrate + Nitrite, TN = Total Nitrogen, TP = Total Phosphorus, As = Arsenic, Cd = Cadmium, Cr = Chromium, Cu = Copper, Pb = Lead, Ni = Nickel, Zn = Zinc, Mn=Manganese

Shading indicates that recorded data is outside of the respective guidelines.

The data shows that the Eastern Channel is of generally poor water quality – characteristic of a suburban drainage channel. The samples show particularly high levels of nutrients, well above the trigger values for the receiving water, the Cooks River estuary.

4.7 Sensitive receiving environments

The project has the potential to interact with a number of sensitive receiving environments, namely:

- The Cooks River
- Botany Bay
- Towra Point Wetlands
- Saltmarsh and other wetlands around the airport
- Green and Golden Bell Frog ponds at Arncliffe. These were constructed in conjunction with the M5 East Motorway. Water quality data from the two (east and west) ponds is shown in Table 18
- Seagrass in Botany Bay.

Potential impacts on groundwater dependent ecosystems and other sites of ecological significance are provided in Chapter 19 (Groundwater) and Chapter 21 (Biodiversity) of the EIS.

Table 18 Water quality in the Green and Golden Bell Frog ponds (White, 2015)

Parameter	Green and Golden Bell Frog pond – East		Green and Golden Bell Frog pond – West		ANZECC (2000) default trigger values*
	Range	Median	Range	Median	Lowland River
Dissolved oxygen (% Sat)	10.4-21.4	17.9	10.3-20.5	17.7	85-110
Temp (ºC)	16.5-23	17.5	16.5-23	17.5	-
pH	7.2-7.6	7.5	7.3-7.6	7.4	6.5-8.0
Turbidity (NTU)	1.4-5	2.6	1.3-4.8	3.1	6-50
EC (µS/cm)	235-440	337	260-442	341	125-2200

DO = dissolved oxygen, EC = Electrical conductivity.
Shading indicates that recorded data is outside of the respective guidelines.
** ANZECC (2000) default trigger values for physical and chemical stressors for south-east Australia for slightly to moderately disturbed ecosystems.*

The data shows the ponds have consistently low dissolved oxygen and turbidity, though maintain an acceptable temperature, pH and conductivity / salinity.