4.7 Surface water quality

4.7.1 Catchments and watercourses

The northern portion of the project lies within the Lower Nepean River Management Zone of the Hawkesbury-Nepean River Catchment, while the southern portion lies within the Mid Nepean River Catchment Management Zone and the Upper South Creek Management Zone. The Nepean River is the ultimate downstream receiving environment to the project area. It is significant both environmentally and economically and provides for a range of domestic and irrigation uses. However, the project itself is located a long distance from the river (about five kilometres at the closest point) and close to the catchment divide, just west of the eastern boundary of the catchment.

The catchment is shale-based and is characterised by meandering streams. It is also highly disturbed due to increasing urbanisation and associated land clearing. The study area falls within the hydrological catchments of Duncans Creek, Badgerys Creek, Cosgroves Creek, Mulgoa Creek, unnamed tributary of South Creek, Blaxland Creek and Surveyors Creek. The watercourses of Badgerys Creek, Cosgroves Creek, the unnamed tributary of South Creek and Blaxland Creek catchments drain east to South Creek which then flows north to join the Hawkesbury River at Windsor (refer to the Hydrology and Flooding Working Paper, **Appendix K** of the EIS). The watercourses of Duncans Creek, Mulgoa Creek, and Surveyors Creek catchments drain west to the Nepean River. Further detail is provided below for each catchment within the study area.

Cosgroves Creek

Within the Cosgroves Creek catchment the project will largely involve the construction of the alignment in green field land. This is not associated with any Commonwealth land. The project will directly traverse the main channel of Cosgroves creek and a number of unnamed tributaries. The catchments are largely rural and without residential development downstream of the site, with the exception of the Twin Creeks residential estate downstream of the site towards Cosgroves Creek's confluence with South Creek (GHD 2015).

Cosgroves Creek is an intermittent stream with a series of disconnected pools and a tributary of South Creek. Water quality data reported for Cosgroves creek in infers that the creek is poorly oxygenated, with elevated levels of total and ammoniacal nitrogen (DIRD 2016). Metal and pesticide concentrations were generally not detected. The creek has been classified as suffering from mild pollution based on macroinvertebrate communities present.

Badgerys Creek

Badgerys Creek is approximately 16 km long, rising near Bringelly, it flows north and then north east before its confluence with South Creek in the suburb Badgerys Creek. Land use within the Badgerys Creek catchment consists of agricultural (grazing of naturalised and modified pastures) and rural residential uses. The catchment includes areas within Commonwealth land. Ecologically sensitive riparian vegetation also exists within the catchment (GHD 2015) as do small areas of Landfill and forest. Badgerys creek has been reported to have highly dispersive soils. Within the Badgerys Creek catchment the project will comprise of a combination of upgrade to the existing road alignment and construction in green field land.

Badgerys Creek has been categorised as a second order intermittent stream containing permanent residual pools which provide refuge for fish habitat (Biodiversity Assessment Working Paper, **Appendix I** of the EIS). Badgerys creek and streams that flow into Badgerys Creek are generally nutrient enriched (nitrogen), with low dissolved oxygen and exhibit excessive algal growth (DIRD2016). Despite the poor water quality, Badgerys Creek supports a diverse ecosystem, although the macroinvertabrate species presented indicate that the ecological health is poor and generally mildly to moderately polluted (DIRF 2016).

Surveyors Creek and the Unnamed tributary of Surveyors Creek

Surveyors Creek is located on the north western side of the project area, and is a tributary of Peach Tree Creek which drains to the Nepean River near Penrith. The catchment includes areas within Commonwealth land. The quality of water in Peach Tree Creek is poor and reflective of a highly degraded system. Peach Tree Creek and Surveyors Creek receive a large proportion of flow from stormwater and as such the water quality is likely to be turbid with elevated nutrients, metals and other typical contaminants found in stormwater.

Mulgoa Creek, Blaxland Creek and an Unnamed Tributary of South Creek

The Northern Road upgrade would be constructed through the catchments of Mulgoa Creek, Blaxland Creek and an unnamed tributary of South Creek. Some of these catchments include areas located on Commonwealth land. These catchments are relatively small and the creeks themselves largely ephemeral. Mulgoa Creek catchment has been impacted by rural residential and urban development, as such the condition of the creek is likely to be poor with degraded water quality. Blaxland Creek which flows for approximately 10kms, passes through the Commonwealth Department of Defence Establishment Orchard Hills near Penrith. As such this section of the creek is largely untouched by development and likely to exhibit good water quality.

Duncans Creek

The project will involve construction of the Northern Road along green field land within the Duncans Creek catchment, some of which is located on Commonwealth land. The project will involve crossing a number of unnamed tributaries which drain to Duncans Creek, but does not directly traverse the creek itself. Much of the catchment is currently rural, however a large proportion of it will be redeveloped as part of the Western Sydney Airport. Similarly to other waterways, Duncans Creek suffers from very low dissolved oxygen and elevated levels of nitrogen.

4.7.2 Existing surface water quality monitoring

Whilst the project drains a number of hydrological subcatchments as identified above, for the purposes of this surface water quality assessment, only those waterways directly impacted by the project have been assessed in detail in terms of existing surface water quality as outlined below.

Visual inspection of existing environment

The project directly traverses a number of unnamed tributaries and drainage lines (some of which are associated with farm dams) which are ephemeral in nature and have largely been modified due to the clearing of riparian vegetation and construction of farm dams. A summary of the water quality condition of the main waterways traversed by the project is provided in **Table 4-5** based on a visual site inspection at these locations. This visual site inspection also formed part of the aquatic habitat survey undertaken as part of the Biodiversity Assessment Working Paper (**Appendix I** of the EIS); therefore some site locations are referred to as per the associated aquatic survey location number.

Table 4-5 Water quality condition based on a visual site inspection

Site	Water quality condition
Badgerys Creek	Water quality appeared moderate, tannin stained and with some frothing and instream rubbish. Runoff from surrounding agriculture is likely to impact upon water quality.
Cosgroves Creek	Water quality appeared to be poor, with a thick algae bloom, oily film and frothing present in some of the stagnant pools.
'Site 29a'	Water quality appeared moderate, with anoxic odour within residual pools, tannin staining and filamentous algae present. Some rubbish such as tyres were present.

As outlined in the methodology section of this report (**Section 3**), sensitive receiving environments have been identified using aquatic habitat as an indicator. No watercourses were mapped as Key Fish habitat by DPI Water (2007). Sensitive receiving environments were instead determined using the NSW *Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management* (2013) and Fish Passage Requirements for Waterway Crossings (Fairfull & Witheridge 2003).

Five sensitive receiving environments have been identified as Type 1 – Key Fish Habitats (DPI 2013), as they had a combination of native aquatic plants and/or woody snags. These watercourses are impacted, intermittently flowing waterways which are also identified as Class 2 – Moderate Key Fish Habitat (Fairfull & Witheridge, 2003) due to the presence of limited in stream aquatic vegetation. The waterways are:

1. Badgerys Creek (287912.65E / 6244897.30N)

2. Cosgroves Creek (287247.11E / 6249490.76N)
3. 'Site 29a' (286060.62 E / 6246544.14N), an intermittent stream
4. The large dam at 'Site 39' (286460.594 E, 6247352.348N), fed by several minor 1st and 2nd order streams. These streams are ephemeral with minimal channel definition, only flowing when the upstream dams overflow
5. Unnamed tributary of Surveyors Creek (286887.04E/6257728.90N).

Whilst the waterways have been surveyed and generally contain suitable habitat for fish, the water quality of these site is generally poor to moderate (refer to **Table 4-5**) and flow at times intermittent. As such no threatened or protected fish species are expected to occur within the creeks located in the study area. Further information on potential fish habitat is provided in the Biodiversity Assessment Working Paper (**Appendix I** of the EIS).

Despite the unlikelihood of supporting protected or threatened fish, the sites did contain key fish habitat and therefore considered to be sensitive receiving environments to any changes in water quality. As such, these sites should be appropriately mitigated from any deterioration in water quality during the construction and operation of the project.

Key hydrological features of the project area are shown on **Figure 4-5**.

4.7.3 Monitoring data

Monthly sampling has been undertaken as part of the environmental assessment of the Western Sydney Airport in the project vicinity since November 2015. The sampling locations are also shown on **Figure 4-5**. The three monitoring sites most relevant to the project are described in **Table 4-6**.

Table 4-6 Monitoring sites relevant to the project

Relevant Sites	Location description
U/S Airport New	Badgerys Creek within project boundary
D/S Basin 8 Willowdene Ave	Duncans Creek, approximately 1.5 km downstream of the project location
D/S Basin 7 @ Adams Rd	Cosgroves Creek, approximately 1 km downstream of the project location

Table 4-7 provides a qualitative description of the water quality at the time of sampling. It suggests particularly poor conditions at the 'U/S Airport New' site on Badgerys Creek.

Table 4-7 Qualitative monitoring results (source: GHD Western Sydney Airport)

Site	Date	Sample appearance	Water surface conditions	Nuisance organisms
D/S Basin 7 @ Adams Rd	2/11/2015	Brown, slightly turbid	Gross pollutants, tyres	
	8/12/2015	Clear		
	5/01/2016	Brown	Some plant matter	
	4/02/2016	Opaque	Gross pollutants	
	2/03/2016	Black, no flow through, pools	Leaf litter	Gambusia
D/S Basin 8 Willowdene Ave	2/11/2015	Light brown, cloudy		Algae
	8/12/2015	Clear	Scum/sheen	Gambusia
	5/01/2016	Brown, slightly turbid	Plant matter	
	4/02/2016	Mostly clear		
	2/03/2016	Mostly clear	Plant matter, sheen	Gambusia

Site	Date	Sample appearance	Water surface conditions	Nuisance organisms
U/S Airport New	2/11/2015	Light brown, cloudy, reeds	Gross pollutants on banks	
	8/12/2015	Brown, turbid	Gross pollutants	
	5/01/2016	Turbid	Plant matter, gross pollutants	
	4/02/2016	Black, smelly	Oily sheen, gross pollutants on bank, reeds cut back	
	2/03/2016	Brown, turbid	Few gross pollutants, plant matter	Algae

Table 4-8 and Table 4-9 provides the water quality monitoring results, with a comparison to the ANZECC/ARCMANZ (2000) and HRC (1998) trigger values to determine how existing water quality meets criteria for the nominated environmental values of aquatic ecosystems and visual amenity.

Monitoring highlights low levels of dissolved oxygen and very high levels of total nitrogen across all sites. At the 'U/S airport new' site on Badgerys Creek, it highlights large exceedances of the trigger levels for turbidity, suspended solids, total nitrogen, ammonia, NOx, phosphorus and sometimes Chlorophyll-a. Waterways in the area are known to exhibit elevated nutrient concentrations, hence the higher trigger values recommended by the HRC for TN and TP. Nutrient concentrations at the site monitored were well in excess of these trigger values on every occasion for TN and all but one occasion for TP. As such the waterways in the study area are considered eutrophic and generally exceed the both the nominated HRC and ANZECC/ARMCANZ guidelines for protection of aquatic ecosystems. The water surface conditions reported during sampling infer that the visual amenity of the creeks is generally poor.

Metal concentrations varied throughout the sites. Arsenic, cadmium and mercury were either not detected or detected in very low concentrations at all sites. Chromium levels were elevated in Badgerys Creek and exceeded the recommended guideline on all occasions but generally not detected or in low concentrations at the other sites with the exception of one exceedance at Cosgroves Creek. Copper and zinc concentrations were consistently elevated in Badgerys Creek exceeding the recommended limit for protection of 95% of aquatic species. These metals were only detected in excess on a few occasions at the other sites. Overall metal concentrations, particularly copper and zinc are elevated, most noticeably in Badgerys Creek, which also exhibits high concentrations of chromium and nickel.

Table 4-8: Water quality monitoring data (phys-chem and nutrients) (source: GHD Western Sydney Airport)

Site	Date	Conductivity (µS/cm)	pH (in situ)	Dissolved Oxygen (% sat)	Turbidity (NTU)	Suspended Solids (mg/L)	Ammonia (mg/L)	TN (µg/L)	TP (µg/L)	Chl-a (µg/L)	NOx (µg/L)
ANZECC/ARMCANZ (2000) trigger levels	Min:	125	6.5	85	6	-	-	-	-	-	
	Max:	2200	8.5	110	50	40	20	350	25	3	40
HRC trigger values	Max:	-	-	-	-	-	-	700	35	-	-
D/S Basin 7 @ Adams Rd (Cosgroves Creek)	2/11/2015	228.4	6.85	49.7*	39	6	20	1,100*	90*	2	30
	8/12/2015	2273	7.98	23.7*	2.42*	6	40*	1,300*	40*	7	40
	5/01/2016	172	7.9	69.1*	20.7	<5	30*	700*	40*	1	20
	4/02/2016	527	7.62	49.5*	11.1	<5	10	1,000*	5	2	<10
	2/03/201	2322	8.1	5.9*	24.8	16	10	1,800*	130*	9	<10

Site	Date	Conductivity (µS/cm)	pH (in situ)	Dissolved Oxygen (% sat)	Turbidity (NTU)	Suspended Solids (mg/L)	Ammonia (mg/L)	TN (µg/L)	TP (µg/L)	Chl-a (µg/L)	NOx (µg/L)
	6		6								
D/S Basin 8 Willowdene Ave (Duncans Creek)	2/11/2015	2168	8.04	51.2*	32.4	24	40*	2,600*	170*	<1	30
	8/12/2015	2019	8	43.6*	9.39	26	280*	1,700*	111*	145*	40
	5/01/2016	1045	7.8	63.3*	32.8	11	40*	800*	70*	3	50*
	4/02/2016	432	7.78	65.7*	19.7	9	10	800*	70*	4	30
	2/03/2016	2253	8.33	26.4*	16	10	160*	1,000*	50*	16*	30
U/S Airport New (Badgerys Creek)	2/11/2015	1841	7.44	39.5*	511*	52*	1,700*	9,800*	2,020*	46*	3,940*
	8/12/2015	3744	7.95	11.7*	450*	180*	95,200*	100,000*	13,800*	3	210*
	5/01/2016	1638	7.75	13.6*	296*	159*	3,980*	46,600*	6,330*	4	22,200*
	4/02/2016	1839	7.28	28*	70.6*	40	4,950*	19,300*	8,450*	<1	10
	2/03/2016	1877	7.73	11*	127.5*	23	4,750*	7,800*	3,670*	28*	<10

***Outside maximum or minimum HRC *and* ANZECC/ARCMANZ (2000) trigger levels**

^ Exceed HRC trigger values but do not exceed ANZECC/ARCMANZZ (2000) trigger levels

Table 4-9: Water quality monitoring data (metals) (source: GHD Western Sydney Airport)

Site	Date	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Mercury (mg/L)
ANZECC/ARMCANZ (2000) Toxicant Values		0.013	0.0002	0.001	0.0014	0.0034	0.011	0.008	0.0019
D/S Basin 7 @ Adams Rd	2/11/2015	<0.0014	<0.0001	0.002*	0.012*	0.001	0.001	0.014*	<0.0001
	8/12/2015	<0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.0001
	5/01/2016	<0.001	<0.0001	<0.001	0.006*	<0.001	<0.001	<0.005	<0.0001
	4/02/2016	0.001	<0.0001	<0.001	0.002*	<0.001	0.001	<0.005	<0.0001
	2/03/2016	0.005	<0.0001	<0.001	<0.001	<0.001	0.004	<0.005	<0.0001
D/S Basin 8 Willowdene Ave	2/11/2015	0.001	<0.0001	0.001	0.003*	<0.001	0.002	0.009*	<0.0001
	8/12/2015	0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001

Site	Date	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Mercury (mg/L)
	5/01/2016	<0.001	<0.0001	<0.001	0.005*	<0.001	0.003	0.010*	<0.0001
	4/02/2016	<0.001	<0.0001	<0.001	0.002*	<0.001	0.001	<0.005	<0.0001
	2/03/2016	0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.0001
U/S Airport New	2/11/2015	0.006	<0.0001	0.002*	0.018*	0.002	0.006	0.032*	<0.0001
	8/12/2015	0.010	0.0001	0.003*	0.076*	0.004*	0.021*	0.293*	<0.0001
	5/01/2016	0.009	<0.0001	0.004*	0.069*	0.003	0.014*	0.082*	<0.0001
	4/02/2016	0.007	<0.0001	0.002*	0.024*	0.002	0.011*	0.058*	<0.0001
	2/03/2016	0.008	<0.0001	0.002*	0.005*	0.001	0.007	0.011*	<0.0001

***Exceeds ANZECC/ARMCANZ (2000) trigger value for toxicants for protection of 95% of species**

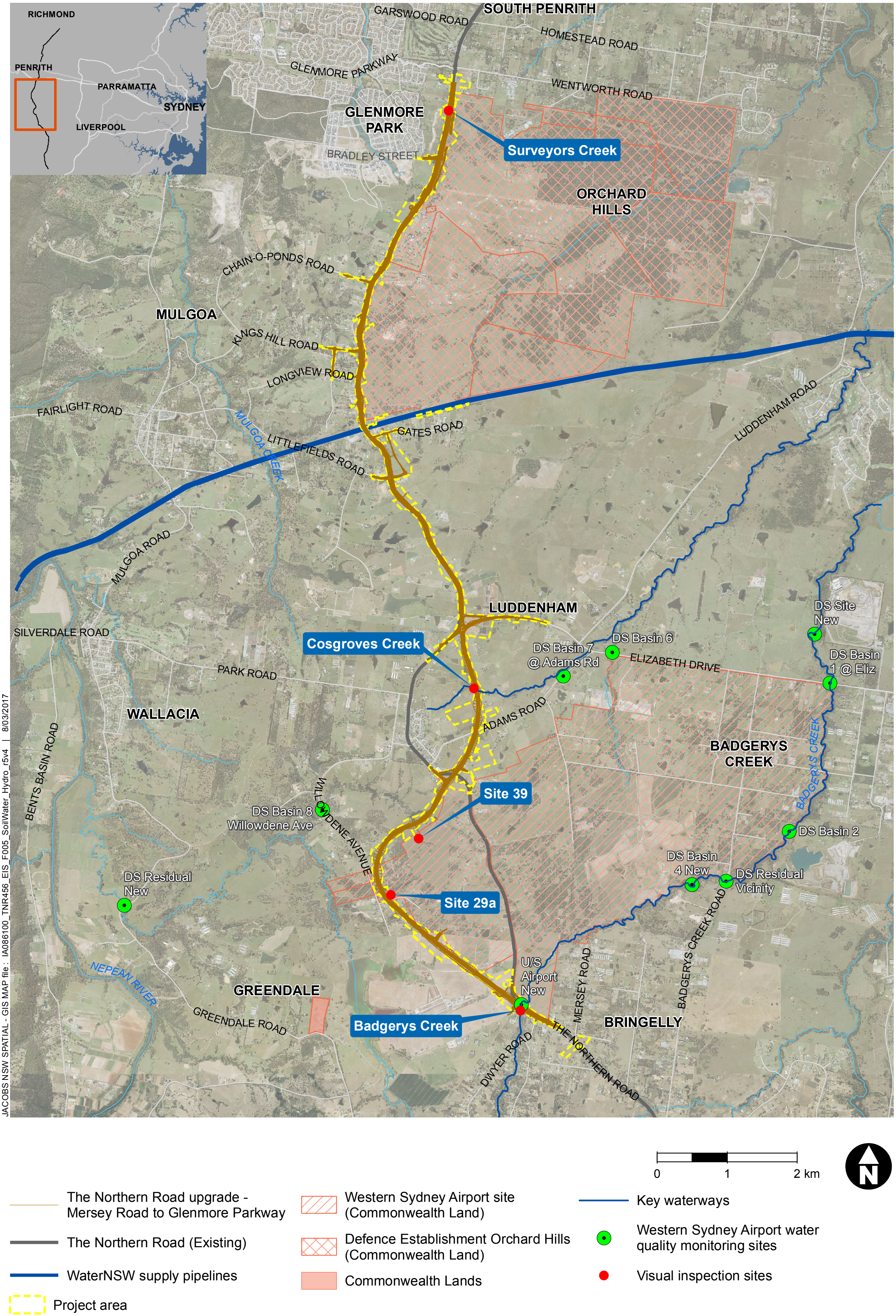


Figure 4-5 | Key hydrological features

4.8 Groundwater

It is expected that three groundwater systems exists along the project alignment including shallow incidental perched aquifers, a regional shallow unconfined water table, and a deep confined aquifer unit.

The perched and shallow regional aquifers are contained within the weathered and fresh Wianamatta Group. The Wianamatta Group shales are characterised by saline groundwater due to marine deposition, and are generally not considered beneficial aquifers. The Wianamatta shales are generally low in permeability and occasionally have minor aquifers and perched water tables. These units behave as aquitards. The Wianamatta Shale is a low permeability formation and therefore the contribution of this aquitard to baseflow in surface water courses is expected to be minor to negligible. The regional water table has an approximate depth of 35mbgl (metres below ground level) as indicated by works summaries obtained from DPI Water. If present the shallow perched water tables, are expected to range from 2 to 30 mbgl depending on the depth of weathering and are anticipated to act in an unconfined manner.

The deep groundwater system comprises the Hawkesbury Sandstone. Recharge to the Hawkesbury Sandstone is expected to occur from rainfall and surface water interaction along the Lapstone Monocline along the far eastern edge of the Blue Mountains (west of the project alignment) and to a minor extent vertical percolation from the overlying Wianamatta Shale. Groundwater flow direction is expected to be north-easterly within the Hawkesbury Sandstone. There are some faults in the area that could indicate enhanced connectivity between the shallow and deeper groundwater systems. The deep groundwater system is considered to behave as a confined aquifer.

4.9 Conceptual Hydrogeological Model

The conceptualised hydrogeological model for the site is presented in **Figure 4-6**. The figure depicts the idealised key interactions between the surface water, regional shallow aquifer and regional deep aquifer systems.

The conceptual model consists of three groundwater systems that have potential to interact with the project as follows:

- Localised perched aquifer systems located in the shallow weathered shale and clay. Road cuttings are not expected to exceed 10m across the project. It is possible that the road cuttings will intercept incidental perched aquifers. The flow from these pockets is expected to be minor to negligible due to the low hydraulic conductivity of weathered shales and clays. These aquifers are likely to recharge and discharge during rainfall events. The Sydney Basin Central Groundwater Source is defined as a less productive groundwater source
- The Bringelly shale represents the regional shallow aquifer system. The depth to the groundwater table is expected to vary across the project, however because the project is largely centred on a topographic ridge, the depth to water is expected to be approximately 30mbgl. The water quality in this aquifer unit is expected to be of poor quality (high TDS) and low hydraulic conductivity. This unit is generally of limited beneficial use for potable or domestic use. The Sydney Basin Central Groundwater Source is defined as a less productive groundwater source
- The Hawkesbury Sandstone represents the deeper semi-confined regional aquifer. The Hawkesbury sandstone is generally of better quality than the shallow groundwater table. Local water supplies tend to be screened in this unit as it is more suitable for stock and domestic uses. This unit has a low primary hydraulic conductivity. This depth to this unit varies from 100 to 130mbgl. Groundwater in the shallow groundwater table is expected to generally flow north-east, down hydraulic gradient towards the Nepean River.

4.9.1 Surrounding Groundwater Users

There is limited groundwater use near the alignment of the project due to the geological environment comprising low permeability shale, siltstone and sandstone. Registered groundwater works were identified during a review of the DPI Water's Groundwater PINNEENA online database (accessed March 2016), which provides current groundwater works data across NSW. All groundwater works within a one kilometre radius (excluding monitoring bores) that are considered to extract groundwater were assessed as potential groundwater receptors to the project.

One work (GW108906) was identified within the study area (**Table 4-10**) and was drilled into un-weathered shale and sandstone. Other groundwater works within the study area are monitoring piezometers installed into the Wianamatta Shale. It is presumed these monitoring piezometers refer to local, site specific investigation for geotechnical or due diligence purposes. Data obtained from PINNEENA indicates the groundwater work (GW108906) is currently inactive.

Table 4-10 Groundwater Supply Works

Groundwater Works ID	Easting	Northing	Depth (mBGL)	Screen (mBGL)	Formation	SWL (mBMP)	Use	Lot/DP
GW108906	287656	6259328	186	48.9	Sandstone / Shale	30	test bore	11/831409

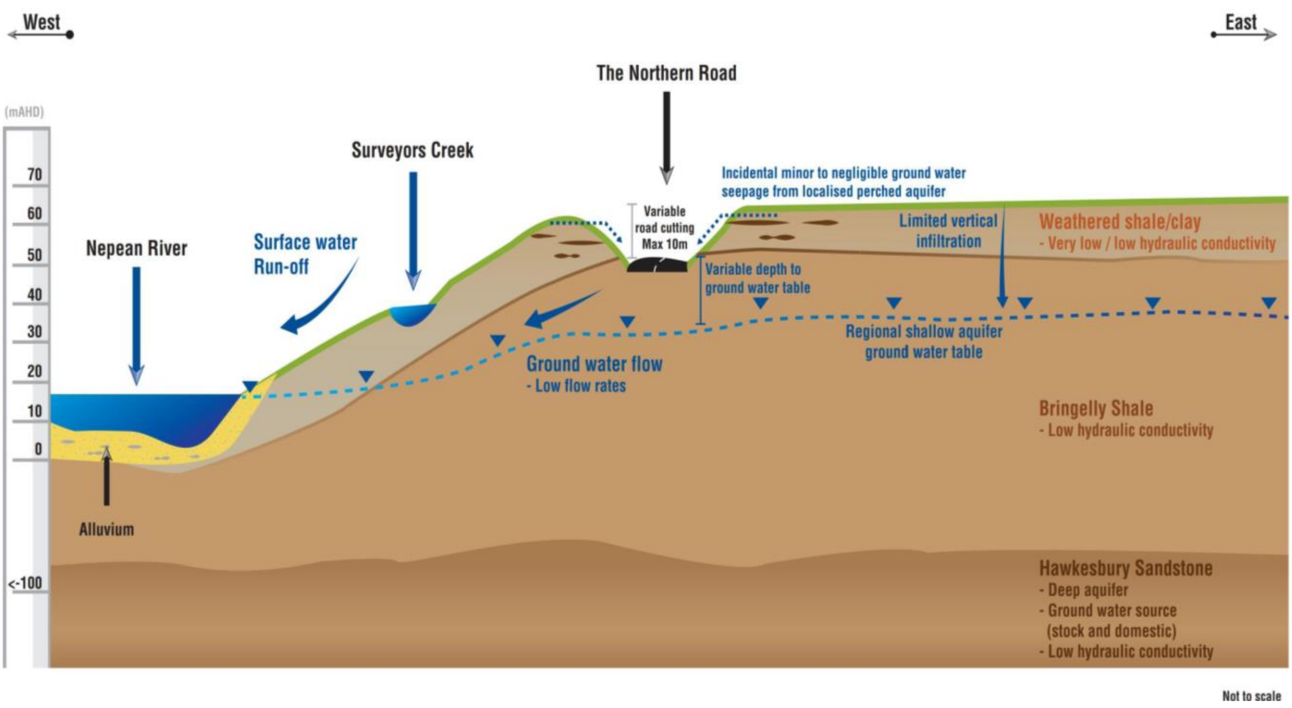


Figure 4-6 The Northern Road conceptual hydrogeological model

4.9.2 Surrounding Water Access Licences

The Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 has established distance regulations to minimise interference between water supply works. A 400 m search for bores was conducted to comply with the minimum distance restrictions from an approved water supply work within the Sydney Basin Central Groundwater Source. There are no active Water Access Licences within 400 m of the study area.

4.10 Groundwater Dependant Ecosystems

A review of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* indicates there are no listed high priority GDE's located in the study area.

This Biodiversity Assessment Working Paper (**Appendix I** of the EIS) prepared for the project uses the definition of a groundwater dependent ecosystem (GDE) as outlined by Serov *et al.* (2012) which is an ecosystem which has its species composition and natural ecological processes wholly or partially determined by groundwater. The location of GDEs within the within the Hawkesbury Nepean CMA area is mapped by Kuginis *et al.* (2012). No high probability GDEs are mapped within or near the study area by Kuginis *et al.* (2012).

The majority of watercourses within the study area are ephemeral and most flow events occur in direct response to major rainfall. These systems are not considered to support GDEs (Serov *et al.* 2012). There is no evidence of baseflow feeding any of the streams within the study area. As such, none of the riparian zones within the study area are considered to be GDEs.

Similarly, a review of the Bureau of Meteorology Groundwater Dependent Ecosystems (GDE) Atlas did not indicate the presence of other groundwater dependent ecosystems.

5. Assessment of potential construction impacts

5.1 Geology and soils

Construction would remove vegetation during early works, clearing and grubbing. Excavations would be required at cut and fill locations along the proposed alignment, generally around the Western Sydney Airport site bypass. The construction of underpasses at Adams Road and near the Leppington Pastoral Company would also require significant earthworks. These types of construction activities have the potential to expose bare ground and soils.

Excavation would involve the stockpiling of spoil prior to reuse or removal from site. These and related construction activities would give rise to potential for erosion of unconsolidated material and entrainment by runoff and subsequent transported off site.

As identified in **Section 4.3**, the existing soil landscape groups within the project area consist of three principal soil landscapes. This includes the Luddenham and South Creek soil landscape groups which have been identified as having a high soil erosion hazard.

Soil erosion and sedimentation are risks posed to surface water quality throughout the construction phase through increased sediment loads entering downstream environments. Soil loss could occur due to the effects of wind or water. Soils transported into local drainage channels could have a number of impacts including:

- Reduced hydraulic capacity due to deposition of material within the channel
- Degraded water quality including lower DO levels, increased nutrients (nitrogen (N), phosphorus (P)), increased turbidity, and altered pH
- Increased levels of nutrients, metals and other pollutants transported via sediment and runoff to receiving waterways leading to increased potential for bioaccumulation of heavy metals in aquatic species
- Increased sedimentation smothering aquatic life and affecting aquatic ecosystems.

As outlined in **Section 3.1.6**, the Acid Sulfate Soil Probability within the project alignment was classified as Extremely Low Probability of occurrence. ASS is therefore not considered to be a risk to the project.

Surface water and groundwater can also dissolve and mobilise salts and cause their accumulation in other areas. Excessive concentrations of salt in such areas can affect plant growth, soil chemistry and cause weakening and degradation of construction materials such as masonry, concrete and bitumen. The assessment of salinity potential along the alignment was undertaken using the map of the salinity potential in western Sydney (NSW Department of Infrastructure, Planning and Natural Resources 2002). The majority of the alignment occurs in areas of moderate salinity potential. Construction activities are not expected to increase the potential for salinity impacts along the project corridor. Durability and aggressivity samples of soil material will be collected and analysed prior to the construction phase, to determine potential impacts of soil salinity on pavement infrastructure.

The geology of the site is not anticipated to be impacted by construction of the project.

5.2 Contaminated Land

Construction of the project, including the establishment of compound sites would partly occur in the existing road corridor (generally north of Littlefields Road) and along offline areas bypassing the Western Sydney Airport site and Luddenham.

Potential environmental impacts associated with these construction activities include:

- Inappropriate handling or disposal of contaminated or hazardous excavated materials
- Adverse effects on human health (construction personnel, travelling public or nearby communities)
- Release of contaminants into underlying soils
- Release of contaminants into groundwater
- Movement of contaminated sediments into stormwater systems

- Adverse effects on flora and fauna.

For the project, there is a potential for contaminated material to be disturbed through construction activities. The majority of AEIs identified are likely to pose a low risk of exposure to site users and environmental receptors to contamination during construction of the upgrade.

The following information summarises the AEI assessed as low to moderate and moderate risk from construction of the project:

- The stockpiles located on the eastern side of The Northern Road between Kingshill and Longview Roads, Orchard Hills are located close to the current road verge and could be disturbed as part of construction activities. The quality of the material within the stockpiles is unknown and could potentially contain contaminated material, including asbestos
- Although there is no evidence of UXO occurrence (from Commonwealth Department of Defence website) within or directly adjacent to the project area, explosives are used and are known to have been used at Defence Establishment Orchard Hills. Although the likelihood of encountering UXO during construction activities is likely to be low, the consequence if encountered could be high
- The market gardens located to the north and north east of the intersection of The Northern Road and Elizabeth Drive have been used historically and currently for intensive agricultural land use within and in the vicinity of the proposed upgrade. This land use could represent a potential source of contamination which could be exposed during construction activities. The contamination from agricultural activities is generally either point source (eg. localised chemical storage and use, waste disposal) or diffuse (broad acre pesticide or herbicide application). The biggest risk of exposure to agricultural contamination would be associated with point sources of contamination
- The stockpiles located on the western side of The Northern Road, north of Park Road, Luddenham are located close to the current road verge and could be disturbed as part of construction activities. The quality of the material within the stockpiles is unknown and could potentially contain contaminated material, including asbestos
- The WaterNSW supply pipelines corridor represents a potential source of contamination associated with the degradation of the external surfaces of the pipeline. The construction activities to be undertaken within the pipeline corridor poses an increased risk of exposure to contamination (if present) especially associated with excavations works within the corridor
- The non-operational service station (identified by concrete covered fill points in the carpark and vent stacks on adjacent building) located within the carpark of the Luddenham shops represents a potential source of contamination associated with leaks and spills from former fuel storage infrastructure (i.e. hydrocarbons and heavy metals). The location of the former service station in the near vicinity of the construction footprint of the upgrade poses an increased risk of exposure to contamination (if present) especially associated with deeper excavations
- The service station located to the south of the Luddenham shops on The Northern Road represents a potential source of contamination associated with leaks and spills from fuel storage infrastructure (i.e. hydrocarbons and heavy metals). The location of the service station in the near vicinity of the construction footprint of the upgrade poses an increased risk of exposure to contamination (if present) especially associated with deeper excavations
- The widespread agricultural land use within and in the vicinity of the proposed upgrade represent a potential source of contamination which could be exposed during construction activities. The contamination from agricultural activities is generally either point source (eg. localised chemical storage and use, waste disposal) or diffuse (broad acre pesticide or herbicide application). The biggest risk of exposure to agricultural contamination would be associated with point sources of contamination
- Although the location of car accidents are not accurately known, the release of fuels and oils from vehicle accidents and the potential use of aqueous film forming foam (AFFF) in the event of a vehicle fire could cause residual contamination in the vicinity of the accident site. Although contamination is likely to be very localised at these sites, the risk of exposure to contamination from these accident sites (if present) during construction of the upgrade is likely to increase as the accidents sites are likely to have occurred on the majority of the current road system which is within the construction footprint.

The majority of the AEIs are considered to represent a low risk with respect to contamination impacting upon construction of the project (refer to exposure risk levels identified in **Table 4-4**). Despite the low to moderate rating of the remainder of the potential AEIs within and adjacent to the project, the risk of contamination impacting upon proposed construction activities would be increased if excavation works take place within these areas.

5.3 Surface Water

The construction phase of the project presents a risk to further degradation of downstream water quality if management measures are not implemented, monitored and maintained throughout the construction phase. If unmitigated, the highest risk to water quality would occur through the following construction activities:

- General construction works that occur upstream of waterways such as Surveyors Creek, Cosgroves Creek and Badgerys Creek
- A number of construction activities would occur within the catchments surrounding the project as outlined above, namely Surveyors Creek, Cosgroves Creek, Badgerys Creek and unnamed tributaries and farm dams. The project would require traversing a number of these waterways and farm dams as follows:
  - Badgerys Creek
  - Cosgroves Creek
  - a number of unnamed tributaries of Duncan's Creek
  - an unnamed tributary of Surveyors Creek
  - a number of unnamed farm dams and watercourses

  Watercourse crossings would be designed and constructed to minimise impacts on natural flow regimes and to not present any barriers. All waterway crossings will be designed in conjunction with *Why do fish need to cross the road – Fish Passage requirements for Waterway Crossings (*Fairfull and Witheridge 2003) and the *Policy and Guidelines for Fish Friendly Waterway Crossings (*DPI 2004). Additionally, temporary watercourse crossings may be required for some or all watercourses traversed by the project to facilitate construction activities. If required, these watercourse crossings would likely comprise a temporary causeway with culverts to maintain the low flows, and they would likely be maintained for the duration of construction. Temporary watercourse crossings may impact on water quality due to the disturbance of bed and banks resulting in erosion and sedimentation, alteration of downstream flows potentially creating isolated stagnant pools of water and scouring of the bed near culvert inlets and outlets. A total of 11 culverts will be installed and/or replaced at the various waterway crossing locations as identified above. The type of each waterway crossing is provided in **Table 4.6** of the Biodiversity Assessment Working Paper (**Appendix I** of the EIS)
- The WM Act defines waterfront land as the bed of any river, lake or estuary and any land within 40 metres of the river banks, lake shore or estuary mean high water mark. All works on waterfront land will be carried out in accordance with the DPI Water Guidelines for Controlled Activities on Waterfront Land (2012), including but not limited to those related to instream works and waterway crossings.
- Additionally as identified in the Hydrology and Flooding Working Paper (**Appendix K** of the EIS, increases in the rate of flow in the receiving drainage lines could result in a lowering of the stream bed through a process of headwater erosion, as well as a possible widening of the watercourse through a process of bank erosion. The lining of channels and the concentration of flow could result in localised scour in the receiving drainage lines at the downstream limit of the drainage works. Scour protection measures such as dumped rock rip rap would be incorporated in the design of the project in order to reduce the scour potential in the receiving drainage lines (refer to **Appendix K** for further details)
- Disturbance/mobilisation of sediment associated with general earthworks including vegetation removal, stripping of topsoil and filling particularly when these sites are located close to waterways. Removal of vegetation and/or filling (generally minor) is proposed at several locations including Surveyors Creek and a tributary of Surveyors Creek, unnamed tributary near Elizabeth Drive, Cosgroves Creek and a tributary of Cosgroves near Adams Road, tributaries of Duncans Creek (particularly near Willowdene Avenue), Badgery's Creek and tributary of Badgerys Creek. Vegetation removal and filling is also proposed around a number of dams. Fill requirements throughout the project are generally minor however loose fill has the potential to be eroded during rainfall events by runoff, thereby increasing the potential for mass movements

of soils and sedimentation of the abovementioned waterways where filling is proposed. This has the potential to smother vegetation and change the soil surface characteristics and habitat of adjacent areas

- Clearing and subsequent flooding and erosion from construction in areas comprising of fine silt and clay can result in siltation of downstream watercourses and storages, particularly in relation to works in and around Cosgroves Creek and Badgerys Creek as identified in section 4.2 as likely to contain alluvium deposits comprising fine sands, silt and clay
- Construction works undertaken within 50 metres of the nominated sensitive receiving waterways (Type 1 Key Fish Habitat) (refer **Section 4.7**) has the potential to impact on bank stability and water quality through excavation, clearing or placement of construction stockpiles. Potential impacts associated with construction works include loss of suitable bank habitat, loss of in-stream shading and increased sedimentation of the watercourses through surface runoff. Detailed design has ensured that no stockpiles are placed within 50m of Type 1 – Key Fish Habitat waterways
- Disturbance and scour of the watercourse bed and banks particularly where culverts and other drainage works are proposed in Cosgroves, Surveyors and Badgerys Creeks resulting in erosion and sedimentation
- Dewatering activities during construction may mobilise sediments and contaminants, and increase the turbidity of the receiving environments along the project, potentially having an adverse impact on water quality if not appropriately managed
- Ancillary facilities to support construction would be required at various locations along the project. Ancillary facilities would include construction compounds, stockpile areas, material and waste storage areas including spoil stockpiles and other waste materials, sediment basins and concrete/asphalt batching plants. The final type, location and number of ancillary facilities would be determined by the construction contractor. The Hydrology and Flooding Working Paper (**Appendix K** of the EIS) has identified that there is the potential for flooding where proposed ancillary sites are proposed near Badgerys Creek. This has the potential to impact on the water quality at this site through flood waters mobilising sediments within stockpile and sediment basins, waste materials and chemicals associated with the ancillary facilities
- Stockpile sites would be used to temporarily store excess spoil and wastes such as concrete from demolition before their reuse on-site or disposal off-site. As stockpile sites present the potential for sediment-laden runoff to wash offsite into the storm water systems and receiving environment, all stockpile sites would include environmental protection measures such as sediment controls and hoardings to minimise impacts on sensitive receivers from dust and receiving waters from erosion and sedimentation and waste contamination. Stockpiles sites would be established and managed in accordance with Environmental Procedure Management of Wastes on Roads and Maritime Services Land (RMS, 2014)
- If stockpiles are to be located within the floodplain, the obstruction of flow paths and loss of floodplain storage has the potential to cause flooding impacts. Loose material stored within the floodplain has the potential to be mobilised during a flood and may impact on water quality downstream
- Construction activities adjacent to waterways could introduce contaminants such as oil or greases and disturb contaminated sediments, potentially having an adverse impact on water quality
- Changes to hydrology and flow have the potential to impact on artificial wetlands which comprise of farm dams, detention basins, roadside drains and effluent treatments systems. Impacts to wetlands are discussed in **Section 7.3** of the EIS and the Biodiversity Assessment Working Paper (**Appendix I** of the EIS)
- Relocation and protection of utilities including potential dewatering of potable water from watermains. Relocation of utilities would involve soil disturbance by trenching and underboring. The disturbance of soil by machinery could increase the potential for soil erosion. Potable water is chlorinated which has the potential to impact on downstream water quality. This has the potential to impact aquatic biodiversity if not managed appropriately
- Transportation of cut and/or fill materials throughout the study area
- Accidental leaks or spills of chemicals, fuels and oils from construction plant or construction materials
- Movement of heavy vehicles across exposed earth

- There is the potential for asbestos fibres to be present in existing stockpiles along the alignment which could potentially migrate through surface water flows if disturbed during construction and not appropriately controlled.

The introduction of pollutants from construction of the project into the surrounding environment if uncontrolled could potentially impact on the water quality of the receiving waterways including Surveyors Creek, Cosgroves Creek and Badgerys Creek, their unnamed tributaries and farm dams in the following ways:

- Increased sediment loads and organic matter from exposed soil during site disturbance and movement of construction vehicles, particularly following rainfall events. This can result in elevated turbidity levels and increased levels of nutrients, metals and other pollutants in downstream waterways in close proximity to the construction works. Increased sedimentation has the potential to smother aquatic life and affect the ecosystems of downstream waterways which would potentially impact on downstream users such as commercial and recreational users. Provided safeguards and management measures are implemented, the project would be unlikely to contribute significant amounts of sediment and organic matter to the immediate waterways. Additionally the waterways in the area have been described as generally low flow with disconnected pools or ephemeral, as such impacts are likely to be localised and occur under high flow conditions and impacts on the downstream environment negligible. Localised impacts such as a deterioration in water quality of farm dams would potentially impact on associated farm dam users
- Increased levels of litter, spoil and other waste materials from construction activities and ancillary sites polluting downstream watercourses
- Tannin leachate from clearing and mulching
- Chemical, heavy metal, oil and grease, and petroleum hydrocarbon spills from construction machinery directly contaminating downstream waterways
- Construction activities could introduce additional materials to local drainage lines, particularly during high rainfall events. Contaminants could include those from construction materials, rubbish, fuel and chemicals from accidental spills.

The potential impact on receiving waterways during construction would generally be mitigated through erosion and sediment controls including appropriately sized temporary sediment basins in accordance with the requirements of the Blue Book. A Surface Water Management Plan would be prepared as part of the environmental management plan prior to the commencement of construction. The plan would detail such measures for reducing the incidence of sediment, litter of chemical pollution reaching Surveyors Creek, Cosgroves Creek, Badgerys Creek and other nearby waterways within the study area during the construction phase. Waste storage and management procedures would also be developed and implemented during construction to ensure appropriate waste storage, transport and disposal management measures are implemented, in particular in relation to the proposed ancillary facilities.

Additionally preconstruction water quality monitoring would be undertaken upstream and downstream of proposed waterways that have the potential to be impacted during the construction of the project. This will provide an appreciation of the existing water quality and allow the development of site specific trigger values as per ANZECC/ARMCANZ (2000) to meet to ensure there is no further degradation in water quality or impact on the nominated environmental values.

Given the ephemeral nature of these waterways which are at times disconnected pools, the poor water quality and small volume of these streams and creeks is unlikely to impact on the downstream larger creeks and rivers to which they discharge. As such any changes in water quality are likely to be localised and not affect downstream users, particularly commercial and recreational users of South Creek and the Nepean River. Overall, potential impacts on surface water quality during construction are considered minor and manageable with the application of standard mitigation measures (as detailed in **Sections 7** and **8**).

5.3.1 Chronic and acute water quality impacts

Water quality impacts from construction are also discussed below in terms of chronic (or day to day) impacts and acute impacts (which result from a one-off severe event). Water quality during construction is proposed to be managed primarily through a series of sedimentation basins and other measures (refer **Section 7.1.1**). Temporary sediment basins have been designed in accordance with the Blue Book with key criteria considered including catchment area contributing to sediment basin, percentage of cut and fill in sub-catchment and whether basin is located in a sensitive receiving environment.

Chronic impacts to water quality are expected to be minimal as sediment basins have been designed for the 80th percentile, 5 day rainfall depth for most basins. Upstream of sensitive receiving environments, the Blue Book (Table 6-1 Vol 2D) requires that the 85th percentile be used construction projects with a duration of more than 6 months. Therefore some basins have been designed for the 85th percentile which means that they would be slightly larger. It should be noted however that larger storm events could result in overtopping of basins and the potential deposition of sediment and associated pollutants into receiving waterways.

Risks of acute water quality impacts during construction would primarily be related to spills or leaks of fuel/oil from machinery due to accidents or negligence. Given that sediment basins (50 in total) are proposed throughout the project area and are of an appropriate size to capture spills of this nature the likelihood of impacts to waterways is minimised. Additionally, onsite and offsite diversion drains, sediment fences, spill procedures, spill kits and erosion controls at the source will provide additional protection of waterways.

5.4 Groundwater

The main potential construction phase groundwater impacts relate to:

- Groundwater levels, flows and connectivity: These include changes to groundwater connectivity, groundwater flow direction, groundwater levels and recharge rates
- Groundwater chemistry: these include pollution of groundwater and changes to groundwater quality
- Groundwater users: Interference to aquifers resulting in a decrease or change in groundwater levels that subsequently affect groundwater users and/or groundwater dependent ecosystems and riparian areas and wetlands.

5.4.1 Impact on groundwater levels, flow and connectivity

The majority of cuttings are not likely to be deep enough to intercept the shallow groundwater table. If by chance cuttings do intercept the shallow groundwater table, the extent of drawdown is likely to be minimal and limited in extent due to the low permeability of the shallow aquifer system (clay regolith and weathered shale). The Wianamatta Shale is a low permeability formation and therefore the contribution of this aquitard to baseflow in surface water courses is expected to be minor to negligible. In this regard there are no expected material changes to groundwater levels or flow direction to the shallow groundwater table.

The depths of cuttings are generally 4-8 mbgl along the project alignment with the exception of several planned cuttings ranging from 10-12mbgl. It should be noted that groundwater works GW108906 is located 170m east of one of the planned major cuttings. This groundwater works is inactive, is screened at 48mbgl and has a historic standing water level at 30mbgl. The groundwater level in GW108906 is likely representative of the deeper groundwater system. The road cutting is therefore unlikely to have any impact on this site.

A perched shallow water table may be encountered; however, the spatial extent of drawdown would be minor to negligible. Similarly, the magnitude of seepage through the road cuttings is expected to be negligible, presumably much less than 0.1L/s/kilometre. This is calculated based on the expected transmissivity of weathered shale and clay. In this regard, no material changes are expected to groundwater levels, flow direction or groundwater connectivity as the unit itself is made up of a geological unit that is already of low permeability.

The proposed fill locations are not expected to impact the groundwater. The existing surface geology is comprised of low permeability material which is expected to match the material characteristics of the compacted fill used for the road alignment which will also be low permeability. The primary concern being that fill material will change the hydraulic characteristics of the underlying geology or create a connection between aquifers. Because the fill is all surficial and will match the characteristics of the underlying geology there are no expected impacts to the shallow aquifer. Compaction is the only expected geotechnical ground treatment, as outlined above this activity is not expected to impact on the hydraulic properties of the shallow aquifer.

5.4.2 Impact on groundwater chemistry

There is a minor potential for spills or leaks to allow oil and grease contamination to enter shallow aquifers. Any petroleum hydrocarbon spill from construction machinery has the potential to seep into the shallow groundwater system. However this would be avoided where possible or potential impacts minimised through the implementation of relevant safeguards as identified in **Section 8** of this report.

5.4.3 Impact on groundwater users

There is no expected drawdown to the regional shallow unconfined water table. There is therefore no expected groundwater impact to groundwater users including water supply users, GDEs, riparian areas or wetlands.

6. Assessment of potential operational impacts

6.1 Geology and soils

The geology of the site is not anticipated to be impacted by the project.

After construction, cleared areas would be paved/landscaped and scour protection installed at drainage outlets. There would be no exposed areas of topsoil and therefore little or no risk of soil erosion and entrainment of unconsolidated material by wind or runoff. During operation, the risk of soil erosion would be minimal as all areas impacted during construction would be asphalt or rehabilitated and landscaped to avoid soil erosion from occurring.

Several treatments, including retaining walls and fill embankments would be provided to suit the existing conditions and to integrate the project with the surrounding landscape.

Assessment of hydrological impacts of the project are addressed in the Hydrology and Flooding Working Paper (**Appendix K** of the EIS) prepared for the project. The drainage network would be designed to account for any additional runoff expected as a result of new paved areas and culverts would be sized accordingly.

The Hydrology and Flooding Working Paper identifies the potential for the project to cause scour in the receiving drainage lines as a result of the rate, velocity and concentration of flow. Increases in the rate of flow in the receiving drainage lines could result in a lowering of the stream bed through a process of headwater erosion, as well as a possible widening of the watercourse through a process of bank erosion. The lining of channels and the concentration of flow could result in localised scour in the receiving drainage lines at the downstream limit of the drainage works. Measures such as dumped rock rip rap protection would be incorporated in the design of the project in order to reduce the scour potential in the receiving drainage lines (refer to **Appendix K** of the EIS).

6.2 Contaminated land

Incidents such as vehicle accidents on the intersection could result in spillage of contaminants or hazardous materials on to the roadway. If not contained and/or cleaned up promptly, there is potential for these to enter the drainage system and be discharged to receiving waterways and groundwater. Accidental spills could impact negatively upon both human health (mainly through direct contact and inhalation exposure pathways) and environmental receptors including receiving soil and water ecosystems.

The operational vegetated swales (see 7.1.2) would function as a containment area for any accidental on-road spills. These water quality channels are subject to maintenance and, in the event of an accident or spill, would be assessed for immediate clean-up.

Overall, the project would only resent a minor increase in the potential for contamination compared with current operation of the road, associated increased vehicle traffic in the future.

6.3 Surface water

The project would involve the construction of new road through greenfield areas and the widening of the existing The Northern Road (and therefore increased impervious areas) that will discharge runoff to the receiving environment. The operation of the project will impact on water quality due to discharge of drainage at new locations or increased discharge at existing locations where road and drainage upgrades have occurred.

The operation of the project has the potential to alter existing hydrology and flooding regimes which may impact on water quality due to increased runoff volumes and peak flow rates. Increased flow rates can impact on the bed and bank stability of watercourses making them highly susceptible to erosion (refer to the Hydrology and Flooding Working Paper in **Appendix K** of the EIS for more information). Stream erosion increases sediment and nutrient loads leading to decreased water quality which would affect the protection of the nominated environmental values.

Operation of the project has the potential to affect existing local water quality due to the generation of additional pollutants directly attributable to increased impervious surface areas and associated increased vehicle traffic in the future. The most important pollutants of concern relating to road runoff are:

- Sediments from the paved surface from pavement wear and atmospheric deposition
- Heavy metals attached to particles washed off the paved surface
- Oil and grease and other hydrocarbon products.

Increased stormwater runoff from new impervious surfaces created by the project would result in a deterioration of water quality due to increased sediment, nutrient loads, oil and grease and floating debris. Additionally the elevated nutrients could result in undesirable aquatic life such as algal blooms or dense growths of attached plants or insects. Without appropriate management, this would result in a more degraded ecosystem that is unable to support aquatic life or aesthetically valuable flora and fauna (refer to the Biodiversity Assessment Working Paper, **Appendix I** of the EIS for more information). The emphasis in stormwater quality management for road runoff is that of managing the export of suspended solids and associated contaminants – namely heavy metals, nutrients and organic compounds (Austroads, 2001). Pollutants such as nutrients, heavy metals and hydrocarbons are usually attached to fine sediments (RTA, 2003). The key concern with increases of these contaminants is the runoff and discharge to the identified receiving environments which contain key fish habitat. Therefore trapping suspended solids is the primary focus of the water quality management strategy for the operational phase of the project. A number of operational water quality swales have been proposed for the project and their effectiveness in managing water quality was assessed via music modelling for those swales which are proposed to control runoff to sensitive receiving waterways as identified in this report.

The results of the water quality assessment indicate that some pollutant load reduction can be achieved by the proposed swales. The pollutant load reduction results vary from one pollutant to another as follows: For Suspended Solids (81% to 90%), for Total Phosphorus (43% to 55%) and for Total Nitrogen (14% to 49%). These results have been achieved across all twenty-four swales, including those located upstream of the locations where the pavement runoff discharges into the five identified sensitive receiving waterways as shown on Table B2 in **Appendix B**.

The proposed swales are highly efficient at providing suspended solid capture and reasonably efficient at reducing nutrients. Accidental spills could occur on any road; however the improved horizontal and vertical geometry of the upgrade and the improved layout of the signalised interchanges would reduce the current risk of accidental spills, therefore no spill basins are proposed.

Similarly to the construction of the project, impacts to water quality are expected to be localised to the creeks, waterways and farm dams directly impacted by the project, namely Surveyors Creek, Badgerys Creek, Cosgroves Creek and other unnamed tributaries. The operation of the project, even with increased flow and runoff is expected to be negligible to downstream waterways and the nominated uses of these waterways will not be affected. They key concern of the operation of the project continues to be the impact of water quality runoff on the identified sensitive receiving environments. It is not expected that there would be any water quality impact on the downstream receiving environments.

6.4 Groundwater

As outlined above, groundwater seepage during the operational phase is likely to be minor and temporary after rainfall events.

The main potential operational phase groundwater impacts from any road project relate to:

- Groundwater levels, flows and connectivity: These include changes to groundwater connectivity, groundwater flow direction, groundwater levels and recharge rates
- Groundwater chemistry: these include pollution of groundwater and changes to groundwater quality
- Groundwater users: Interference to aquifers resulting in a decrease or change in groundwater levels that subsequently affect groundwater users and/or groundwater dependent ecosystems and riparian areas and wetlands. Impact on groundwater levels, flow and connectivity.

Potential impacts to groundwater as a result of the project are further discussed below.

6.4.1 Groundwater levels, flows and connectivity

There is not expected to be any material impact during operation on groundwater level or connectivity, any impact would be minor and short term. The project is not expected to interact with groundwater during operation. There is no planned groundwater abstraction that would impact groundwater levels, flow or connectivity during the operational phase of the project. The installation of the road infrastructure will result in reduced local recharge into the groundwater along the paved section of the road, as precipitation that would normally fall on the recharge surface will be drained away The impact on the local groundwater system is expected to be minor and short term as the surface water runoff is expected to infiltrate into the regional groundwater system regardless of the increased paved area.

6.4.2 Impact on groundwater chemistry

There is no expected operational impact on groundwater chemistry during the operational phase of the project given the unlikely occurrence of accidental spills as well as the proposed operational control of runoff. Any impact is likely to be minor and short term. Impact on groundwater users

There is no expected drawdown to the regional shallow unconfined water table during the operational phase of the project. Therefore any impact to groundwater users including water supply users, GDEs, riparian areas or wetlands is likely to be minor and short term.

7. Proposed Mitigation Measures

The potential impacts on water quality as a result of the upgrade would be minimised by implementing adequate temporary and permanent water quality controls for the construction and operational phases respectively. For the construction phase, erosion and sediment controls including sediment basins have been designed and sized in accordance with the requirements of the Blue Book (Soils and Construction, 2008 Volume 2D Main Road). For the operational phase water quality treatment would be provided through vegetated swales with rock check dams. The vegetated swales would provide treatment for suspended solids and any particle bound heavy metals.

7.1.1 Construction phase

Water quality controls

Techniques to reduce potential water quality impacts and prevent degradation of downstream waterways include the use of a range of erosion and sediment controls including progressive clearing and rehabilitation of land to reduce the amount of exposed disturbed areas and subsequent offsite sediment loss during construction, implementation of diversion drains to direct clean water away from disturbed areas, sediment and erosion controls at the source such as sediment fences, silt barriers, covering disturbed areas and stockpiles with geofabric material or similar, controlled access points for construction plant and vehicles, or sediment controls such as basins.

The site topography and the number of cross drainage culverts is such that a large number of sediment basins would be required to treat every section of the construction area throughout all stages of the work. In order to minimise the number of sediment basins, and the impact of the construction of these basins on the local natural environment, the Blue Book criteria of 'Minimum 150m^3 of annual sediment loss has been adopted. This criteria indicates that if the estimated annual soil losses from a disturbed catchment is less than 150 m^3, then a sediment basin may not be required subject to other erosion and sediment controls being implemented.

It was estimated that a contributing disturbed area exceeding about 1.0 ha on this project would generate 150 m^3 of annual soil loss. Therefore for catchments less than about 1.0 ha, a sediment basin has not been proposed. This is about the equivalent of a surface area of 50 m wide and 200 m long. If 50 m is assumed to be an average width of disturbance, then lengths of about less than 200 m would not require a sediment basin. These dimensions represent an approximation only as catchments widths and shapes vary. In total about 50 temporary sediment basins are proposed during construction of the project. These are listed in **Table 7-1** below.

Where construction phase water quality sedimentation basins are required, the design criteria are defined in the Blue Book (Soils and Construction, 2008 Volume 2D Main Road) which requires that sediment basins be designed for the 85 percentile, five day rainfall depth for basins located near sensitive receiving environments, and for the 80th percentile for non-sensitive receiving environments.

At the locations where sediment basins are not required (i.e. catchment areas less than 1.0 ha), impacts to waterways would be appropriately managed through the implementation of controls as outlined in an Erosion and Sediment Control Plan to be developed for the project. This may include small sediment traps (typically less than 5m^3 each) where possible.

In addition, where basins are required, consideration would be given to the following relevant documents in their design:

- *Managing Urban Stormwater: Soils and Construction, Volume 2D Main Road Construction* (DECC, 2008)
- *Managing Urban Stormwater – Soils and Construction, Volume 1 4th Edition*, March 2004
- Roads and Maritime General Specifications G36 and G38.

The sediment basins would provide sufficient volume for settling and storage of sediments. The settling zone volume would be estimated using the appropriate design rainfall depth and catchment areas. The storage zone is estimated using the Revised Universal Soil Loss Equation (RUSLE).

The sediment basins on the Northern Road have been designed as Type D or F, as per the Blue Book classifications and the assumed soil parameters. Some localised pockets of Type C soils exist; however these are small and isolated, therefore Type D soils have been adopted for the design. Type F basins treat runoff for fine soil particles and type D basins treat runoff for fine and dispersible soils. The type D basins would require flocculation during the construction for the settlement of fine soil particles in the basins.

The three key design elements that have been used in the individual sizing of each sediment basin are:

- Catchment areas contributing to the sediment basins (disturbed and undisturbed areas)
- The percentage of the total contributing sub-catchment area that is either “cut” or “fill”. These are batters/embankment areas that would generally be in the order of less than 25 per cent for this project. These sub-catchments generate greater soil losses and
- Whether the basin is located in a “sensitive” environment, thus requiring the 85th percentile, five day rainfall depth design criteria.

Other design input parameters include, soil type, rainfall erosivity (which is a function of local rainfall intensity), soil hydrologic group, volumetric runoff coefficients and soil erodibility. From these key elements and the Blue Book design methodology, the sediment basin volumes have been derived.

An assessment of the construction phase catchments and the selected sediment basin locations have been carried out to confirm all sediment basin locations. The location of the sediment basins have been selected to provide the maximum runoff capture from catchments throughout the construction process using gravity driven diversion drains to divert runoff to the basins. The required volume of each sediment basin has been determined according to an estimate of the maximum disturbed catchment area that drains to the basin during various stages of the construction.

After the sediment basin locations were identified, basins were modelled in 12D. This means that the location and basin volume was tested for each basin against the local existing and proposed contours in a 3D model. This was done to ensure the space requirements for the construction phase sediment basins were adequate, to determine or confirm that they could be built within the boundary requirements.

The exact location and sizing of sediment basins would be determined during detailed design and would be implemented during construction to avoid substantial impacts to the environment.

Sediment basin design

The proposed locations and sizes of the 50 temporary sediment basins for the construction phase of the road upgrade are presented in **Table 7-1** and shown on **Figure 7-1**.

The design and the location of the road have a substantial effect on the size and location of the basins. The design of the sediment basins would be confirmed during detailed design.

Table 7-1 Temporary sediment basins for the reference design of The Northern Road upgrade

Basin name*	Min basin volume required (m^3)	Receiving Creek^
B560R	882	Badgerys Creek
B670R	935	Badgerys Creek
B880R	209	Badgerys Creek
B940R	468	Badgerys Creek
B1320R	1835	Badgerys Creek
B2200L	632	Duncans Creek
B2580L	589	Duncans Creek
B2820L	335	Duncans Creek
B3250L	830	Duncans Creek
B3340L	781	Duncans Creek
B3740L	761	Duncans Creek
B3800L	650	Duncans Creek

Basin name*	Min basin volume required (m^3)	Receiving Creek^
B4400L	714	Duncans Creek
B4500L	329	Duncans Creek
B4760L	714	Duncans Creek
B5140L	1439	Duncans Creek
B5060L	329	Duncans Creek
B5710R	403	Cosgroves Creek
B6260R	695	Cosgroves Creek
B6660R	787	Cosgroves Creek
B6800L	436	Cosgroves Creek
B7040L	293	Cosgroves Creek
B7100L	532	Cosgroves Creek
B7420L	417	Mulgoa Creek
B7440R	406	Cosgroves Creek
B7660R	444	Cosgroves Creek
B7680R	350	Cosgroves Creek
B7960R	331	Cosgroves Creek
B8420R	499	South Creek
B8480R	481	South Creek
B9000R	645	South Creek
B240R	476	Blaxland Creek
B260R	323	Blaxland Creek
B580L	659	Blaxland Creek
B620R	891	Mulgoa Creek
B900R	275	Blaxland Creek
B1280R	1110	Blaxland Creek
B1780L	446	Mulgoa Creek
B1820L	251	Mulgoa Creek
B2140R	659	Blaxland Creek
B2540L	300	Blaxland Creek
B2860R	977	Blaxland Creek
B2900R	676	Blaxland Creek
B3680R	589	Blaxland Creek
B4600R	695	Surveyors Creek
B5120R	891	Surveyors Creek
B5520R	731	Surveyors Creek
B6020R	1161	Surveyors Creek
B6320L	589	Surveyors Creek
B6660R	730	Surveyors Creek

*B5200L denotes that the sediment basin is at approx. Chainage 5,200, and L indicates that it is on the Left hand size, looking at increasing chainages

^Receiving creek refers to the named creek itself or an unnamed tributary draining into the named creek

Groundwater Controls

It is not expected that specific controls for groundwater will be required. This is primarily due to the low to very low permeability of Wianamatta Shale and subsequently minor to negligible extent of drawdown and negligible seepage through identified road cuttings. The expected groundwater inflows are anticipated to be in the order of 0.1 L/s/km of cuttings, although probably much less. It is considered prudent that if groundwater is encountered during excavation works the groundwater monitoring plan detailed below should be implemented.

Surface Water Monitoring

Prior to construction, baseline water quality monitoring would be undertaken to identify parameters for monitoring during construction and to determine indicative existing water quality. Sampling locations and monitoring methodology would be determined during the detailed design stage. In accordance with the *Guideline for Construction Water Quality Monitoring* (RTA 2003) the following parameters are recommended to be monitored:

- pH, electrical conductivity, dissolved oxygen, turbidity and temperature;
- total suspended solids;
- oils and grease;
- other parameters as identified from existing literature, previous water quality monitoring or recommendations from government organisations such as NSW OEH, EPA, DPI and Council.

Data collected during the preconstruction monitoring would be used to develop site specific trigger values so that monitoring undertaken during the construction phase can be compared to these values. This will identify if any changes in water quality are a result of construction activities and demonstrate compliance with any monitoring requirements or targets (RTA 2003)

7.1.2 Operational Phase

Water quality controls

The ANZECC/ARMCANZ and HRC Guidelines indicate that several physical-chemical and toxicant parameters need to be controlled to maintain the required protection level for aquatic ecosystems and visual amenity during the operational phase of the project. Some of the parameters include nutrients (total phosphorus, total nitrogen and ammonia), suspended solids, oils and grease, petroleum hydrocarbons and several heavy metals including copper, lead, cadmium, zinc and chromium which are commonly found in stormwater runoff from roads.

This section of the report focuses on the proposed water quality controls for the operational phase of the project. Water quality during operation would be managed by:

- Procedural controls
- Physical controls
- Monitoring.

Vegetated Swales

There are proposed swales (table drains) that convey pavement runoff to the receiving waterways and creeks. These swales will provide some water quality treatment depending on their length and slopes. Rock check dams have been added for these swales to provide additional treatment by slowing down the runoff and allowing it to temporarily pond during storm events

Pollutant removal is facilitated by the interaction between the flow and the vegetation along the length of the swale. The vegetation and rock check dams act to spread and slow velocities, which in turn aids the deposition of sediments. Ten swales are proposed upstream of the environmentally sensitive creeks as identified above in terms of those that are classified as sensitive receiving environments as identified in the Biodiversity Assessment Working Paper (**Appendix I** of the EIS). An additional fourteen swales have been proposed wherever possible for further water quality treatment into other receiving waterways. These swales are labelled as S1 through to S24 as shown in **Table 7-2** and **Figure 7-1**.

In order to protect these sensitive receiving environments the size of these swales has been optimised where possible and rock check dams have been added. Other swales, whilst not located in sensitive receiving environments have been provided elsewhere throughout the project area.

Table 7-2 Permanent water quality swales for the reference design of The Northern Road upgrade

Swale name	Swale length (m)	Receiving Creek	Catchment area to swale (ha)
S1	280	Badgerys Creek	2.16
S2	35	Badgerys Creek	0.24
S3	95	Unnamed Creek	0.56
S4	150	Unnamed Creek	0.39
S5	95	Unnamed Creek	0.24
S6	185	Duncans Creek	0.58
S7	150	Duncans Creek	1.37
S8	90	Unnamed Creek	0.91
S9	110	Duncans Creek	1.55
S10	70	Duncans Creek	0.83
S11	35	Duncans Creek	0.23
S12	375	Unnamed Creek	3.55
S13	40	Unnamed Creek	0.54
S14	110	Cosgroves Creek	3.67
S15	105	Unnamed Creek	0.31
S16	40	Unnamed Creek	1.46
S17	65	Unnamed Creek	0.49
S18	115	Unnamed Creek	1.77
S19	50	Unnamed Creek	0.59
S20	115	Unnamed Creek	1.64
S21	135	Unnamed Creek	0.67
S22	155	Unnamed Creek	1.00
S23	140	Surveyor's Creek	0.96
S24	195	Surveyor's Creek	1.15

A water quality assessment has been undertaken to estimate the pollutant load reductions that would be achieved by the proposed swales shown in **Table 7-2**. This assessment has been undertaken using the eWater water quality MUSIC model (Ver 6.2).

The pollutant load reduction results of the water quality assessment are shown in **Table 7-3** below.

Table 7-3 : Annual average pollutant load reductions for the proposed swales

Swale	Total Suspended Solids (%)	Total Phosphorous (%)	Total Nitrogen (%)
S1	88	48	24
S2	86	43	18
S3	88	43	23
S4	89	55	49

Swale	Total Suspended Solids (%)	Total Phosphorous (%)	Total Nitrogen (%)
S5	89	55	48
S6	87	45	32
S7	87	47	22
S8	86	46	17
S9	86	46	19
S10	90	51	28
S11	90	48	29
S12	88	48	29
S13	84	44	16
S14	81	45	14
S15	87	44	31
S16	87	46	19
S17	87	44	20
S18	86	46	17
S19	86	44	18
S20	86	46	18
S21	88	45	22
S22	88	48	24
S23	87	44	26
S24	87	46	26

Further information on the results is provided in **Appendix B**.

Spill Management Basins

Spill basins are normally provided at locations where two key factors are identified. The first factor is the risk of accidents occurring due to the road horizontal and vertical geometry, and the second factor is the existence of a sensitive receiving waterway as identified by an aquatic ecology assessment. When both factors occur at any one location along the road upgrade, a spill basin would be required.

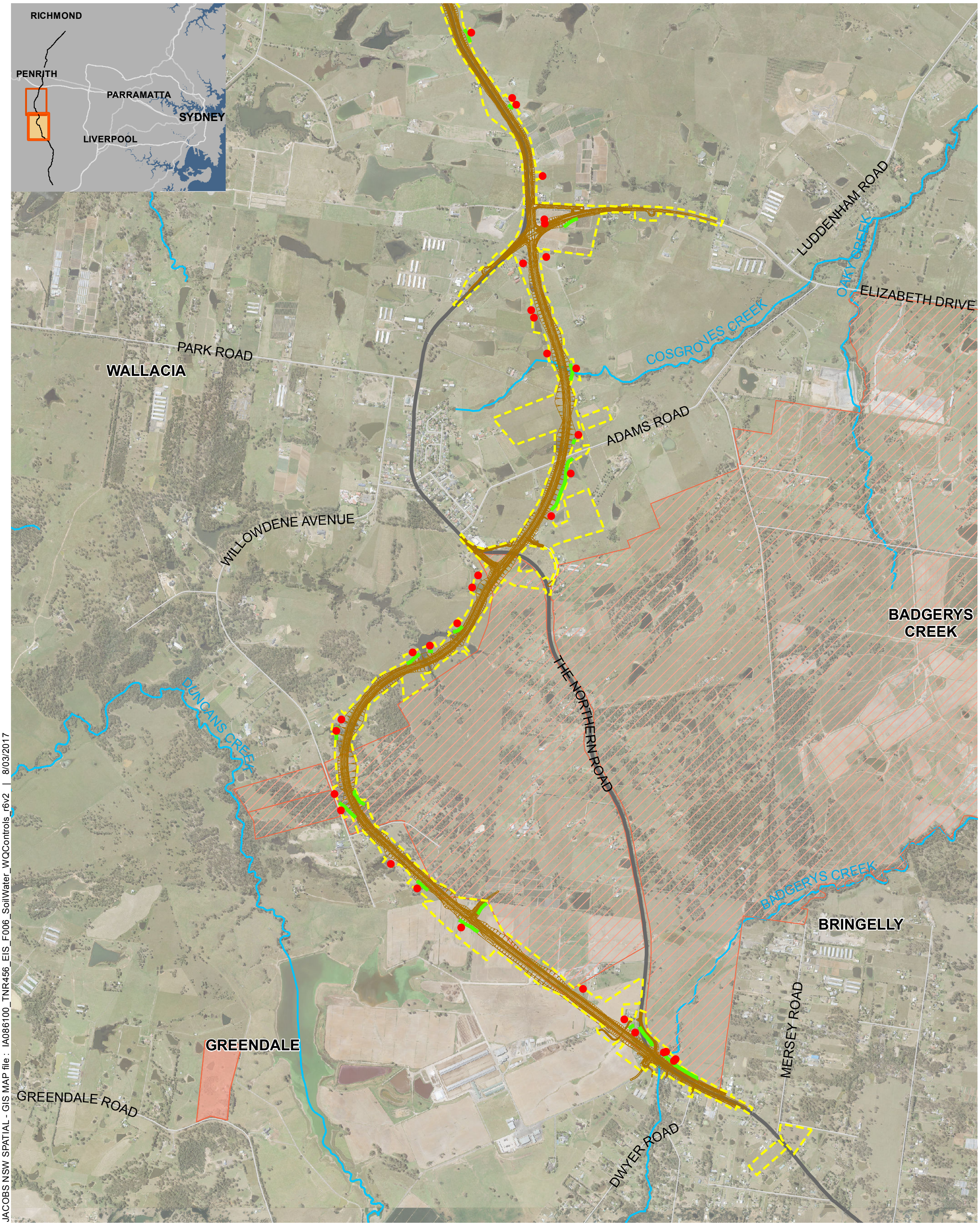
Some sensitive waterways have been identified along the road upgrade which meets one of the two conditions for providing spill basins; however the improved horizontal and vertical geometry of the upgrade and the improved layout of the signalised interchanges has reduced the risk of accidental spills along the upgraded road. In this regard, spill basins are not required for the project.

Monitoring

Operational phase monitoring would be undertaken in order to:

- Assess and manage impacts on the receiving waters as the site stabilises
- Assist in deciding when the site has stabilised
- Identify water quality conditions after development.

Monitoring would be undertaken in line with the Roads and Maritime Guidelines for Construction Water Quality Monitoring (RTA 2003).



JACOBS NSW SPATIAL - GIS MAP file : IA086100_TNR456_EIS_F006_SoilWater_WQControls_r6v2 | 8/03/2017

The Northern Road upgrade - Mersey Road to Glenmore Parkway
The Northern Road (Existing)
Project area
Western Sydney Airport site (Commonwealth Land)
Defence Establishment Orchard Hills (Commonwealth Land)
Commonwealth Lands
Sediment basins (construction phase)
Water quality treatment swale (permanent)

0 0.5 1 km

N

2
1

Figure 7-1 | Water quality controls

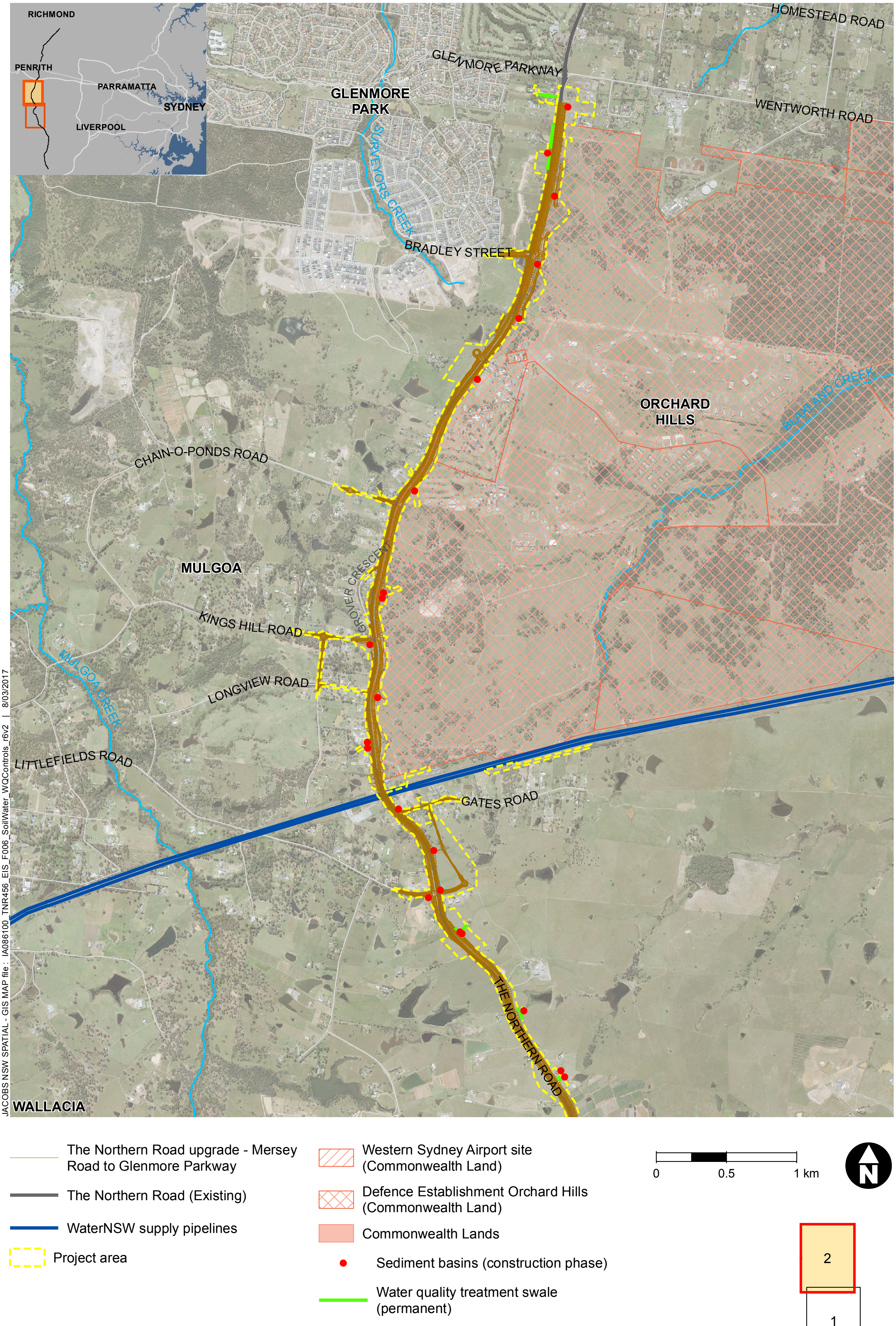


Figure 7-1 | Water quality controls

8. Safeguards and management

Safeguards and management measures will be implemented to minimise and manage the impacts of the project on surface water and groundwater throughput construction and operation. These measures are presented in **Table 8-1**.

Table 8-1 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
General Construction Impacts	A soil and water management plan (SWMP) would be developed in accordance with the Roads and Maritime specification G38 – Soil and Water Management and the Blue Book – Soils and Construction – Managing Urban Stormwater Volume 1 (Landcom 2004) and Volume 2D (DEC 2008a). The SWMP would include but not be limited to: • An erosion and sedimentation control plan and maintenance schedule for ongoing maintenance of temporary erosion and sediment controls • A sediment basin management plan to guide appropriate management of runoff during construction and operation • An incident emergency spill plan which will include measures to avoid spillages of fuels, chemicals and fluids onto any surfaces or into any nearby waterways	Contractor	Pre-construction and construction
Soil salinity impacts	• Durability and aggressivity samples of soil material will be collected and analysed prior to the construction phase, to determine potential impacts of soil salinity on pavement infrastructure	Contractor	Pre-construction
Sedimentation and Erosion	• Erosion and sediment controls would be implemented in a staged approach before clearing of the given catchment. • Sediment basins will be regularly serviced and maintained to comply with water quality and capacity requirements • Clearing of vegetation and site stabilisation of disturbed areas would be undertaken progressively to limit the time disturbed areas are exposed to erosion prices • High risk soil and erosion activities such as earthworks will not be undertaken immediately before or during high rainfall or wind events • Stockpiling of topsoil separately for potential reuse in landscaping and rehabilitation works • Permanent catch drains will be installed behind cut faces to act as diversion drains during the construction phase • Erosion and sediment control measures will be maintained until the works are complete and areas are stabilised by revegetation	Contractor	Pre-construction and construction
Impacts to water pollution (surface water and groundwater)	• All fuels, chemicals, and liquids would be stored at least 50 metres away from the existing stormwater drainage system and would be stored in an impervious bunded area within the compound site • The refuelling of plant and maintenance machinery	Contractor	Pre-construction and construction

Impact	Environmental safeguards	Responsibility	Timing
	would be undertaken in impervious bunded areas in the designated compound area. • Vehicle wash downs and/or concrete truck washouts would be undertaken within a designated bunded area of an impervious surface or undertaken off-site		
Disturbance of contaminated or potentially contaminated land	• Intrusive investigations should be undertaken in the vicinity of moderate risk areas including service stations (operational and non-operational), WaterNSW supply pipelines corridor, stockpiles and market gardens. • Other areas of potential contamination (low and moderate risk areas) should be managed under an appropriate Construction Environmental Management Plan (CEMP), including an unexpected finds protocol. • Excavated material that is not suitable for on-site reuse or recycling will be transported to a site that may legally accept that material for reuse or disposal	Contractor	Pre-construction and construction
Encountering UXO	• For UXO’s, an investigation would be undertaken to confirm the risk of UXO’s being present within the areas of the project within Defence Establishment Orchard Hills. The investigation would be undertaken prior to construction activities by a suitably qualified consultant registered on the Commonwealth Department of Defence UXO Panel (DUXOP) now subsumed into the Defence Environment and Heritage Panel (DEHP).	Contractor	Pre-construction and construction

9. Residual Impacts

Following implementation of the nominated safeguards and management measures, some residual impacts may occur as a result of construction or operation of the project. Residual impacts are outlined below. It is noted that no significant residual impacts are expected.

9.1.1 Construction

Some offsite sediment loss may occur during construction in the unlikely event of significant and/or unforeseen storm events where controls may become damaged or at full capacity before they can be appropriately replaced or maintained. For instance if the sediment basins are full after containing the volume generated by the design event, then some overflow with high turbidity may occur but this is unlikely.

Similarly in the event of an unexpected leak or spill, potential contamination impacts to surface or groundwater may occur before appropriate containment or clean-up operations can be implemented. For example an unexpected fuel leak from construction plant or vehicles that reaches a waterway or drain prior to containment.

Given the unlikely occurrence of these potential impacts, coupled with the clean-up procedures that would be implemented in the unlikely event of such an occurrence, residual impacts as a result of construction are not expected to be significant.

9.1.2 Operation

The proposed swales are expected to control water quality from runoff to an acceptable level during operation of the project, and have been optimised at locations where sensitive receiving waterways have been identified. However potential residual impacts may occur during operation of the project in the event of unforeseen leaks or spills of materials that could potentially contaminate nearby waterways or seep into groundwater if uncontained, for example in the event of a road crash or during road maintenance activities. However the occurrence of road crashes would be reduced by the project due to proposed improvements to road safety, therefore impacts are not expected. Based on this, residual impacts during operation of the project are not expected to be significant.

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