CHAPTER 18

SURFACE WATER AND FLOODING

18 SURFACE WATER

18.1 Introduction

This chapter describes the physical environment within the NWRL corridor in relation to surface water. It identifies and assesses the potential hydrologic impacts related to the operation of the railway as well as construction activities associated with the stations, rail infrastructure and systems of the NWRL. Recommended mitigation measures provide a framework for managing operation and construction related impacts.

The scope of the surface water assessment for the purposes of Stage 2 of the NWRL is:

Operations

- Assessment of flooding impacts on the surrounding environment
- Assessment of drainage and water quality
- Assessment of impacts on stream flows

Construction

- Assessment of flooding impacts to the construction works
- Assessment of water quality impacts resulting from station precinct construction and related road improvements.

18.2 Assessment Methodology

18.2.1 Director-General's Requirements, Conditions of Approval and Statement of Commitments

The following sections set out the Director-General's Requirements, the Conditions of Approval and Statement of Commitments as they relate to surface water, and where in the project these have been addressed (refer to **Table 18.1**). Unless otherwise stated, references are to chapters of EIS 2 for Stations, Rail Infrastructure and Systems and EIS 1 in relation to Major Civil Construction Works.

Table 18.1 Director General's Requirements, Conditions of Approval and Statement of Commitments

DGR Reference	Description	Addressed
Director-General's Requirements 31 August 2012	Hydrology A detailed hydrological and hydraulic assessment for mainstreams and overland paths associated with major drainage changes.	A detailed flood assessment has been carried out that covers mainstream flooding and significant overland flowpaths potentially impacted by the Project (Section 18.5 and 18.6). The flood assessment has been tailored to the nature and extent of the project.
CoA Reference	**Description**	**Addressed**
3.9	For surface components of the project located on floodplains, the Proponent shall identify flood design criteria in accordance with the Floodplain Development Manual (2005), describing risks to existing and planned future receivers and infrastructure based on the modelling of a full range of flood sizes up to and including the probable maximum flood (PMF).	Floodplain management requirements in accordance with the Floodplain Development Manual (2005) are outlined in Section 18.3. Specific flood design criteria have been established to manage impacts on the project and the surrounding environment. Assessment of risk has been based on the modelling of a range of flood sizes up to an including the Probable Maximum Flood (PMF), as outlined in Appendices A and B of Technical Paper 7.
3.10	For temporary construction sites located on floodplains, the Proponent shall identify reasonable and feasible mitigation measures for mitigating flood risk, including procedures for restoring and monitoring any temporary creek diversions consistent with pre-construction conditions.	Mitigation measures for managing flood risks during construction are outlined in Section 18.8. The need for, and measures to manage temporary creek diversions was addressed in EIS 1.
3.11	For cut and cover tunnel components which cross creek lines, the Proponent shall describe the proposed construction methodology, identifying measures to minimise the risk of bed cracking and loss of surface flow and contingency measures for restoring and monitoring waterways, consistent with pre-construction conditions.	Construction of the tunnels was addressed in EIS 1. It should be noted that the need for construction of cut and cover tunnel components across creek lines has been engineered out of the design. The cut and cover tunnel crossing previously proposed at Cattai Creek has been removed by shifting the track alignment and location of the Hills Station away from the creek. The need for a cut and cover tunnel crossing at Caddies Creek Tributary 3 has been removed by the viaduct design, which elevates the rail line above the creek at this location.

DGR Reference	Description	Addressed
3.12	The Proponent shall identify impacts to riparian and instream ecology from any direct disturbances to waterways and to flora and fauna from changes to creek flow or flood behaviour, during construction or operation.	Water quality impacts are addressed in Section 18.6 and 18.7. Impacts on riparian vegetation and stream ecology relating to changes in flow regimes are addressed in the Riparian Assessment (Eco Logical Australia, 2012a).
Statement of Commitment Requirements	**Description**	**Addressed**
36	A detailed flood assessment would be undertaken in accordance with appropriate NSW Government guidelines and in consultation with Councils and relevant Government agencies. This would include a two dimensional model of the Caddies Creek confluence to facilitate a better understanding of the discharges at the confluence of the creeks and associated design requirements	A detailed flood assessment has been carried out, including two dimensional modelling of the Caddies Creek confluence. The flood assessment carried out has been tailored to the nature and extent of the project. Section 18.5 and 18.6 and Technical Paper 7.
37	Investigations into the construction and operational impacts on the Elizabeth Macarthur Creek would be undertaken in accordance with relevant NSW Government guidelines.	Investigations have been undertaken to assess flood and water quality related impacts of the project on Elizabeth Macarthur Creek. Relevant guidelines used in the assessment are described in Section 18.3. Flood and water quality related impacts are discussed in Sections 18.5 and 18.6.
38	The floodplain storage impacts would be defined during design development in accordance with the relevant NSW Government guidelines	Floodplain storage impacts are discussed in Section 18.5.3. Flood impacts in general have been assessed through detailed modelling that, where appropriate, has taken into account floodplain storage impacts.
39	Further investigations into the location, size and treatment levels of a water treatment plant(s) would be undertaken in consultation with DECC, Councils and RailCorp. Investigations would include identifying discharge points, determining the receiving water quality and water re-use/recycling opportunities.	Groundwater and other water from the tunnels and below ground stations will be collected and treated at the existing Lady Game Drive WTP developed for the ECRL Details provided in Chapter 8.

18.3 Methodology

18.3.1 General

The following tasks have been undertaken in preparing the surface water assessment:

- Collation and review of background information (previous studies, survey and mapping data) relevant to the project.
- Consultation with government agencies and stakeholders. Consultation has been carried out during the EIS process by TfNSW. Government authorities have also been consulted by DP&I in reviewing the requirements for EIS 2. Comments from government authorities were provided with the Supplementary Director General requirements and have been taken into consideration in the preparation of the hydrologic assessment.
- Identification of guiding principles for the assessment of hydrologic impacts during construction, including floodplain management and water quality.
- Flood modelling (combination of hydrologic and hydraulic models) to quantify existing flood behaviour and identify potential flood impacts and risks associated with the proposed works.
- Water quality impact assessment through the collation and review of available information to define existing conditions and identify potential impacts associated with the proposed works.
- Identification of mitigation measures to manage flood and water quality impacts.

The surface water assessment has been divided according to the three sections of the project which traverse eight major waterway catchments as shown in **Table 18.2**. Some of the surface water impacts are dependent on the specific characteristics of these catchments and their associated floodplains in the vicinity of the sites. Other impacts, particularly those relating to the management of site runoff, are more generic.

The approach to the assessment of flooding and water quality related impacts are outlined in Sections 18.3.2 and 18.3.3 respectively.

Table 18.2 Major Waterway Catchments and NWRL Stage 2 Sites

Section	Sites*	Catchment
Epping Station to Bella Vista Station (Predominantly tunnel)	1. Epping Services Facility**	Devlins Creek
	3. Cheltenham Services Facility	
	4. Cherrybrook Station**	Pyes Creek
	5. Castle Hill Station**	Cattai Creek
	6. Showground Station**	
	7. Norwest Station**	Strangers Creek
	8. Bella Vista Station**	Elizabeth Macarthur Creek
Bella Vista Station to Rouse Hill Station (Predominantly on viaduct)	9. Balmoral Road	
	10.Memorial Avenue	
	11. Kellyville Station**	
	12. Windsor Road/Old Windsor Road	Caddies Creek (including Tributaries 3, 4 and 5)
	13 Old Windsor Road/Whitehart Drive	
	14. Rouse Hill Station**	
Rouse Hill Station to Tallawong Road (Predominantly at-grade)	15. Windsor Road Viaduct	Second Ponds Creek
	16. Windsor Road Viaduct to Cudgegong Road	
	17. Cudgegong Road Station** and Tallawong Stabling Facility	First Ponds Creek

* Work Site 2 - Epping Decline is no longer required ** Operational Sites

18.3.2 Flooding

The following tasks were undertaken in the assessment of the surface water catchments draining to and through the Project corridor:

- Hydrologic modelling to determine peak flow estimates applicable for design and flood assessment.
- Hydraulic modelling to quantify flood behaviour (levels and velocities) as well as identify potential flood impacts and risks posed to the construction and operation of the stations, rail infrastructure and systems.
- Quantification and assessment of flood impacts and risks associated with the stations, rail infrastructure and systems proposed under EIS 2.
- Identification of appropriate mitigation measures that are commensurate to the potential for and consequences of flood inundation to the proposed works.

Outcomes of the flood assessment have been used to:

- Define flood behaviour under existing conditions (refer Section 18.4).
- Quantify the nature and extent of flood risks to the proposed works as part of Stage 2 of the NWRL, and potential flood impacts of the proposed works on the surrounding environment (refer to Section 18.5).
- Identify appropriate mitigation measures required to manage risks to the project and impacts on the surrounding environment (refer to Section 18.6).

The flood assessment has included consideration of existing and future catchment conditions. By the time the works for Stage 2 of the NWRL commence, it is possible that further development will occur in the catchments, particularly those in the North West Growth Centre area. For this reason quantification of flood behaviour and impacts on the Stage 2 works has taken into consideration ultimate catchment conditions. These conditions would be applicable to the operational life of the project. Details of catchment conditions under existing and ultimate conditions and the impact on flow behaviour are included in Appendix A of Technical Paper 7.

18.3.3 Guiding Principles

Key guiding principles for the flooding assessment and floodplain management (refer to Technical Paper 7) were derived from relevant guidelines and standards, including:

- Floodplain Development Manual (NSW Government, 2005)
- Australian Rainfall and Runoff (Institute of Engineers Australia, 1987; AR&R)
- Floodplain Risk Management Guideline – Practical Considerations of Climate Change (Department of Environment, Climate Change and Water, 2007)

A 100 year ARI flood standard has typically been adopted for the assessment and design of permanent works. However, consideration was given to the full range of flood events up to and including the PMF, in accordance with the guiding principles. Detailed assessment of flood risks in excess of the 100 year ARI event is particularly relevant in the context of flood emergency evacuation and flooding to tunnels and below ground stations and rail infrastructure due to the consequential risk to life and damage to critical services and infrastructure. Flooding in excess of the 100 year ARI event has also been considered in the context of the potential for floods to impact on critical infrastructure adjoining the NWRL. This includes key transport links such as Windsor Road, Old Windsor Road, Schofields Road and the Tallawong Road electricity substation. Refer to Section 18.5 for an assessment of flood risks and impacts.

Flood risks and impacts during Stage 2 construction works for the stations, rail infrastructure and systems are outlined in Section 18.6. In relation to the guiding principles for flooding, flood risks and impacts during construction have been evaluated in the context of the Stage 2 construction period in order to set requirements that are commensurate to the period of time that the risk exposure occurs. To this end, the surface water assessment identifies the risks and impacts associated with each construction practice such that informed decisions can be made on the flood criteria that should be set.

18.3.4 Water Quality

The following tasks were undertaken in the assessment of surface water quality impacts from proposed works as part of Stage 2 of the NWRL:

- Collation and review of available data on stream condition, water quality and soils to define the existing environment within the catchments and watercourses.
- Review of existing policies and guidelines applicable to water quality management.
- Assessment of proposed activities for impacts on the water quality of receiving environments.
- Identification of required mitigation measures, including type of controls and design criteria required to manage potential impacts.

18.3.5 Guiding Principles

A suite of relevant guidelines and standards for water quality management were considered in the surface water assessment. In addition, council policies relating to surface water for the three LGAs traversed by the NWRL were also considered in the assessment (refer to Technical Paper 7).

18.3.6 Available data

A number of surface water related studies have been undertaken on behalf of Sydney Water, the Growth Centres Commission, TIDC, RMS and local Councils within the vicinity of the project area. Studies, guidelines, survey and mapping data and reports reviewed as part of the Surface Water and Hydrology assessment are listed in Technical Paper 7.

18.4 Existing Environment

18.4.1 Waterways

The NWRL corridor crosses a number of named and unnamed tributaries of Parramatta River and Hawkesbury River. Named creeks that are crossed by the NWRL corridor are listed below (from southeast to northwest).

Epping to Showground Station

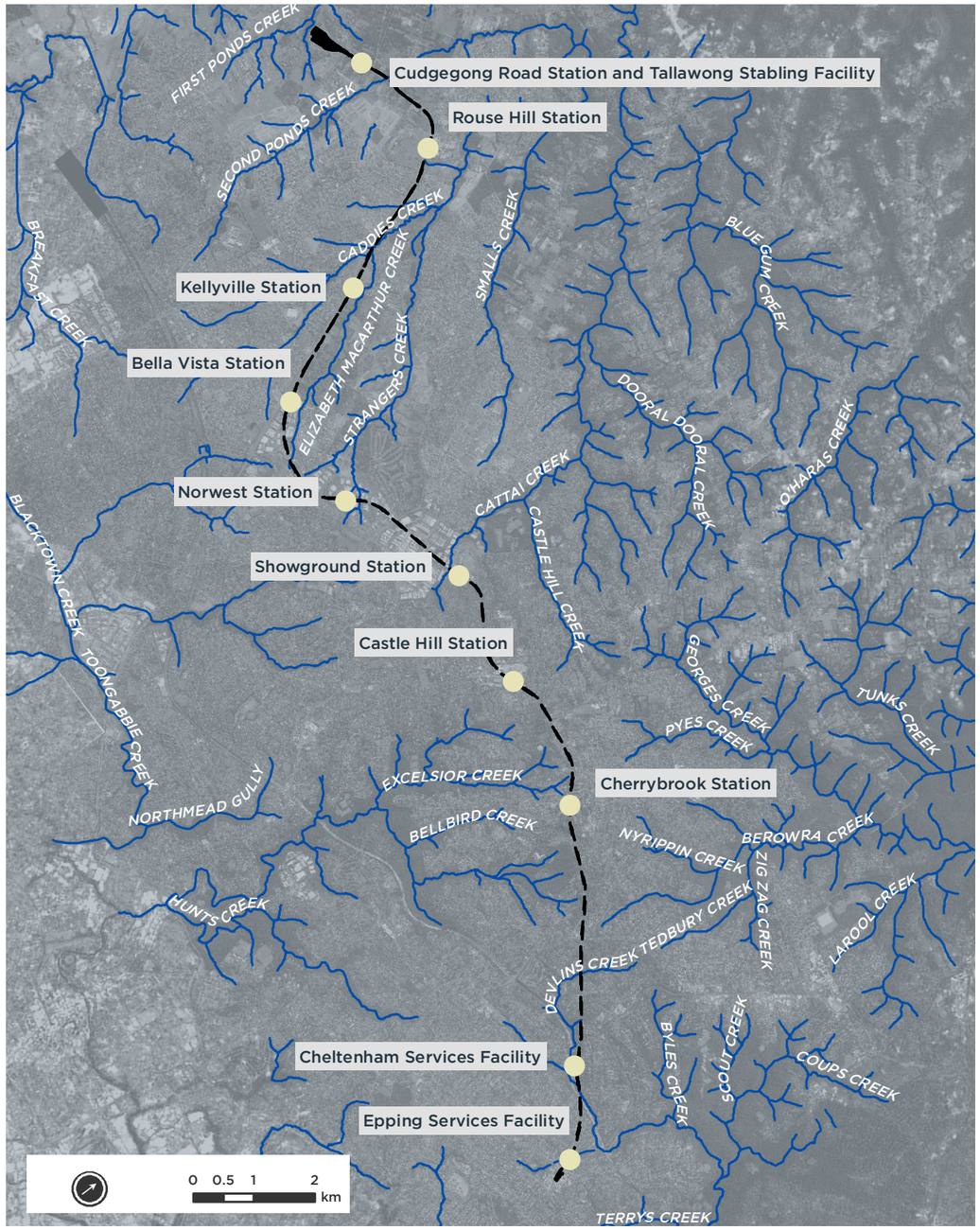
- Devlins Creek tributary at Beecroft Road
- Devlins Creek (tributary of Lane Cove River)
- Berowra Creek (tributary of Hawkesbury River)
- Darling Mills Creek (tributary of Parramatta River)
- Pyes Creek (tributary of Berowra Creek)
- Excelsior Creek (tributary of Parramatta River)
- Castle Hill Creek (tributary of Cattai Creek)
- Cattai Creek (tributary of Hawkesbury River)
- Strangers Creek (tributary of Caddies Creek)

Showground Station to Tallawong Stabling Facility:

- Elizabeth Macarthur Creek (tributary of Caddies Creek)
- Caddies Creek (tributary of Cattai Creek)
- Strangers Creek (tributary of Caddies Creek)
- Caddies Creek Tributary 5
- Caddies Creek Tributary 4
- Caddies Creek Tributary 3
- Second Ponds Creek (tributary of Caddies Creek)
- First Ponds Creek (tributary of Caddies Creek)

Major waterways in the vicinity of the project are shown in **Figure 18.1**.

Figure 18.1 Major Waterways in the Project Area (Epping to Showground Station)



18.4.2 Flooding

General

Development within the catchments in the south east portion of the project (Epping to Bella Vista Station) is typically well established. This includes the suburbs of Epping, Cherrybrook, Castle Hill and Bella Vista.

For catchments within the North West Growth Centre (covering Strangers Creek, Caddies Creek and tributaries, Elizabeth Macarthur Creek, First Ponds Creek and Second Ponds Creek) a considerable degree of development is underway and ongoing. To manage changes in flow behaviour as a result of urbanisation, water management strategies have been incorporated into the planning of these growth areas that include the provision of detention basins to offset potential increases in runoff.

Particular areas within the North West Growth Centre where significant future development has been identified include Balmoral Release area, Area 20 Precinct, Alex Avenue, Riverstone, The Ponds and Beaumont Hills. Many of these areas are largely undeveloped under existing conditions.

The following sections provide an overview of the catchments draining to or through the project corridor. For major waterways traversed by the project flood extent mapping is provided for the 20 year, 100 year ARI flood events and the PMF. For local overland flow paths, peak flows are provided for the 20 year, 100 year ARI and the PMF.

Further details of modelled flood behaviour is presented in Appendices A and B of Technical Paper 7.

Epping to Bella Vista Station

Devlins Creek (including the Beecroft Road tributary) – Epping Services Facility (Site 1) and Cheltenham Services Facility (Site 3)

The Epping Services Facility at Beecroft Road is located adjacent to the Devlins Creek tributary (referred to herein as the Beecroft Road tributary) that runs parallel to and between Edensor Street and Beecroft Road before joining Devlins Creek downstream of the Beecroft Road and Kandy Avenue intersection.

The Beecroft Road tributary has been significantly modified by urbanisation. The watercourse consists of a concrete and brick channel with concrete box culvert crossings at Ray Road and Kandy Avenue. The Beecroft Road tributary drains a catchment area of approximately 230 hectares. There is considerable existing development on the floodplain in the vicinity of the project corridor, consisting mainly of medium density residential development and commercial development. These areas of existing development would be sensitive to changes in flood behaviour.

Flood extent mapping for Beecroft Road tributary is provided in **Figure 18.2** for the 20 and 100 year ARI events and the PMF. Site 1 is in close proximity to the watercourse. A small proportion of the site lies within the defined flood extents.

The Cheltenham Services Facility is located within the middle reaches of the main Devlins Creek catchment. In this area Devlins Creek is relatively incised, running in an easterly direction between the M2 (north of the creek) and residential development (south of the creek). With the M2 located between the Cheltenham Services Facility and Devlins Creek the potential for impacts from mainstream flooding is low. A local catchment drains through the Cheltenham Services Facility precinct. Local overland flows are in the order of 4.3m3/sec for the 20 year ARI peak flow, 5.3m3/sec for the 100 year ARI peak flow and 20.8m3/sec for the PMF peak flow.

Pyes Creek - Cherrybrook Station (Site 4)

Cherrybrook Station lies in the upper reaches of Pyes Creek, which is a tributary of Berowra Creek. The site is located at the top of the catchment and therefore is not affected by mainstream flooding. The existing topography is characterised by a local depression that runs south to north across the proposed location of the station and would be the predominant flowpath for runoff from the site. Local overland flows to the north of Cherrybrook Station, for the 20 and 100 year ARI, and the PMF are in the order of 1.7m3/sec, 2.0m3/sec and 9.6m3/sec respectively. To the south, the overland flows are lower at 0.4m3/sec for the 20 year ARI and 0.5m3/sec and 1.7m3/sec for the 100 year and PMF respectively.

Cattai Creek – Castle Hill Station (Site 5) and Showground Station (Site 6)

Castle Hill Station (Site 5) is located in the upper reaches of a tributary to Cattai Creek. The site is located at the top of the catchment and is not affected by mainstream flooding or significant overland flows. Showground Station (Site 6) is located adjacent to Cattai Creek, which in this location drains a catchment area of approximately 327 hectares and is deeply incised. Development in the upstream catchment is well established, consisting of a mix of residential and industrial. Immediately adjacent to the site lies the Castle Hill showground and Civic Centre and Council administration building.

Development within the catchment is well established and the creek line is heavily vegetated. These factors combined have the potential to generate large amounts of debris in flood waters (such as trees, cars, shopping trolleys and other floatable items which may be washed from upstream) and consequently any structures placed within the banks are likely to have blockage issues during flood events. Anecdotal evidence suggests that parts of Carrington Road are currently subject to flooding and therefore would be sensitive to any changes in flood behaviour.

Flood extent mapping for Cattai Creek is provided in **Figure 18.3** for the 20 and 100 year ARI events and the PMF. Castle Hill Station is located east of Cattai Creek and is generally not flood affected in events up to the 100 year ARI. A small portion of the south-western part of the site is located within the PMF extents.

Strangers Creek – Norwest Station (Site 7)

Norwest Station is located on Norwest Boulevard, west of Strangers Creek, which in this location is a highly modified system consisting of a series of ponds interconnected with drainage culverts, draining a catchment area of approximately 36 hectares. In larger flood events the ponds would overtop and flows would travel across Norwest Boulevard. The station area is elevated above Strangers Creek and is not affected by mainstream flooding. Local overland flows for the 20 and 100 year ARI and PMF are in the order of 2.0m3/sec, 2.6m3/sec and 9.1m3/sec.

Bella Vista Station to Rouse Hill Station

Elizabeth Macarthur Creek – Bella Vista Station (Site 8) to Kellyville Station (Site 11)

The rail alignment between Bella Vista Station (Site 8) and Kellyville Station (Site 11) runs parallel and in close proximity to Elizabeth Macarthur Creek. Development in the upstream catchment (south of Celebration Drive) is well established, consisting of a mixture of residential and commercial development. The catchment draining to Elizabeth Macarthur Creek between Celebration Drive and Samantha Riley Drive is currently largely undeveloped. However, significant urbanisation is currently underway and ongoing as part of the development of the North West Growth Centres.

Flood extent mapping for Elizabeth Macarthur Creek is provided in **Figure 18.4** for the 20 and 100 year ARI events and PMF. As shown, the alignment between Bella Vista Station and Kellyville Station is typically located clear of the Elizabeth Macarthur Creek floodplain, with a relatively small eastern fringe of the Bella Vista Station and Balmoral Road sites being flood affected. A portion of the Memorial Avenue site in the north lies within the defined flood extents of both the 100 year and PMF.

Caddies Creek (including Tributaries 3, 4 and 5) – Windosr Road/Old Windsor Road (Site 12) to Windsor Road Viaduct (Site 15)

Within Sites 12 and 13, the project consists of rail viaduct that spans the broad floodplain of Caddies Creek shown in **Figure 18.5** including its confluence with Elizabeth Macarthur Creek and Caddies Creek Tributaries 3, 4 and 5. The creek lines in this area are moderately incised with well vegetated main channel and overbank areas.

Rouse Hill Station (Site 14) is located north of Caddies Creek Tributary 3 and would be susceptible to inundation from flows overtopping Windsor Road at the Tributary 3 culverts. Previous hydraulic studies undertaken for the Windsor Road T-way Project (Maunsell 2005a and 2005b) show that the Tributary 3 culvert crossing has in excess of a 100 year ARI capacity. Consequently, the Rouse Hill Station area is not expected to be affected by flooding up to the 100 year ARI event, apart from runoff from the local

drainage network. Windsor Road overtops in the PMF and the southern edge of the site could therefore be affected by flooding in the PMF. Flood extent mapping for Caddies Creek is provided in **Figure 18.5** this is figure 11 from the tech paper for the 20 and 100 year ARI events and PMF.

Site 15 is located immediately north of Rouse Hill Station. In this area the project crosses over Windsor Road on an elevated viaduct. Site 15 is located within the Caddies Creek catchment but outside the floodplain of mainstream flooding.

Rouse Hill Station to Tallawong Stabling Facility

Second Ponds Creek – Windsor Road Viaduct to Cudgegong Road (Site 16)

Second Ponds Creek at the NWRL alignment has an upstream catchment area in the order of 620 hectares. The catchment has undergone significant urban development over recent years. Parts of the catchment, particularly in the immediate vicinity of the project corridor, are largely undeveloped and consist mainly of rural residential. Urban development in the catchment is ongoing. Existing areas of rural development are earmarked for urbanisation as part of the Area 20 Precinct Plan.

Flood extent mapping for Second Ponds Creek is provided in **Figure 18.6** for the 20 and 100 year ARI events, as well as the PMF. Cudgegong Road Station is located to the east of Second Ponds Creek and is not located within the defined flood extents.

First Ponds Creek – Cudgegong Road Station and Tallawong Stabling Facility (Site 17)

The western edge of the Tallawong Stabling Facility borders a tributary of First Ponds Creek. The tributary drains a catchment area of approximately 55 hectares. The junction with First Ponds Creek is approximately 150m further downstream (to the north) at which location the catchment area draining to First Ponds Creek is approximately 300 hectares. The First Ponds Creek catchment is currently largely undeveloped, consisting of rural residential development. Future urbanisation is proposed as part of the Alex Avenue Precinct.

Flood extent mapping for First Ponds Creek is provided in**Figure 18.6** for the 20 and 100 year ARI events and the PMF. The western edge of the Stabling Facility bordering the First Ponds Creek tributary is partially flood affected.

Figure 18.2 Flood Extent Mapping Beecroft Road Tributary

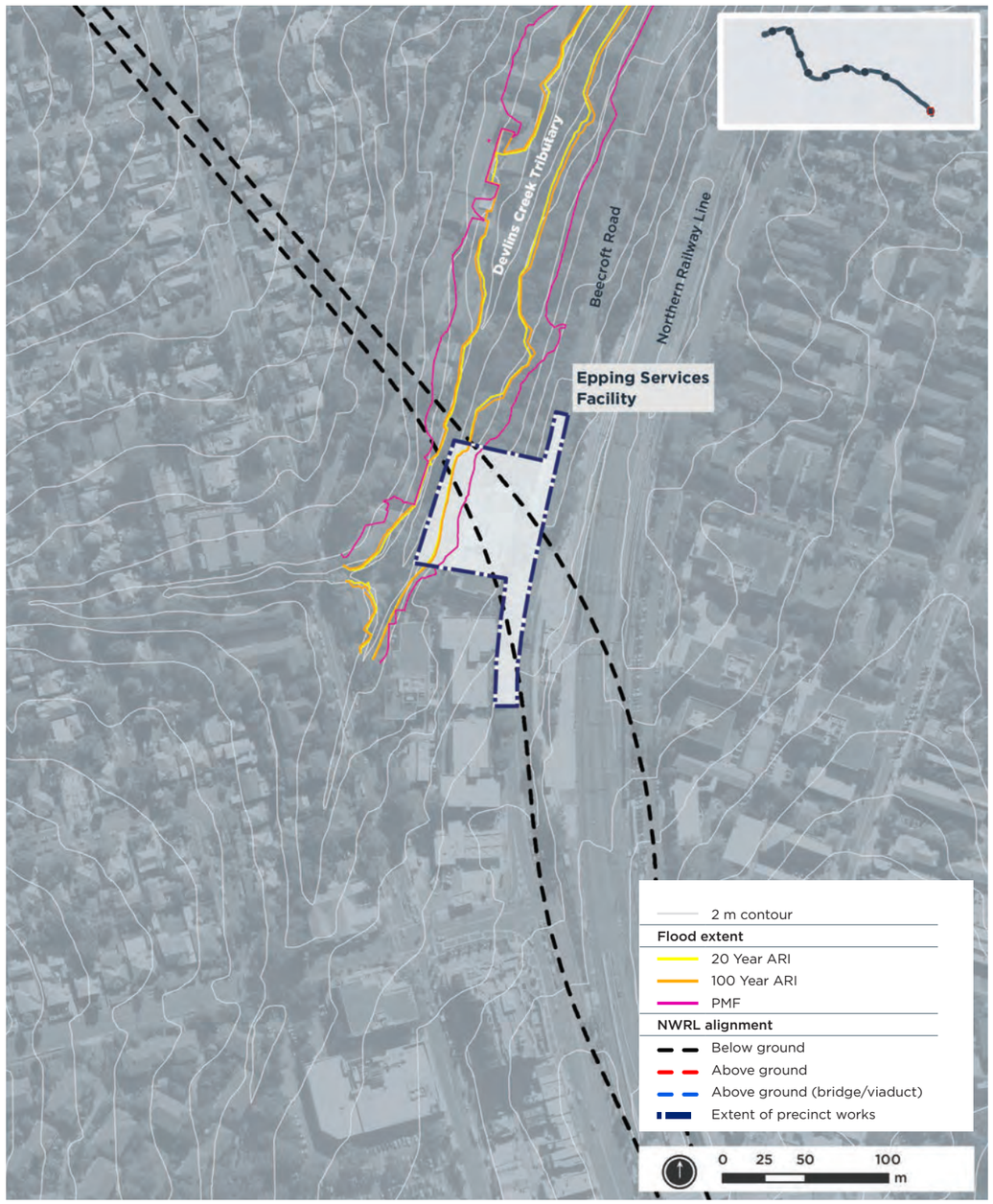


Figure 18.3 Flood Extent Mapping Cattai Creek

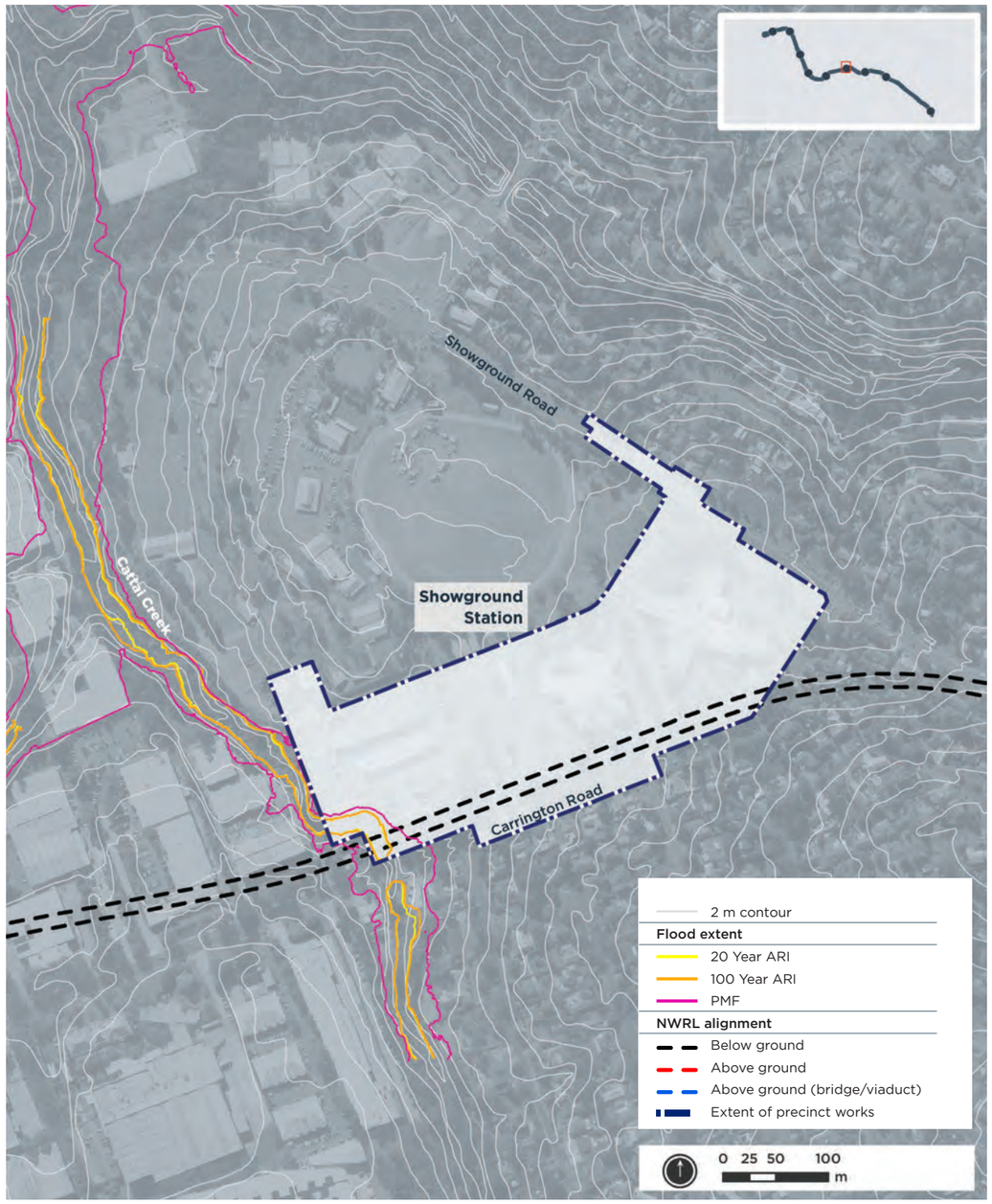


Figure 18.4 Flood Extent Mapping - Elizabeth Macarthur Creek

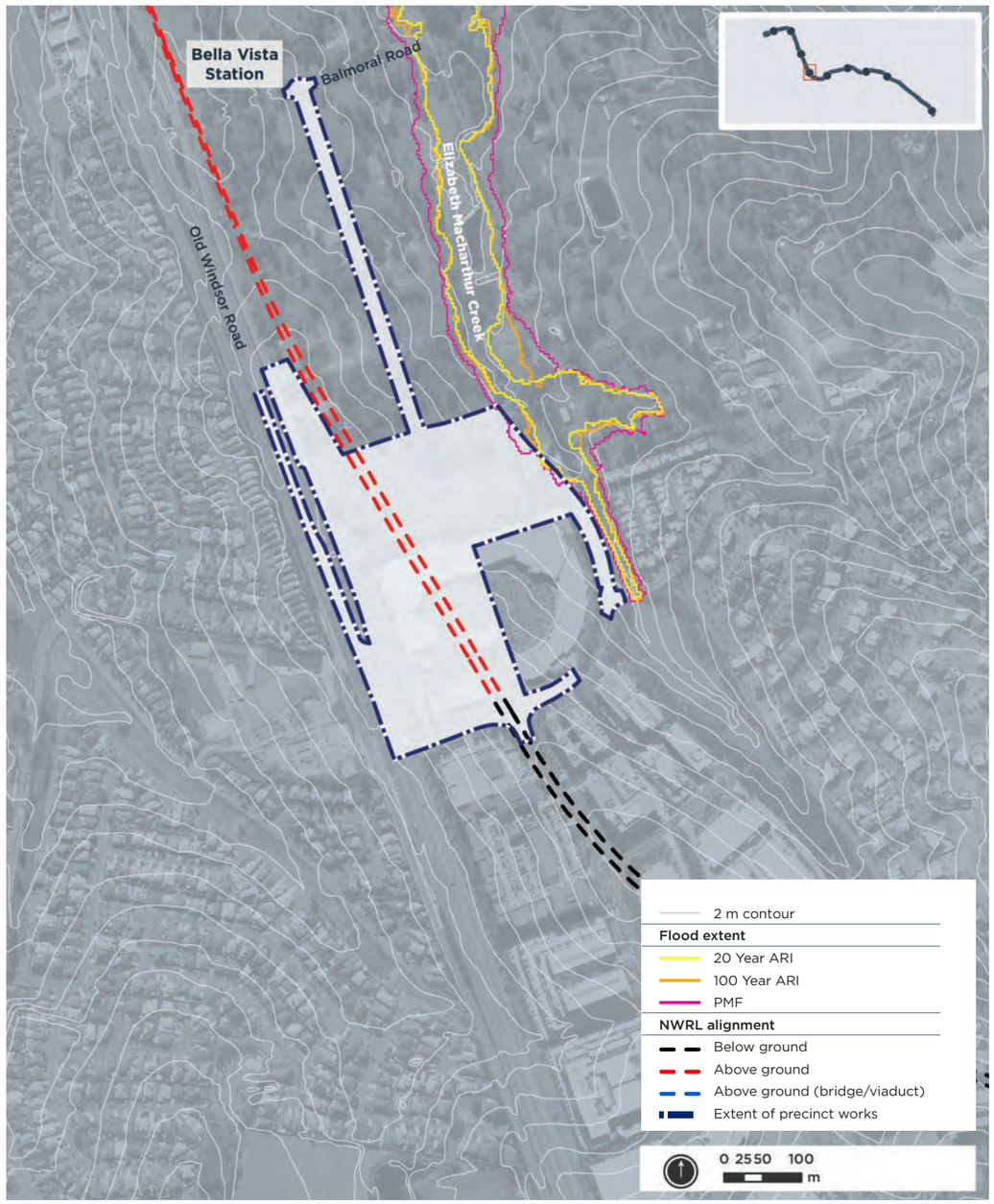


Figure 18.5 Flood Extent Mapping - Caddies Creek Including Tributaries 3, 4 and 5

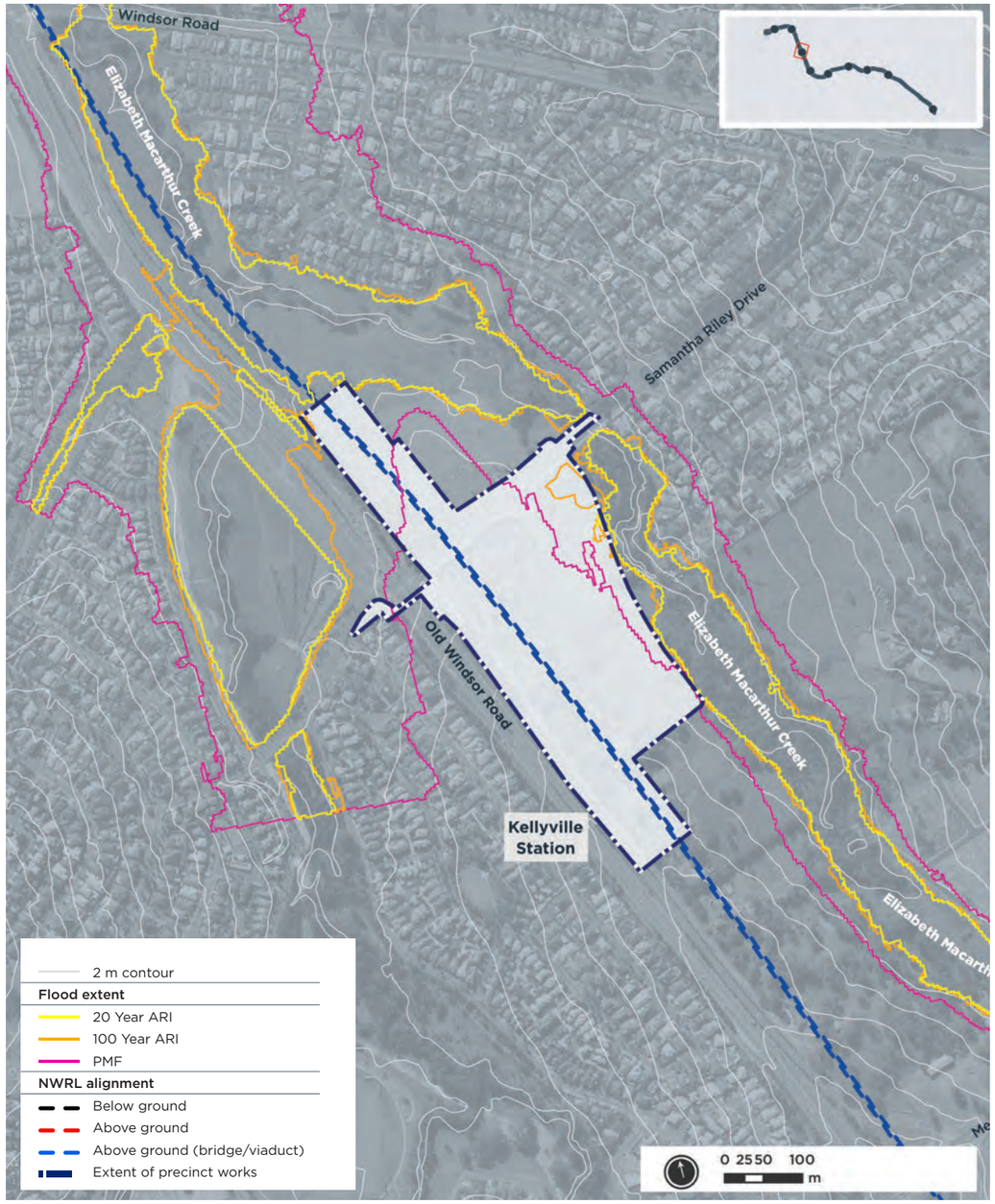
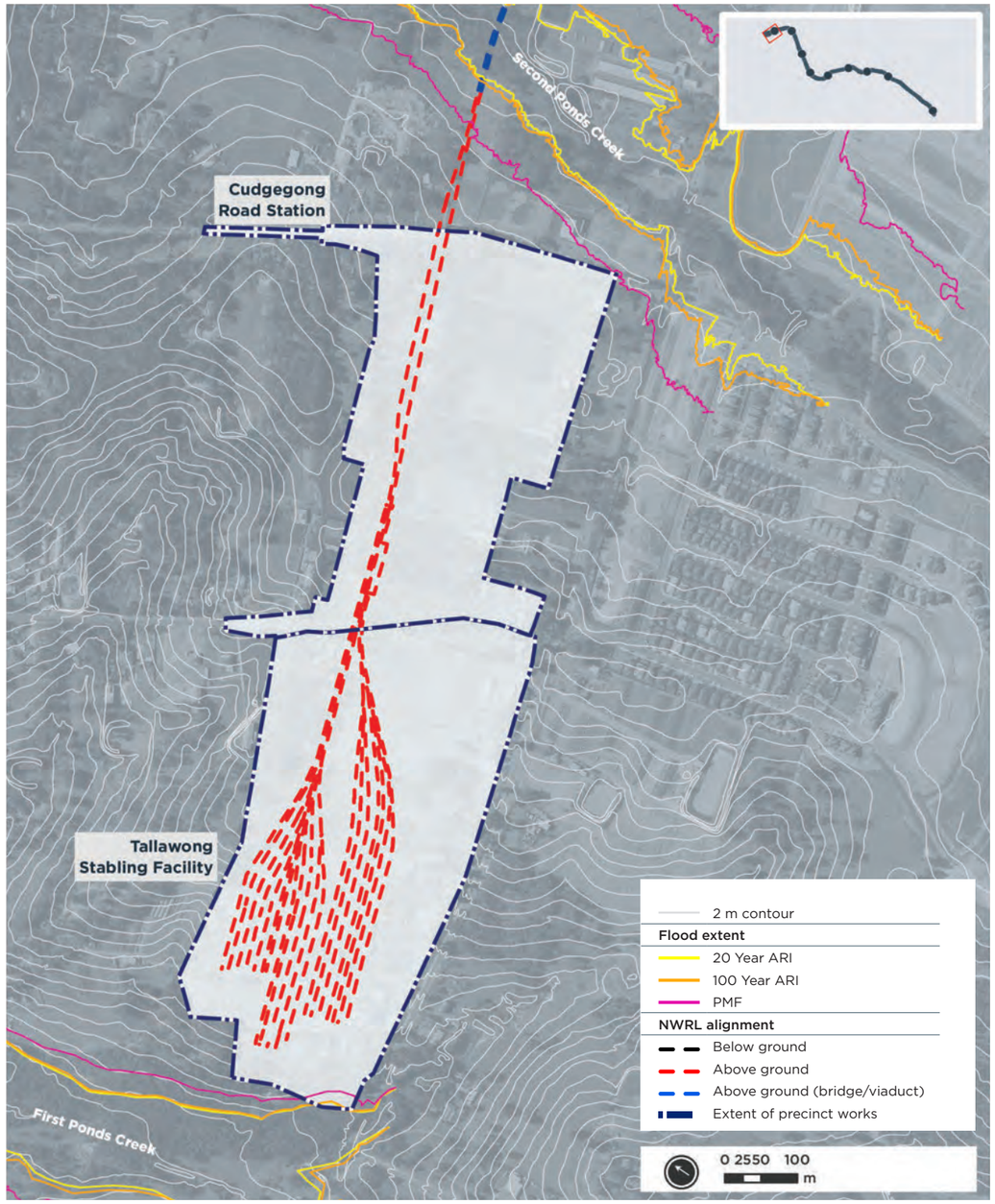


Figure 18.6 Flood Extent Mapping - Second Ponds Creek



18.4.3 Water Quality

Local Councils within the area (namely Hornsby Shire Council, The Hills Shire Council and Blacktown City Council) have extensive water quality monitoring and reporting programmes. Water quality monitoring data is or has previously been collected by various government agencies including Sydney Water, the former Department of Land and Water Conservation (DLWC), the Environment Protection Agency, the Sydney Catchment Authority and the Hawkesbury Nepean Catchment Management Trust.

Hornsby Shire Council publishes an annual water quality report, which is made available to the community and interested authorities through the Council's web site.

As part of the original approval conditions for the M2 Motorway a water quality monitoring program was established in 1997-98 following the commencement of operation in May 1997. The aim of the program was to monitor water quality in the receiving systems to check for conformance with recommended quality limits and identify any long term impacts associated with the M2 Motorway. Since that time, water quality data has been collected and analysed (HLA Envirosciences) at 16 locations on waterways upstream and downstream of the M2 Motorway corridor. Four of these sites are relevant to the NWRL Project. These are located on Devlins Creek in the vicinity of the Epping Services Facility (Site 1) and Cheltenham Services Facility (Site 3).

The Hills Shire Council's Health and Environmental Protection Team routinely monitors the water quality of major creek systems in the Council area. This includes monitoring sites upstream and downstream of the Project Area within:

- Cattai Creek
- Strangers Creek
- Elizabeth Macarthur Creek
- Caddies Creek
- Second Ponds Creek

Blacktown City Council has an ongoing water quality monitoring program but the locations of monitoring sites are not directly applicable to the project area.

Epping Services Facility to Bella Vista Station

Devlins Creek (including Beecroft Road Tributary)

Hornsby Shire Council has established a monitoring station on Devlins Creek, approximately 200m downstream of the Cheltenham Services Facility. The monitoring station is adjacent to Sutherland Road at Cheltenham. Monitoring commenced in October 1994. Results of Council's monitoring is presented in Hornsby Shire Council (2009 and 2010).

At Hornsby Monitoring Location 8 occasional high levels of faecal coliforms have been encountered, particularly after storms. The source of elevated levels is reported to be from stormwater runoff and/or sewer pipe overflows. Results exceeded the ANZECC Guidelines for Ammonium Nitrogen (NH_3) and phosphorous concentrations in the majority of samples taken. However, because faecal coliforms were low, sewer leaks were not suspected. The levels of turbidity and suspended solids in urban sites were generally acceptable. Test results showed typically low Dissolved Oxygen (DO) levels, especially at low flow conditions when the pools tend to turn black.

The M2 Motorway monitoring sites for Devlins Creek sites are located upstream of the Cheltenham Services Facility. Comparison of the M2 Motorway monitoring results for pre and post construction of the Motorway indicates that construction of the existing motorway has not had any significant impact on the water quality of the downstream receiving systems.

Pyes Creek

Hornsby Monitoring Location 5 is located on Pyes Creek at Cherrybrook (refer **Figure 18.1**). The catchment draining to the monitoring site is approximately 380 hectares of which 79% is zoned residential. The monitoring site is located in a section of creek that has extensive patches of exposed bedrock. Monitoring by Hornsby Shire Council commenced in October 1994.

The monitoring site is located approximately 3km downstream of Cherrybrook Station and is therefore not suitable to provide a direct analysis of potential changes in runoff quality from the project. However, results do provide a useful background to the nature of the broader downstream receiving system.

Monitoring results exceeded the ANZECC guidelines for Ammonium Nitrogen (NH_3) and phosphorous concentrations in the majority of samples taken. The levels of turbidity and suspended solids in Pyes Creek were generally recorded at acceptable levels. Sewer leaks were not suspected due to low faecal coliform readings.

Cattai Creek

The Hills Shire Council operates three monitoring locations on Cattai Creek, upstream of the Showground Station, downstream of Showground Road and one site a further 1.2km downstream. Additional monitoring locations have previously been operated by the Environment Protection Authority, Sydney Catchment Authority, Sydney Water, Department of Land and Water Conservation and the Hawkesbury Nepean Catchment Management Trust.

In general, *E. Coli* and nutrients Total Nitrogen and Total Phosphorous were found to be above the ANZECC guidelines in over half the samples, with dissolved oxygen readings below recommended guidelines.

Strangers Creek

The Hills Shire Council operates two monitoring locations on Strangers Creek, downstream of Norwest Station. Results of monitoring indicate nutrient levels below ANZECC guidelines, with dissolved oxygen readings below recommended guidelines.

Bella Vista Station to Rouse Hill Station

Elizabeth Macarthur Creek

Two monitoring sites operated by The Hills Shire Council are located on Elizabeth Macarthur Creek, off Celebration Drive upstream of the proposed Bella Vista Station and off Clovelly Crescent, upstream of the confluence with Caddies Creek. The former site has generally shown readings within acceptable limits for secondary contact recreation under the ANZECC guidelines. Slightly more than half the samples showed elevated Total Nitrogen levels. Results at the other monitoring site indicate poorer quality, with elevated levels of Total Nitrogen and Total Phosphorous in nearly all the samples taken, along with elevated *E. Coli* in approximately half the samples. Dissolved Oxygen at this location was below recommended levels within the ANZECC guidelines.

Caddies Creek (including Tributaries 3, 4 and 5)

The Hills Shire Council's Health and Environmental Protection Team operate two monitoring sites on Caddies Creek, one located approximately 1km downstream of the proposed Rouse Hill Station and another further 500m downstream.

Results from both sites indicate *E. Coli* and nutrients Total Nitrogen and Total Phosphorous are above the ANZECC guidelines in over half the samples, with dissolved oxygen readings below recommended guidelines.

Rouse Hill Station to Tallawong Stabling Facility

Second Ponds Creek

The Hills Shire Council's Health and Environmental Protection Team operate one monitoring site on Second Ponds Creek, located approximately 2.5km downstream of the project corridor and therefore not suitable to provide a direct indication of the existing runoff quality relevant to the NWRL project.

First Ponds Creek

Blacktown City Council has two water quality monitoring sites in First Ponds Creek. The nearest of these is approximately 2.3km downstream of the project and is therefore not suitable for use as a monitoring location.

18.4.4 Topography

Between Epping and Showground Station the rail corridor passes through an area of established suburbs and relatively hilly terrain, with ground levels varying between 50m Australian Height Datum (AHD) and 190m AHD. Mostly commercial or industrial development exists from Showground Station northwest to Bella Vista. This area is typified by gently rolling hills and valleys. From Bella Vista the alignment follows Old Windsor Road and Windsor Road northwest towards Rouse Hill, traversing relatively flat or gently undulating terrain with relatively broad floodplains.

18.4.5 Rainfall and Evaporation

The project area is characterised by generally high summer-autumn and low winter-spring rainfall. For the south eastern section of the project (Epping to Bella Vista), average monthly rainfall ranges from approximately 80-140 millimetres in the summer-autumn months to approximately 60-110 millimetres in the winter-spring months. For the northwestern section of the Project (Bella Vista to Rouse Hill) average monthly rainfall ranges from approximately 70-120 millimetres in the summer-autumn months to approximately 40-110 millimetres in the winter-spring months.

Average annual rainfall across the project area varies from 1,140 millimetres in the south east, to 870 millimetres in the north-west. (Source: Bureau of Meteorology (BOM) monthly rainfall data for Macquarie Park, Pennant Hills, Seven Hills and Prospect). Average monthly evaporation in the region ranges from less than 100 millimetres in the winter months to over 400 millimetres in the summer months (Source: BOM monthly average pan evaporation map, 2006).

18.4.6 Geology and Soils

Key characteristics of the geology and soils of the project area are described in Chapter 8 Soils and Groundwater.

The project area lies within the Sydney Basin and generally on elevated terrain known as the Hornsby Plateau. The rocks, which comprise the upper part of the Basin, consist largely of Triassic aged sedimentary rocks with occasional Jurassic aged volcanic intrusions. This bedrock geology is overlain by residual soils, and locally by Quaternary alluvium, slope wash and fill.

There are six major soil landscapes occurring throughout the corridor. The Glenorie Landscape (gn) is the main soil landscape on the Wianamatta Group Shales. Typically these soils have a depth of up to 2m, with the topsoil consisting of a friable dark brown loam. This soil is present across the majority of the eastern section of the project.

Other soils within the south-eastern section of the Project include Hawkesbury (ha) and Gymea (gy) Landscapes. Soils within the Hawkesbury Landscape (ha) are typically less than 0.5m deep. These shallow soils in conjunction with the steep terrain are classified as an extreme erosion hazard. The Gymea Landscape is typified by soil depths of up to 1m and has a high to extreme erosion hazard.

The north-western section of the Project is dominated by the Blacktown (bt) group and bordered by the Luddenham (lu) group. These alluvial soils are classified as a high erosion hazard and can be expansive.

Soil salinity has been identified as a growing problem in the Western Sydney region. Salinity potential maps prepared by DIPNR in 2002 identify the potential risk of soil salinity. Based on these maps, areas around Caddies Creek, First Ponds Creek and Second Ponds Creek show high salinity potential or known salinity.

Acid sulfate soil risk mapping undertaken by the DLWC show that the project lies within areas designated as 'no known risk' of ASS or PASS (DLWC, 1998).

18.5 Potential Operational Impacts

18.5.1 Flooding

General

Flooding of the creeks and waterways which traverse the project corridor has the potential to inundate the rail infrastructure, station precincts and ancillary facilities during the life of the project, cause damage to the rail infrastructure and pose a safety risk to the public and rail workers. Furthermore, any proposed works within the floodplain have the potential to change existing flood behaviour and adversely impact on the surrounding environment. It is therefore necessary to manage the nature and extent of works within the floodplain in order to minimise the flood risk to the NWRL project and surrounding environment.

Potential flood impacts were considered for each component of Stage 2 of the NWRL:

- Stations
- Development within stations precincts
- Tallawong Stabling Facility
- Tunnels
- The skytrain and Surface Tracks
- Rail Services Facilities
- Rail System Infrastructure
- Surrounding Environment

Construction impacts of the major civil works and operational impacts of major civil structures (bridges and viaducts) are addressed in the EIS 1.

Station Precincts

Each station will include a surrounding precinct that consists of a range of existing and future facilities including:

- Commercial/retail space.
- Transport interchanges/drop off/taxi facilities.
- Car and bicycle parking.
- Public domains and station plazas.
- Station access for emergency, delivery and maintenance vehicles.
- Pedestrian access.

As a minimum, railway stations are required to have 100 year ARI flood immunity. However, in accordance with the principles of the NSW Floodplain Development Manual (2005) a higher level of protection is needed where flows in excess of 100 year ARI have the potential to cause significant damage and/or risk to life. This is particularly relevant to underground stations where ingress of floodwaters has the potential to cause significant damage to critical services/infrastructure and where safe evacuation of rail users and staff may be difficult, particularly where there may be limited warning.

Underground stations are to be located at Cherrybrook, Castle Hill, Showground, Norwest and Bella Vista. Due to the potential consequences of flooding to these stations, a PMF flood standard will be required against mainstream and significant overland flooding.

Based on the current concept design each station has been located above the PMF level of mainstream flooding. For above ground stations, it is possible to adopt a lesser (100 year ARI) standard providing a flood risk assessment and flood evacuation plan is developed to identify how flood risks are managed for events greater than the 100 year ARI. Above ground stations are to be located at Kellyville, Rouse Hill and Cudgegong Road.

A summary of flooding potential at each station precinct, including PMF levels adopted for the concept design is provided in **Table 18.3**. Flood levels provided relate to mainstream flooding. At some stations, drainage collection systems will be required to manage the potential for local stormwater runoff to enter the stations. This is particularly relevant to Cherrybrook and Bella Vista Stations. Local issues and potential impacts relevant to each station are identified in **Table 18.3** which also outlines mitigation measures to reduce the potential flood impacts.

The planning approach being adopted for the NWRL recognises that development in the precincts around the stations would occur over time, but that measures must be taken now to provide a robust framework within which this development can occur. In this context, the key flooding constraints and opportunities relevant to the broader station precincts have been assessed and key floodplain management requirements are also summarised in **Table 18.3**.

Table 18.3 Flooding Potential and Mitigation Measures at Station Precincts

Station Precinct	Type	Flooding Potential From	PMF Level (mAHD)	Potential Impacts	Mitigation Measures	
					Station	Broader Precinct
Cherrybrook	Below ground open box	Local overland flow only.	N/A (Local overland flow only)	The station and broader precinct is not affected by mainstream flooding. However, a local overland flowpath runs south to north across the siteCastle Hill Road lies to the south of the site. Flows in excess of the road drainage system capacity will collect at the low point adjacent to Glenhope Road. Some of these flows will enter the station precinct and travel south along the existing depression that runs through the centre of the site. Overland flow through the site in the PMF is estimated to be $1.7m^3/s$. Without appropriate site grading and drainage measures there is the potential for overflows from Castle Hill Road to enter the precinct and flood the station.	Design of site grading and local drainage system within the station precinct to provide for the diversion of overland flows around the station opening. System to be designed to convey the PMF without ingress into the station, with appropriate allowance for drainage system blockage. Runoff draining to and through the site will be discharged into the natural depression at the north west corner of the site. This will be incorporated into the precinct design.	Site grading and precinct layout designed to manage overland flows along roadways and landscaped areas.
Castle Hill	Below ground	Local overland flow only.	N/A (Local overland flow only)	Station is located at the top of the catchment and therefore flood impacts are not anticipated.	Apart from appropriate drainage design, no additional flood mitigation measures are required. Drainage design would include station entries at a minimum 0.3m above local ground elevations.	Apart from appropriate drainage design and surface grading to cater for local overland flows no additional floodplain management measures are required.
Showground	Below ground	Cattai Creek	84.2	Station has been located above the PMF level for Cattai Creek flooding. The broader precinct is located outside the 100 year ARI flood extents. However, the southwest corner of the precinct is flood affected in the PMF. The area affected is confined to an access road and a small section of the multi-level carpark building. Access to the station off Carrington Road is outside the PMF extent. Refer **Figure 18.4** for flood extent mapping.	Station located outside the PMF extent. Drainage design would include station entries being a minimum 0.3m above local ground elevations.	Western access road, adjacent to Cattai Creek, to be designed to manage flood impacts on Carrington Road and surrounding development.
Norwest	Below ground	Strangers Creek	81 (refer comments under 'Potential Impacts')	Station precinct is located adjacent to Norwest Boulevard, west of Strangers Creek. Preliminary hydraulic assessment has been carried out to determine the PMF level in Strangers Creek at Norwest Boulevard based on the conservative assumption of all runoff in the PMF flowing overland across the road. The station is located above the PMF level for Strangers Creek flooding. However, a minor tributary to Strangers Creek runs north along Brookhollow Avenue (along the western boundary to the station site). The PMF flow along Brookhollow Avenue is estimated to be $9.1m^3/s$ with a depth of 0.6m. Refer to Section 18.3.5 for peak overland flows.	Station located outside the PMF extent for mainstream flooding. Local overland flows along Brookhollow Avenue to be managed by elevating western entry points to the station a minimum 0.6m above road level or providing surface grading to cater for overland flows in the PMF. Otherwise, station entries shall generally be set a minimum 0.3m above local ground elevations.	Buildings and entry points to station to be located 0.6m above Brookhollow Road or surface grading within precinct designed to manage overland flows through the site.

Station Precinct	Type	Flooding Potential From	PMF Level (mAHD)	Potential Impacts	Mitigation Measures	
					Station	Broader Precinct
Bella Vista	Below ground open cut	Elizabeth Macarthur Creek	71.0	The station and broader precinct is located above the PMF level for Elizabeth Macarthur Creek flooding. Immediately north of Bella Vista Station is a 700m long cutting that falls to a low point away from the station thus presents minimal risk of overland flows entering the station.	Station located outside the PMF extent. Appropriate drainage design shall include setting of station entries a minimum 0.3m above local ground elevations.	Apart from appropriate drainage design and surface grading to cater for local overland flows no additional floodplain management measures are required.
Kellyville	Above ground	Elizabeth Macarthur Creek	48.6	The station is located above the PMF level for Elizabeth Macarthur Creek flooding. A small proportion of broader precinct along the eastern edge is affected by 100 year ARI flooding. The area affected is largely confined to proposed access road. A larger proportion of the precinct, including the area of carpark north of Samantha Riley Drive, is located within the PMF extent. Access to station from Old Windsor Road is outside the PMF extent. Refer **Figure 18.5** for flood extent mapping.	Station is located outside the PMF extent and so, apart from appropriate drainage design, no additional flood mitigation measures are required.	Any filling within the floodplain associated with the construction of access roads or car parking to be designed to manage impacts on the surrounding development. Impacts on Old Windsor Road would be managed up to the PMF.
Rouse Hill	Above ground	Caddies Creek Tributary 3	49.5 Note 2	Under the current viaduct design Rouse Hill Station is an elevated scheme, located above the PMF level. Located north of Caddies Creek Tributary 3 the precinct would be susceptible to inundation from flows that overtop Windsor Road at the Tributary 3 culverts. Previous hydraulic studies undertaken for the Windsor Road Transitway Project (Maunsell 2005a and 2005b) show that the Tributary 3 culvert crossing has in excess of a 100 year ARI capacity. Consequently, aside from runoff from the local drainage network, the precinct is not expected to be affected by flooding up to the 100 year ARI event. Access to station off Windsor Road is located outside the PMF extent. However, the rail service facility is located within the PMF extents.	Station is located outside the PMF extent and so, apart from appropriate drainage design, no additional flood mitigation measures are required.	Critical infrastructure within the facility to be designed above the PMF level. Precinct works within the floodplain would be designed to manage impacts on Windsor Road.
Cudgegong Road	Above ground (within cutting)	Second Ponds Creek	48.8	Station is located above the PMF level and so the risk of flooding from Second Ponds Creek is low. Located outside the PMF flood extents for Second Ponds Creek. The existing site is largely undeveloped and contains a number of drainage lines and depressions that currently convey overland flows through the site. Refer to **Figure 18.6** for precinct location and peak overland flows.	Station is located outside the PMF extent and so, apart from appropriate drainage design, no additional flood mitigation measures are required.	Apart from appropriate drainage design and surface grading to cater for local overland flows no additional floodplain management measures are required.

Notes

1. Flood standard could be reduced to 100 year ARI providing flood risk assessment carried out to ascertain the risk to life and operational requirements during events in excess of the 100 year ARI and develop emergency management plan.
2. Based on Maunsell (2005b).

Tallawong Stabling Facility

Tallawong Stabling Facility would be located south of First Ponds Creek and west of Schofields Road.

A 100 year ARI flood standard is typically adopted for stabling facilities to provide a suitable level of flood immunity. However, any critical service facilities located within the stabling faciliity would require a higher standard. The proposed location of the stabling facility at Tallawong Road is outside the First Ponds Creek floodplain (**Figure 18.6**). Consequently, apart from appropriate drainage design, no additional flood mitigation measures would be required.

Tunnels

Twin underground rail tunnels would extend from Epping for 15.5km to a tunnel portal at Bella Vista station. Flooding of the tunnels has the potential to pose a risk to life of rail users and staff and lead to damage to critical services and infrastructure. Consequently, entries to the tunnels have been designed at or above the PMF level to minimise the potential for floodwaters entering the tunnel. Tunnel entries include the tunnel portal at Bella Vista as well as access points to below ground stations and service facilities. The PMF flood level applicable to the tunnel portal is provided in **Table 18.4**.

Table 18.4 Tunnel Portal Entry

Portal Location	Flooding Potential From	PMF Flood Level (mAHD)	Potential Impacts	
North of Celebration Drive	Elizabeth Macarthur Creek	72.0	Tunnel portal is located above the PMF level so the risk of mainstream flooding is low. Rail alignment north of the portal has been aligned along a ridgeline to minimise the potential for overland flows entering the portal and tunnel.	Portal is located outside the PMF extent and so, apart from appropriate drainage design, no additional flood mitigation measures are required.

The Skytrain and Surface Tracks

From the tunnel portal at Celebration Drive the rail line would continue through to Tallawong Stabling Facility via a combination of skytrain (on viaduct) and surface tracks (in cut or on embankment).

Skytrain

The bridges and viaducts to support the skytrain will be constructed as part of the major civil and construction works that were assessed in EIS 1.

The underside of bridges and viaducts spanning waterways have been set a minimum 500mm above the 100 year ARI flood level (including climate change allowances). This level of protection is designed to not only manage flood risks to the rail line but also help to minimise impacts on adjacent development.

Where critical infrastructure or risks of flood impacts in events greater than the 100 year ARI event are present upstream of the rail alignment then, in accordance with the NSW Floodplain Development Manual (2005), a higher standard is required to manage impacts on surrounding development. This is particularly relevant in the context of potential flood impacts on critical infrastructure adjoining the rail alignment at Caddies Creek and Second Ponds Creek. This critical infrastructure includes key transport links such as Windsor Road, Old Windsor Road and Schofields Road and the Tallawong Road electricity substation.

A summary of flood level estimates applicable to the bridge/viaduct waterway crossings is provided in **Table 18.5**. As a minimum, bridge/viaduct levels have been set at least 500mm above these values.

Table 18.5 Bridge and Viaduct Waterway Crossings

Creek	Crossing	Estimated 100 year ARI Flood Level (mAHD) [1]
Confluence of Caddies, Elizabeth Macarthur and Caddies Tributary 5	Viaduct	45.0 [2] 43.2 [2]
Caddies Tributary 4	Viaduct	44.5 [2] 43.0 [2]
Caddies Tributary 3	Viaduct	48.4 [3]
Second Ponds Creek	Bridge/viaduct and embankment	46.2
First Ponds Creek	West of project limit – future bridge crossing	40.4

Notes

1. Includes allowance for climate change based on 10% increase in rainfall intensity.
2. Flood levels at the start and end chainages are listed due to the length of viaduct spanning the floodplain
3. Based on Maunsell (2005b).

Surface Tracks

The NWRL design includes at grade sections from Bella Vista to north of Balmoral Road and from the western abutment of Second Ponds Creek through to Tallawong Stabling Facility. Sections of track at grade (including sections in cut or on fill embankment) have been set above the 100 year ARI flood level (including allowance for climate change) when measured to the track formation at edge of ballast in accordance with standard practice.

Rail Services Facilities

Flooding to the services facilities would have the potential to inundate the tunnels and below ground infrastructure with the potential risk to life and damage to critical infrastructure. Consequently the facilities have been located to manage the risk of flooding up to the PMF. A summary of flood level estimates applicable to the locations for the services facilities is provided in **Table 18.6**.

Table 18.6 Services Facilities

Facility	Flooding Potential From	PMF Flood Level (mAHD)	Potential Impacts	Mitigation Measures
Epping	Devlins Creek Beecroft Road Tributary	78.8	Facility entry points are located above the PMF level and so the risk of mainstream flooding is low.	Facility is located outside the PMF extent and so, apart from appropriate drainage design, no additional flood mitigation measures are required.
Cheltenham	Local runoff only	Not applicable – local drainage only	Facility is located outside the floodplain	Portal is located outside the PMF extent and as a result, apart from appropriate drainage design, no additional flood mitigation measures are required.

Rail System Infrastructure

The operation of the NWRL would require new traction substations at Epping West, Cherrybrook, Castle Hill, Showground, Norwest and Tallawong stabling facility. A sectioning hut would be required at the Cheltenham services facility. In addition, an off precinct traction substation would be required at Bella Vista and a sectioning hut at Rouse Hill.

Above ground traction stations and sectioning huts have been located a minimum 500mm above the 100 year ARI flood leve,l in accordance with the NSW Floodplain Development Manual (2005) and past project practices such as South West Rail Link.

At below ground facilities (between Epping and Bella Vista) entry points have also been located above the PMF level due to the increased risk to life and infrastructure as a result of potential ingress of floodwaters into the below ground structure. Facilities that are identified as being critical to emergency response operations will also be protected up to the PMF.

A summary of flood level estimates applicable to currently proposed locations for rail system infrastructure is provided in Technical Paper 7.

Impacts on the Surrounding Environment

The Project crosses a number of creeks and watercourses and their associated floodplains. Under the current design a range of works are required within these floodplains, including embankments, bridge piers/columns and abutments, viaduct piers/columns, station precinct works (including carparks and roads) and facility structures. Any works within the floodplain have the potential to change flood behaviour and adversely impact on the surrounding environment.

In accordance with the NSW Floodplain Development Manual the NWRL concept design has been developed to manage the extent of impacts on the surrounding environment.

The 100 year ARI event has generally been adopted for assessing impacts on surrounding properties. However, in accordance with the DGRs, consideration has also been given to the implications of flooding during events in excess of the 100 year ARI event. Detailed assessment of flood risks in events greater than the 100 year ARI flood is particularly relevant in the context of potential flood impacts on critical infrastructure adjoining the project, including key transport links (such as Windsor Road, Old Windsor Road and Schofields Road) and infrastructure that are integral to emergency response operations (such as electricity substations).

Potential impacts associated with the construction of the rail embankments, bridges and viaducts were assessed in EIS 1 Major Civil and Construction Works. These elements, plus components of Stage 2 within the floodplain, such as station precincts, have been assessed in combination to identify cumulative impacts of the Stage 1 and Stage 2 works.

The following sections provide an outline of the nature of operations and works proposed, potential flood impacts on the surrounding environment and measures incorporated into the design to manage these impacts. For sites affected by overland flows, impacts on the surrounding environment would be managed through the provision of flow paths integrated with the design of the station precincts to control flows that currently discharge to and through the sites.

Devlins Creek Tributary (Epping Services Facility)

There is considerable existing development on the floodplain in the vicinity of the project corridor, consisting mainly of medium density residential development and commercial development. These areas of existing development would be sensitive to changes in flood behaviour.

Given the sensitive nature of the surrounding development the Epping Services Facility has been designed to locate works outside the 100 year ARI flood extent and therefore negate any potential flood impacts on adjacent development up to the 100 year ARI flood. However, part of the proposed services facility is located within the PMF extent. Flood modelling results show that in a PMF, flood levels could increase by up to 0.3m along the tributary between the facility site and Raby Road. Under existing conditions the area experiences widespread flooding in the PMF with properties along the tributary, including Raby Road, already flood affected. No new properties would be affected as a result of Stage 2 of the NWRL. Consequently the increase in flood levels is not considered to be significant in the context of the nature of existing flooding in the PMF.

Cattai Creek (Showground Station)

During the development of the design Showground Station has been relocated outside the PMF extent to reduce the risk of flooding to the station, and potential impacts on adjacent development. The broader precinct area is located outside the 100 year ARI flood extent. However, a portion of the western access road off Carrington Road would be located within the PMF extent. The access road is not expected to have any adverse flood impacts on the surrounding environment providing the level of the road is set at or below Carrington Road.

Strangers Creek (Norwest Station)

Norwest Station is located on Norwest Boulevard, west of Strangers Creek. Strangers Creek in the vicinity of Norwest Boulevard is a highly modified system consisting of a series of ponds interconnected with drainage culverts. In larger flood events, the ponds would overtop and flows would travel across Norwest Boulevard.

Norwest Station is elevated above Strangers Creek and located outside an area of mainstream flooding. However, significant overland flow from a tributary to Strangers Creek would travel down Brookhollow Road and Norwest Boulevard in larger events (along the western and northern boundaries to the precinct).

Therefore, subject to management of local runoff and overland flowpaths, the proposed station layout is not expected to have any adverse impacts on flooding for the surrounding area.

Elizabeth Macarthur Creek (Bella Vista Station to Kellyville Station)

Between Bella Vista Station and Kellyville Station the rail alignment runs parallel and to the west of Elizabeth Macarthur Creek and immediately east of Old Windsor Road, and thus outside the Elizabeth Macarthur Creek floodplain. Flood modelling indicates that the rail corridor is clear of the PMF extent and therefore, impacts on flooding are expected to be negligible.

The Bella Vista Station precinct is located outside the PMF extents for Elizabeth Macarthur Creek and therefore is not expected to have any adverse impacts on flooding.

Parts of the Kellyville Station Precinct are affected by flooding from Elizabeth Macarthur Creek in the 100 year ARI and greater. The area that encroaches on the floodplain consists of roads and future development. Due to the conceptual nature of the precinct layouts, there is currently limited information on finished design levels. Consequently, in order to determine an upper limit of potential impacts the extent of proposed works has been assumed to be elevated above existing flood levels.

Flood Level Impacts

Modelled flood level impacts are shown in **Figure 18.7** and **Figure 18.8** for the 100 year ARI and PMF events, respectively. The modelling results show that based on the precinct footprint there would be some localised impacts on the properties to the east/ south east of the creek that are currently sensitive to flooding. Precinct works would be designed to ensure that existing flood storage and conveyance is maintained to ensure that there are no impacts on adjacent properties.

In the PMF the modelled precinct footprint would result in flood level impacts of up to 0.5m along the precinct boundary immediately upstream (south) of Samantha Riley Drive. Further upstream (south) of Samantha Riley Drive impacts would generally be in the order of 0.1 to 0.15m. Properties along Elizabeth Macarthur Creek, as well as Samantha Riley Drive would experience increases in flood level of up to 0.15m. However, these properties are already flooded in the PMF under existing conditions. While no additional properties will be affected by the proposed works along Elizabeth Macarthur Creek, the intersection of Old Windsor Road and Samantha Riley Drive would be flooded.

Flow Velocity Impacts

Under existing conditions peak flow velocities along the Elizabeth Macarthur Creek main channel are generally in the order of 1 – 1.5m/s but can be up to 3m/s in isolated locations. In overbank areas peak velocities are typically less than 1m/s. In the PMF, peak flow velocities would be slightly higher, especially adjacent to Windsor Road and the T-way, north of Samantha Riley Drive due to overtopping of the road.

The model results show that there would be no discernible changes to flow velocities in the 100 year ARI event, however peak flow velocities in the PMF could increase significantly at some locations, particularly around Samantha Riley Drive. This is because the modelled precinct arrangement would reduce the flow area by almost 50% near Samantha Riley Drive.

Conclusion

Overall, the model results show that it would not be feasible to raise the levels across the entire precinct above existing flood levels without having adverse impacts on the surrounding environment. Surface grading that minimises any adverse changes to existing flood storage and conveyance would therefore be incorporated into the design.

Caddies Creek Confluence with Tributary 5 and Elizabeth Macarthur Creek (Kellyville Station to Windsor Road)

Between Kellyville Station and Windsor Road the rail alignment traverses the broad floodplain of Caddies Creek including its confluence with Elizabeth Macarthur Creek and Caddies Creek Tributary 5. The creek lines in this area are moderately incised with well vegetated main channel and overbank areas. Windsor Road lies to the west of the rail alignment while to the east of the alignment and creek is residential development.

The rail alignment in this area consists of a viaduct elevated above the floodplain, consisting of box section spans supported by columns and headstocks. The impacts of the viaduct structure were assessed as part of Stage 1 (refer to EIS 1). For the purposes of EIS 2 the viaduct structure has been modelled in combination with station precinct works to assess the combined impacts of Stage 1 and Stage 2 of the NWRL.

Kellyville Station Precinct includes an area north of Samantha Riley Drive that is outside the 100 year ARI flood extent but would be inundated in the PMF event.

Detailed hydraulic modelling has been carried out to assess the potential impacts of the proposed viaduct arrangement and station precinct works on the existing flood regime. The hydraulic modelling undertaken is discussed in Appendix B of Technical Paper 7. The results of this assessment are summarised below.

Potential flood impacts of the viaduct arrangement have been assessed, consisting of twin 1.8m diameter concrete columns at each span support. Finished levels within the precinct have been assumed to be located above the existing flood levels, providing an upper bound estimate of likely impacts associated with Stage 2.

Flood Level Impacts

Modelled flood impacts are shown in **Figure 18.9** for the 100 year ARI event. The results show that there would be localised flood level impacts of up to 0.06m in the 100 year ARI event around the viaduct columns. Within the adjacent residential development the flood level impacts would be up to 0.04m but typically less than 0.02m. There is the potential for localised impacts of 0.05m in areas that are currently sensitive to flooding. These impacts could be offset by local flood mitigation works such as bunding or levees. The design of these overbank works depends on the final location, size, shape and spacing of the viaduct piers to be determined during the future detailed design stages.

Flood impacts were also assessed for the PMF to identify the implications for regional flooding during events in excess of the 100 year ARI event (refer to **Figure 18.10**). The results indicate that flood level impacts would generally be less than 0.1m on the floodplain around the confluence of Caddies and Elizabeth Macarthur Creeks. However, the modelled precinct layout would result in flood level impacts of up to 0.5m at Old Windsor Road and the T-way near the intersection with Samantha Riley Drive. While Old Windsor Road and the T-way are already flooded in the PMF under existing conditions, there is the potential for parts of Samantha Riley Drive to flood which are flood free under existing conditions. Apart from this, overall flood extents would not increase significantly in a PMF event and as a result increases in flooding due to the proposed works would have a negligible impact.

Flow Velocity Impacts

Under existing conditions peak flow velocities in the 100 year ARI event on the floodplain of Caddies Creek are generally low (less than 1m/s). Within the main channel, peak flow velocities are in the order of 1-2m/s, but can be up to 3.5m/s in isolated locations, depending on local channel controls.

Flood modelling shows that there would be localised increases in peak flow velocity in the 100 year ARI event, particularly on the floodplain around the confluence of Caddies Creek, Elizabeth Macarthur Creek and Caddies Creek Tributary 5. Increases in velocity would be typically less than 0.1m/s but up to 0.3m/s. However, peak velocities in these areas would still be relatively low (less than 1.5m/s in the 100 year ARI event) and hence unlikely to cause excessive erosion.

Velocities would also likely increase locally around the viaduct piers. This would require appropriate scour protection, especially around piers located close to the main channels where peak flow velocities are likely to be high (greater than 2m/s).

In the PMF peak flow velocities on the floodplain of Caddies Creek are in the order of 1-2m/s, but can be greater than 4m/s where roads are overtopped. Peak flow velocities are likely to increase by up to 0.5m/s along Old Windsor Road and the T-way. However, peak flow velocities would already be high under existing conditions in most areas affected and so the relative change in velocity would not be significant. The greatest impacts would be expected downstream of the T-way near the proposed Kellyville Station precinct. Peak flow velocities could potentially increase from 2.5 to over 3.5m/s. The design includes only a parking area for the Kellyville Station precinct north of Samantha Riley Drive.

Conclusion

Overall, the modelled impacts show that it would not be feasible to raise the precinct works completely above existing flood level without having adverse impacts on the surrounding environment. In particular, it would be necessary to manage impacts on Old Windsor Road and the T-way for flooding in excess of the 100 year ARI event. For the area of the precinct north of Samantha Riley Drive provision for overland flows in the PMF would be made to reduce the potential impacts.

Caddies Creek Tributary 4

There would be localised impacts at Tributary 4 in the 100 year ARI event as a result of viaduct piers located in the floodplain. However, the cross-sectional area of structure columns within the floodplain relative to the total floodplain area is relatively small and consequently, based on hydraulic modelling undertaken for Caddies Creek, the potential impacts are considered to be negligible for both the 100 year ARI and PMF events.

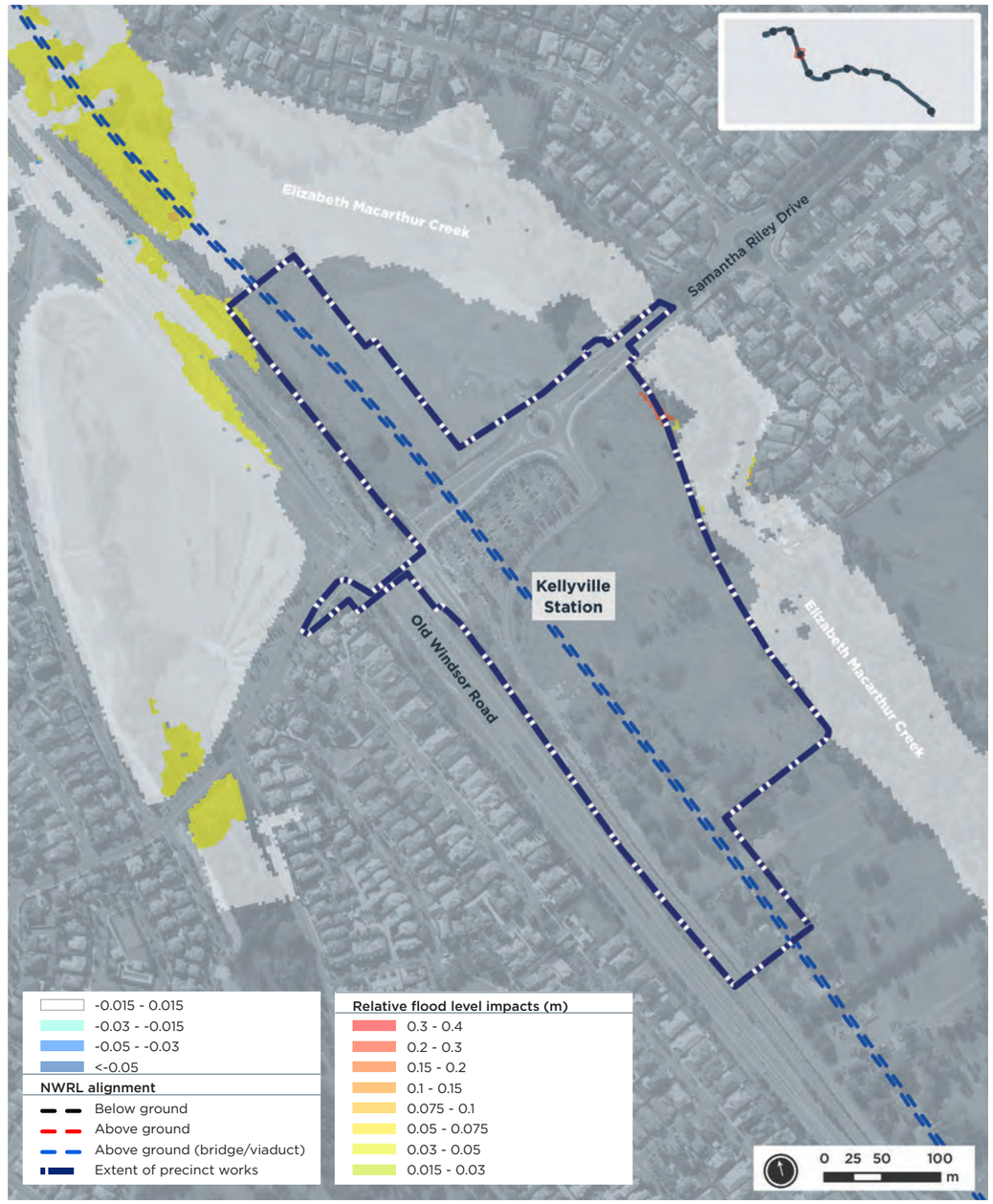
Given the size of the waterway relative to the area of piers within the floodplain, changes in velocities resulting from the proposed bridge crossing are estimated to be generally negligible. There would however be localised increases in velocity around piers that would require appropriate scour protection measures in accordance with normal bridge design practices.

Caddies Creek Tributary 3

At Tributary 3, previous flood studies show that Windsor Road is not overtopped in a 100 year ARI event. Consequently flows discharging from the Windsor Road culverts in the 100 year ARI event are confined to the channel downstream, resulting in a relatively confined flow width. The viaduct piers are expected to span the 100 year ARI flood extent and consequently, no impacts are expected for flooding up to the 100 year ARI event.

The precinct would be susceptible to inundation from flows that overtop Windsor Road at the Tributary 3 culverts. In the PMF event overtopping of Windsor Road would occur and the southern end of the precinct would be inundated. The area affected currently comprises a carpark, T-way interchange and local access roads for the Rouse Hill town centre. Finished levels are expected to be largely unchanged under the proposed precinct design. Consequently, flood impacts in the PMF are not expected to be significant.

Figure 18.7 Relative Flood Level Impacts (100 Year ARI) - Elizabeth Macarthur Creek



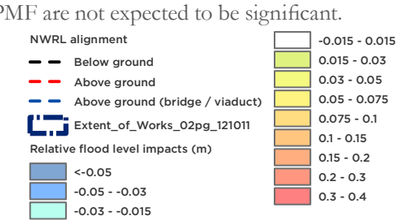


Figure 18.8 Relative Flood Level Impacts (PMF) - Elizabeth Macarthur Creek

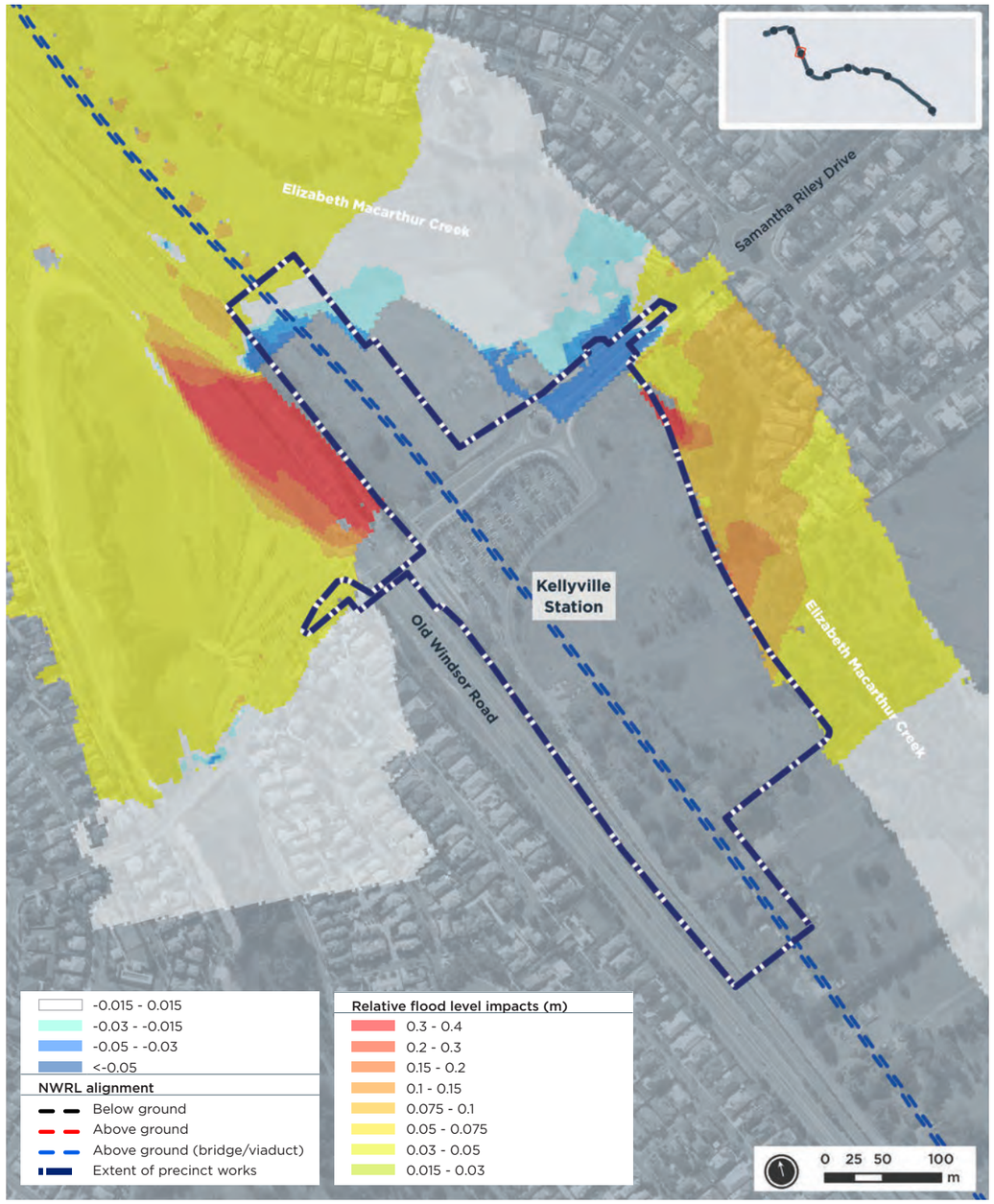


Figure 18.9 Relative Flood Level Impacts (100 Year ARI) – Caddies Creek

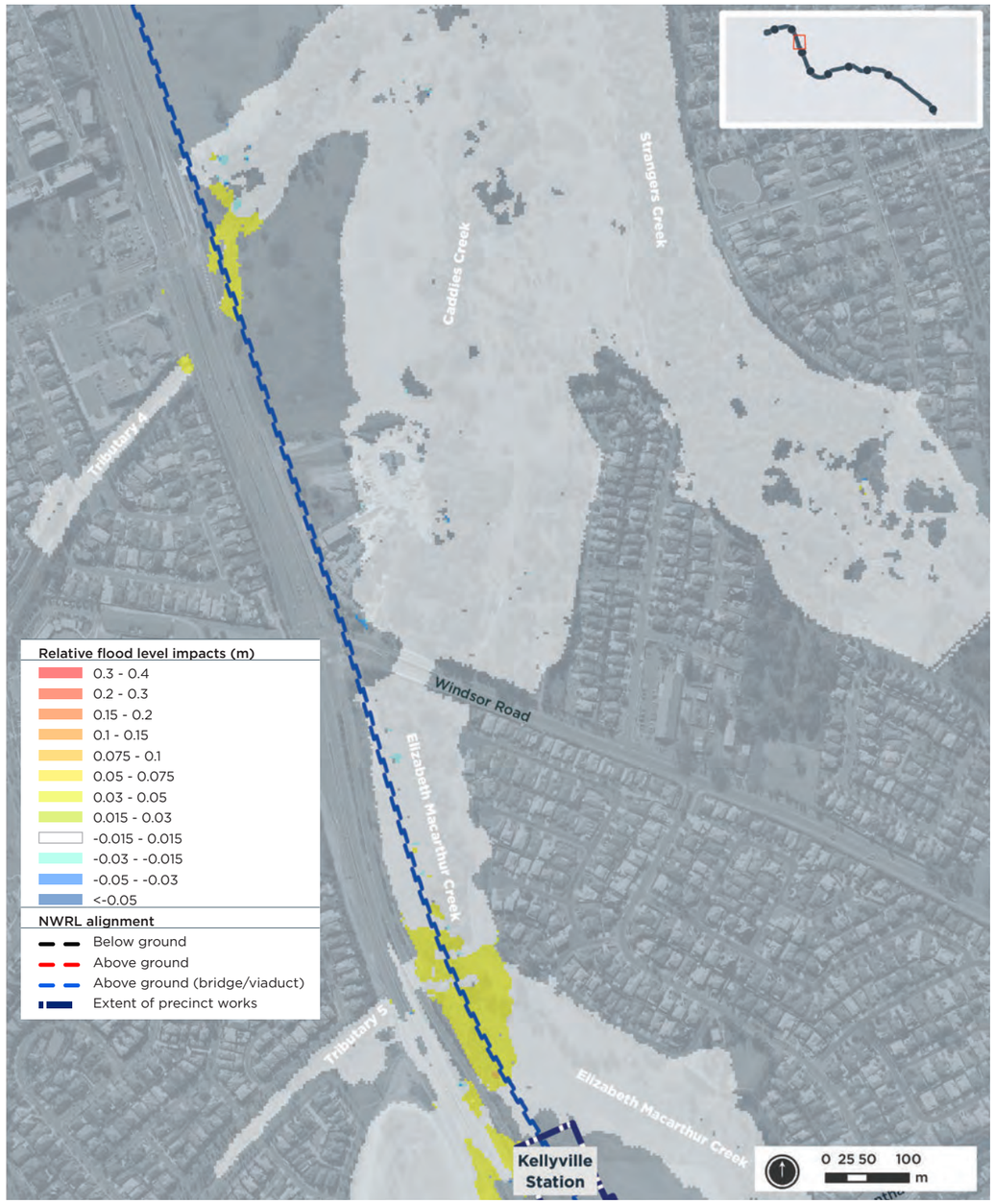
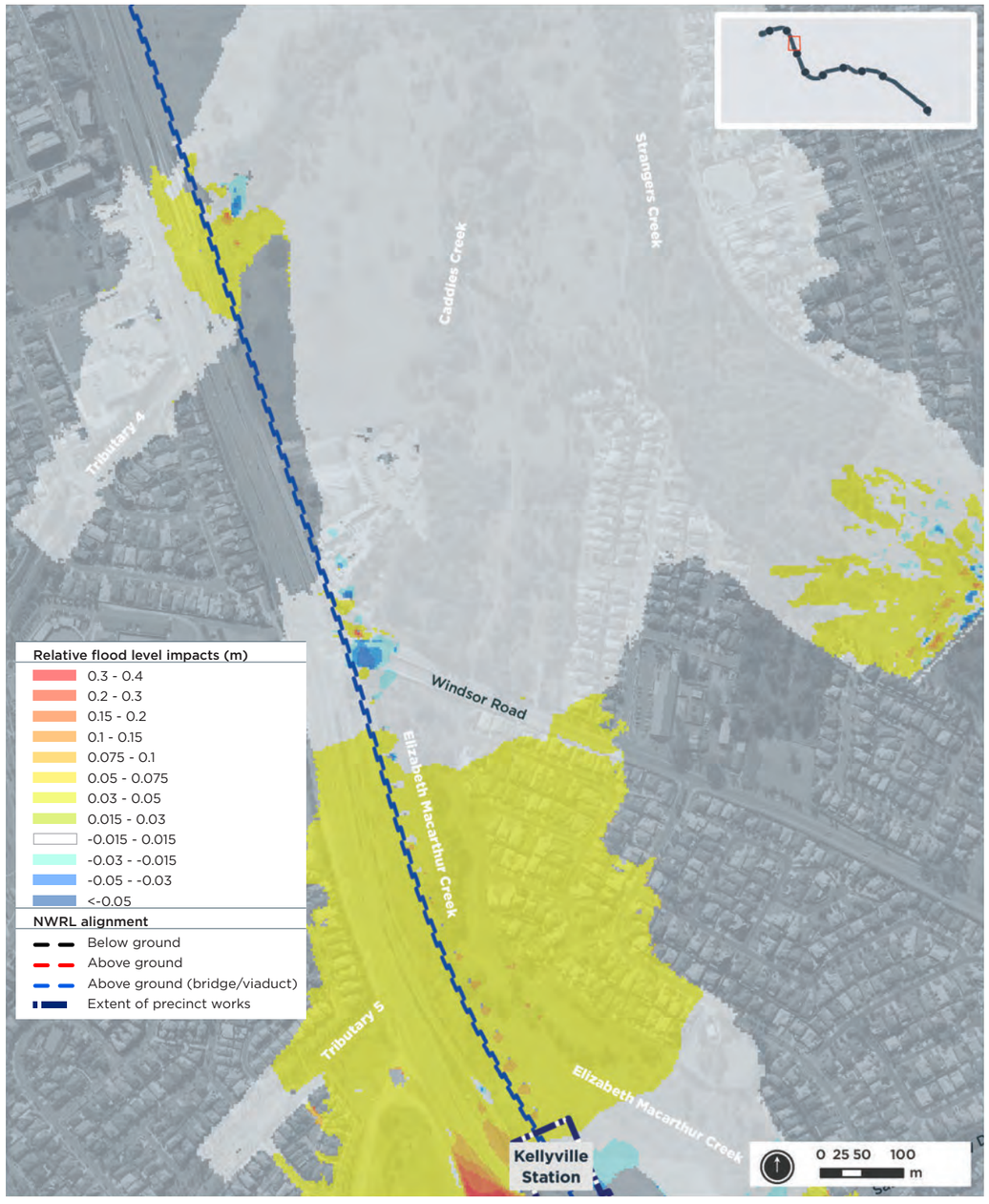


Figure 18.10 Relative Flood Level Impacts (PMF) – Caddies Creek



Second Ponds Creek

Flood model results show that flood level impacts in the vicinity of Schofields Road are 0.03m or less for both the 100 year ARI and PMF events. On this basis the viaduct and bridge are expected to have negligible impacts on the flood immunity of Schofields Road during operation.

At the Cudgegong Road Substation site the lowest ground levels are over 2m above the 100 year ARI flood level. Consequently, estimated flood level impacts during the 100 year ARI flood are not expected to adversely affect the substation. In the PMF a small portion of the southern edge of the substation site would be partially inundated. The proposed works would result in a slight increase in the extent of inundation. Measures to offset adverse flood impacts on the substation would include increasing bridge length or local flood mitigation works (bunding, levee or filling) to prevent floodwaters inundating the substation site.

First Ponds Creek

The stabling facility at Tallawong Road is located outside the PMF flood extent of First Ponds Creek. Therefore there would be no flood impacts or risks expected as a result of Stage 2 operation with the implementation of measures to manage localised drainage and overland flow.

18.5.2 Stormwater Quantity

The proposed stations and rail infrastructure would alter the percentage impervious area within the catchments that the rail link traverses, leading to increased volumes of runoff and catchment response times. Appropriate measures such as onsite detention (OSD) facilities and/or water sensitive urban design features would be provided to mitigate potential flood impacts.

Consideration of requirements between Epping and Showground showed that at Epping Station, Cheltenham Services Facility and Castle Hill Station, there would be no significant increase in imperviousness or development and therefore OSD is not likely to be required. At Cherrybrook Station and Showground Station there would be significant increases in impervious area and change in land use.

From Norwest Station to Cudgegong Road Station, the station precincts fall within an area where a regional stormwater management strategy has been implemented as part of the North West Growth Centre. This regional strategy is outlined in the report titled *Rouse Hill Stage 1b Area Trunk Drainage Strategy* (GHD, 1998) and was further reviewed and updated in *Rouse Hill Integrated Stormwater Strategy Review – Hydrology, Hydraulics and Water Quality Review* Sinclair Knight Merz (2009).

A key objective of the regional trunk drainage strategy for the North West Growth Centre is that 100 year ARI peak flows discharging to areas further downstream under ultimate conditions do not exceed existing peak flows. To achieve this, the strategy is based on a regional detention basin approach catering for all development within the catchment, rather than separate sub-division detention basins or individual OSD measures. However, if runoff from a particular site increases peak flows above existing such that it would impact on existing development, then OSD would need to be considered. Consideration of sites between Norwest Station and Cudgegong Station has determined that operation of these sites would not increase existing peak flows or runoff volumes and therefore OSD would not be required. The Tallawong Stabling Facility is located within the Riverstone East Precinct in the North West Growth Centres. Masterplanning for this precinct is still underway and while it is anticipated that this will make provision for the NWRL, this would be confirmed during design development.

While the regional and local detention strategies identified above would manage flooding in larger events, up to the 100 year ARI event, there is a risk of increased volume and velocity of flows to receiving waterways during more frequent rainfall events. This could lead to an exacerbation of erosion and the mobilisation of sediments. This would be managed by implementing appropriate Water Sensitive Urban Design (WSUD) measures such as grassed swales, bioretention systems and use of rainwater harvesting at buildings. Where discharge is to an existing stormwater network, the capacity of the existing network would be assessed to ensure that the system can cope with additional flows.

18.5.3 Floodplain Storage

Impacts of major civil works (rail embankments, viaduct and bridges) on floodplain storage were assessed in EIS 1. As has been identified, the Stage 2 works would involve some station precinct works within the floodplain. In these areas it would be necessary to provide a balance of cut and fill up to the 100 year ARI flood level to minimise impacts on floodplain storage.

18.5.4 Potential Impacts Due to Climate Change

Scientific research into the potential impacts of climate change has been rapidly evolving over recent years. Latest research indicates that climate change is likely to result in more frequent and intense storms, but lower annual rainfall. This has the potential to increase rainfall intensities for storms leading to increases in the frequency and magnitude of flooding to catchments and waterways in the vicinity of the NWRL project.

Expected trends in rainfall behaviour have the potential to impact on flooding and drainage for the NWRL project in a number of ways. Increased frequency and severity of extreme rainfall events could potentially lead to an incremental increase in:

- flooding of tracks, tunnels, stations, pedestrian underpasses, stabling yards, foundation instability and damage to associated infrastructure.
- failure of local drainage systems and inundation of station carparks.
- the frequency and extent of scouring at drainage outlets.
- the bypass of water quality systems.

It should be noted that all of these risks already need to be managed under existing conditions. However, climate change has the potential to exacerbate rainfall conditions adding to these risks. Therefore the surface water assessment included an assessment of the incremental increase in risk due to climate change impacts and identified whether additional allowance needed to be incorporated into the design.

Based on currently available information and recommended procedures set out in the Floodplain Risk Management Guideline – Practical Considerations of Climate Change (DECC, 2007), the approach adopted to manage the potential impacts of climate change on flooding for NWRL has involved:

- generally adopting a 10% increase in design rainfall intensities for events up to the 100 year ARI event; and
- undertaking sensitivity analyses for increases in rainfall intensity of 20% and 30% to identify areas of the project that may be sensitive to further potential increases in design rainfall intensities.

Results are documented in Appendices B and C of Technical Paper 7 and generally the assessment showed that potential flood impacts due to climate change are not expected to be significant.

18.5.5 Water Quality

General

The operational impacts of Stage 2 of the NWRL include potential changes in the hydrologic regime leading to increased erosion and sedimentation and pollutant generation from the rail infrastructure, station precincts and ancillary facilities. Water quality measures for the rail infrastructure and precincts would be incorporated into the design of stormwater drainage systems in accordance with ANZECC (2000) and relevant Railcorp and Council standards.

The increased impervious surfaces associated with the works (such as building roofs and paved areas) would have the potential for adverse impacts on the hydrological regime in terms of increased runoff volumes and peak flows. This could lead to a range of impacts associated with increased erosion and sedimentation. Water Sensitive Urban Design Principles would be incorporated into the design to minimise the impacts of the works on the existing hydrologic regime. Such measures would include:

- Managing total runoff volumes through the use of rainwater tanks at stations and stabling depot buildings and measures that promote stormwater infiltration (such as pervious paving and rain gardens).
- Minimising increases in peak flows through the use of detention and retention measures (such as water quality ponds). Stormwater detention is discussed in Section 18.5.2.
- Preserving and enhancing the amenity of waterways by providing more natural vegetated measures in lieu of concrete channels.
- Treating stormwater through a range of at source and end point measures that are integrated with the urban landscape. Such measures would include the use of rain gardens and bioretention swales to treat runoff from carparks and streets and water quality ponds integrated into public areas.

The station precincts would be areas of high vehicular and pedestrian traffic which have the potential to generate a significant amount of pollutants. Where drainage discharge is to an existing waterway, there is the risk of an increase in pollutant loads reaching waterways. Runoff would be treated prior to discharge into the receiving drainage systems. Water quality treatment measures (including a combination of swales, water quality basins and gross pollutant traps) would be provided at outlet points from the drainage system prior to discharge into existing waterways to mitigate impacts to these waterways.

At the Tallawong Stabling Facility, provision of a water quality basin or the like would be required prior to discharge into First Ponds Creek. A separate drainage system is to be provided for the wash down area and the remainder of the stabling facility. Runoff from wash down facilities within the stabling facility would be collected, stored and treated prior to being discharged from the site.

Water quality measures adopted would be tailored to the specific requirements of the Project and the potential for pollutant generation. A summary of potential pollutants and proposed measures for each drainage element is provided in **Table 18.7**.

Table 18.7 Summary of Drainage Elements and Associated Water Quality Impacts and Mitigation Measures

Drainage Element	Impacts and Potential Pollutant Generation	Mitigation and Requirements	Examples of Typical Treatment(s)
Track Drainage	Low volumes of pollutant generation are expected from track runoff, and would mainly relate to sediments (including brake dust particulate matter).	Management of pollutants to be accommodated within the design through the implementation of at source measures such as the use of vegetated swales in lieu of concrete or bitumen lining, and absorption trenches with slotted pipes in lieu of unslotted pipes and collection pits. Where unslotted pipes are required (for example at under line crossings) then silt traps would be provided by lowering the invert of the pit 300mm below the downstream pipe outlet. Absorption trenches and vegetated swales reduce flow velocities thereby removing water-carried sediment. This type of arrangement provides natural water filtering which reduces the impacts of runoff pollutants and minimises sediment deposition within the receiving bodies downstream. Treatment of runoff from the viaduct to be incorporated into the broader precinct stormwater management strategy.	Absorption trenches with slotted pipes along tracks in lieu of unslotted pipes where feasible. Grassed swales where room available. Litter baskets on inlets at station platforms.
Groundwater from Below Ground Stations and Tunnels	Groundwater flows collected at below ground stations and (nominal) flows collected from the tanked tunnels will potentially be of poor quality, requiring treatment prior to discharge into the surface water system. Other runoff within the tunnels would be from washdown of station platforms, which would be high in nutrients. Litter from the stations could also be transported along the tunnels and into the drainage system. Refer to Chapter 8.	Groundwater flows and other flows from the below ground stations and tunnels would be collected and pumped to the existing treatment facility at Lady Game Drive. Refer to Chapter 8.	Litter guards at station platforms. Central water treatment facility at Lady Game Drive.
Stations Precincts	Pollutant generation at stations and carparks is mainly expected to be due to litter, grease and oils from motor vehicles, sediments and wash down chemicals at stations.	Water quality measures at the stations and associated carparking facilities will be provided in accordance with Sustainable Design Guidelines for Stations, Commuter Car Parks and Maintenance Facilities (Transport Construction Authority NSW, 2011) and local Council requirements.	High traffic areas such as station plazas and carparks: ▪ Gross pollutant traps ▪ Filter pits For roads, footpaths and public space: ▪ Grassed swales ▪ Biorentention trenches and rain gardens ▪ Water quality ponds

Drainage Element	Impacts and Potential Pollutant Generation	Mitigation and Requirements	Examples of Typical Treatment(s)
Stabling Yard	Facility areas and access roads may be subject to grease and oils from motor vehicles, sediments and general gross pollutants. Cleaning of trains would be carried out in a maintenance building. Wash water would be collected in a separate system, thus avoiding wash water from entering the local drainage system.	Water quality measures would be provided in accordance with the NSW Sustainable Guidelines for Rail (TfNSW, 2011). Water quality measures have been incorporated into the conceptual site layout including vegetated swales and a water quality basin at the outlet of the site drainage system. Rainwater would be harvested from the roof of the train maintenance building for reuse on site. An oil and grit separator would be required in the event of stabling any diesel trains used for track maintenance works.	At source measures integrated with the drainage system: ▪ Slotted pipe in filter trench ▪ Grassed swales At major outlets: ▪ Water quality ponds ▪ Gross pollutant traps and filters.

Groundwater Discharge from Tunnels

Groundwater seepage into the tunnel will be collected and pumped to the Lady Game Drive Water Treatment Plant (WTP). Further details relating to groundwater treatment are provided in Chapter 8.

18.6 Potential Construction Impacts

18.6.1 Flooding

A detailed description of the Stage 2 construction activities is provided in Chapter 7. Activities would include station construction and fit-out, station precinct works, services and stabling facility construction and fit-out, tunnel, at-grade and viaduct systems fit-out and testing and commissioning. Of these activities, works within the station precincts, services facilities and stabling facility have the potential for flood related impacts.

Below Ground Stations and Facilities - Epping to Bella Vista Station

For the tunnel section of the NWRL between Epping and Bella Vista Station, flood inundation of excavations for below ground stations and services facilities could lead to flooding of the tunnels and result in damage to works, delays in construction program and risk to personal safety.

During the construction of the below ground stations and facilities and associated precincts, the potential for ingress of floodwaters into the sites would be appropriately managed, particularly at the entries to the underground sites. At all sites there would be potential for local runoff to enter the stations/ facilities and this would be addressed through local stormwater management of the site.

The flood assessment identified that the construction sites at Epping Services Facility, Showground and Bella Vista have the greatest potential risk of flood affectation. The layout of the sites would be further developed taking into consideration the nature and potential risk of flooding, duration of construction, the magnitude of inflows and the potential risks to the project works, facilities and personal safety.

Above Ground Stations and Facilities

The above ground stations (Kellyville (Site 11), Rouse Hill (Site 14) and Cudgegong Road (Site 16)) as well as the Tallawong Stabling Facility (Site 17) are generally located outside the 100 year ARI flood extent and therefore flooding is not expected to pose a significant risk during Stage 2 construction.

18.6.2 Floodplain Storage

Temporary filling (such as haul roads, stockpiles, etc) within the floodplain for the construction of the stations, precincts and ancillary facilities proposed as part of Stage 2 would be minimal. Filling within the floodplain would be removed at the completion of construction.

18.6.3 Stormwater Quantity

Proposed works during construction, particularly earthworks and temporary access roads, would alter the extent of impervious area and catchment response times. Potential impacts would be offset by the provision of erosion and sediment control measures, such as sediment basins and bunded swales, which would be designed to control the discharge of runoff from the site and minimise the potential for impacts offsite.

18.6.4 Water Quality

The Stage 2 construction works would involve some disturbance and exposure of the underlying soils, which have the potential to lead to increased erosion and sediment transport and ultimately sedimentation in downstream water bodies. The potential for sediment transport and sedimentation issues is influenced by factors such as severity of storm events, the slope and footprint of disturbed area and the management controls that are implemented on site. Potential impacts on water quality could also result from erosion and sedimentation generated during excavation and spoil handling, and from spills.

Erosion and Sedimentation

Works involving excavation would have the greatest potential to result in sediment transport and sedimentation. Such construction works for Stage 2 would include:

- general civil works associated with the construction of the rail precincts, temporary and permanent roads and ancillary station facilities,
- handling of spoil associated with the above activities.

These works affect all construction sites in one form or another and pose the greatest risk where they occur near waterways (such as Caddies Creek and its tributaries), on steep slopes or on land subject to overland flow or flooding. A management framework and site specific controls would be developed and implemented during the construction phase of the project to reduce the risks of sedimentation in down gradient water bodies due to the proposed constructions works.

Preliminary soil risk maps (Appendix C of Technical Paper 7) have been prepared to identify areas more likely to be prone to erosion due to the construction works. The preliminary risk mapping has been prepared based on soil landscapes, ground conditions (rock or soil), erodibility, slope, extent of clearing required, location of works relative to sensitive receiving environments and the type of construction works being undertaken (piers/piling works, fill earthworks or cut slopes). The soil risk map would be further developed as part of the CEMP.

Procedural and physical management measures would be implemented during construction to retain sediment at the work locations. Measures could include the use of sediment basins or bunded swales. During significant rainfall events however, there is the potential that these sediment control measures would be filled to capacity and surcharge into the downstream environment. In such large events, higher quantities of sediment and pollutants from the site works may be discharged into downstream water bodies, potentially affecting local water quality.

However, providing the site measures to control erosion and sedimentation are designed to an appropriate standard, then the spills would only occur following significant volumes of runoff and the quantity of sediment or pollutant would be appropriately diluted.

Spoil Handling

Stage 2 construction works would not generate significant quantities of spoil. Where spoil is generated, appropriate management and control measures would be implemented to minimise the potential for impacts on water quality.

Potential for Spills

During Stage 2 construction, there would be a risk of release of potentially harmful chemicals and other substances into the environment from spills. This would have the potential to impact on water quality in receiving waters down gradient from the project. Such potentially contaminating substances would include acids and chemicals from washing processes, construction fuels, oils, lubricants, hydraulic fluids and other chemicals.

Release of these substances might occur due to spills, as a result of equipment refuelling, failure and maintenance, via treatment and curing processes for concrete, as a result of inappropriate storage, handling and use of the substances or from the disturbance and inappropriate handling of contaminated soils. These substances have the potential to be transported in surface runoff down gradient from the proposed works locations. Water quality and associated ecological impacts could result if these contaminants reach water bodies. Appropriate measures would be implemented during construction to minimise the risk of spills occurring. In addition, spill response procedures form part of the environmental management framework.

18.7 Mitigation measures

18.7.1 Operation

An OEMP would be developed detailing the processes to manage environmental impacts during the operation of the project.

Mitigation measures have been developed to avoid, reduce and manage identified potential operational impacts. These mitigation measures are presented in**Table 18.8**.

Table 18.8 Surface Water Operational Mitigation Measures

No.	Mitigation Measures	
OpSW1	Procedures to quickly address any contaminant spill or accident would be developed and implemented during operation of the station sites.	All
OpSW2	All feasible and reasonable opportunities for captured surface water reuse would be utilised in the first instance.	Tunnel
OpSW3	Surface water discharge quality would be required to comply with the relevant Environment Protection Licence	All
OpSW4	Treatment measures would be applied to water collected in on site detention basins, including settling of coarse sediments, the use of flocculation for finer sediments and pH correction.	All
OpSW5	Entries to below ground stations would be located above the PMF level for mainstream flooding and local measures provided to manage the ingress of runoff from local overland flooding up to the PMP.	Stations
OpSW6	The stabling facility would be located above the 100 year ARI flood level.	Stabling
OpSW7	Tunnel entries would be located above the PMF level for mainstream flooding and local measures provided to manage the ingress of runoff from local overland flooding up to the PMF.	Tunnels
OpSW8	The rail line would be located above the 100 year ARI flood level to provide an appropriate level of flood immunity.	At Grade Tracks
OpSW9	Entries to below ground services facilities would be located above the PMF level for mainstream flooding and local measures provided to manage the ingress of runoff from local overland flooding up to the PMP.	Services Facilities
OpSW10	Critical rail system infrastructure such as substations and sectioning huts would be located at a suitable level above the 100 year ARI peak flood level to protect against mainstream and local overland flooding.	Services Facilities
OpSW11	Development within the floodplain would be designed to minimise adverse impacts on adjacent development for flooding up to the 100 year ARI event. And would be designed to maintain the operation of key evacuation routes, minimise impacts on critical infrastructure and flood hazard for flooding up to the PMF.	All
OpSW12	OSD would be provided where required to mitigate impacts associated with increased impervious areas.	Stations
OpSW13	Local drainage systems and overland flowpaths at all precincts would be designed to provide appropriate flood immunity to the precincts and minimise the risk of ingress of floodwaters to the underground stations.	Stations and Stabling
OpSW14	Water quality treatment measures (including a combination of swales, bioretention systems, water quality basins, gross pollutant traps) would be integrated into the drainage system to mitigate impacts to waterways.	All
OpSW15	A holistic approach to water quality and stormwater management would be adopted that incorporates Water Sensitive Urban Design principles to minimise impacts on the existing hydrologic regime. Such measures would include: Managing total runoff volumes through the use of rainwater tanks and measures that promote stormwater infiltration. Minimising increases in peak flows through the use of detention and retention measures as appropriate. Preserving and enhancing the amenity of waterways by maintaining or providing natural vegetated measures. Treating stormwater through a range of at source and end point measures that are integrated with the urban landscape.	All
OpSW16	A surface water quality monitoring program would be developed post construction for the station precincts, services facilities and the stabling depot to monitor water quality upstream and downstream of the works. Monitoring procedures and performance criteria would be established in consultation with local councils and relevant government agencies.	All

18.7.2 Construction

The Construction Environmental Management Framework, provided in Appendix B, details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

Mitigation measures have been developed to avoid, reduce and manage identified potential construction impacts. These mitigation measures and their application to the construction sites for the NWRL are presented in **Table 18.9**.

A number of mitigation measures detailed in other chapters would also be relevant to surface water. These include:

- Mitigation measures relevant to groundwater treatment and discharge within Chapter 8 (Soils and Groundwater).
- Mitigation measures relevant to contaminated spoil are detailed within Chapter 19 (Non-Key Issues – Waste Management).

Table 18.9 Surface Water Construction Mitigation Measures

No.	Mitigation Measure	Applicable Sites*
Flooding		
SW3	Construction equipment (or excess material) would be removed from waterway or flood prone areas if wet weather is approaching and at the completion of each day's work activity. The extent of the flood prone area would be defined during detailed construction planning.	1 – 17
SW4	Temporary levees or bunds would be strategically placed to contain potential flooding impacts resulting from any temporary works on the floodplain and minimise the risk to surrounding properties which might otherwise be affected.	1 – 17
SW5	Entries to tunnel excavations would be protected against flooding by locating openings outside flood prone areas, local bunding and / or appropriate drainage.	1 – 9 and tunnels
SW6	The flood standard adopted at each tunnel entry during Stage 2 construction would need to be developed taking into consideration the duration of construction, the magnitude of inflows and the potential risks to the project works and personal safety.	1 – 9 and tunnels
SW12	Stockpile sites would be generally located outside the 20 year ARI flood. The exact level of flood immunity provided to stockpile sites would depend on the duration of stockpiling operations, the type of material stored and the nature of the downstream waterway or any other specified requirements. This would be defined during detailed construction planning.	1 – 17
SW14	Water quality mitigation measures would be implemented in accordance with relevant requirements of: ▪ Landcom Managing Urban Stormwater - Soils and Construction Volumes 1 and 2 (often referred to as the Blue Book, 2004 and 2006). ▪ NOW Guidelines for Controlled Activities. ▪ ANZECC Guidelines for Fresh and Marine Water Quality. ▪ ANZECC Guidelines for Water Quality Monitoring and Reporting. ▪ *Water Management Act 2000*. ▪ Applicable Environment Protection Licences.	All
SW15	Treatment measures would be applied to water collected in sediment basins, including settling of coarse sediments, the use of flocculation for finer sediments and pH correction.	9 – 17
SW16	As a first preference, treated surface water collected in sediment basins would be reused onsite, eg for dust suppression. Additional opportunities for re-using water on site or for construction would be investigated and implemented where feasible and reasonable.	9 – 17 and tunnels
Erosion and Sediment Control		
SW17	Exclusion zones would be designated on construction sites to limit disturbance.	1 – 17
SW18	Re-vegetating or stabilising disturbed areas would occur as soon as feasible.	1 – 17
SW20	Appropriate erosion control measures would be installed such as sediment fencing, check dams, temporary ground stabilisation, diversion berms or site regrading.	1 – 17
SW21	Clean water runoff would be diverted away from the works or disturbed areas wherever possible.	1 – 17
SW22	Temporary sediment basins would be installed as appropriate. The exact size and layout of sediment basins would be determined as part of the CEMP in accordance with the requirements of the relevant Environment Protection Licence.	1 – 17
SW26	Surface controls to promote ground stability, limit run-off lengths and reduce run-off velocities within the work sites would be implemented.	1 – 17
SW27	Ground stability would be re-established as soon as practicable following the completion of construction.	1 – 17
SW28	Installation of any permanent scour protection measures required for the operational phase would occur as soon as practical.	1 – 17
Riparian Areas		
SW32	Where water is released into local creeks, outlet scour protection and energy dissipation would be implemented. The discharge point would be at the upstream end of a large pool where feasible and reasonable, to allow for slowing of water.	1 – 4, 6 and 8 – 17

No.	Mitigation Measure	Applicable Sites*
SW37	Temporary stockpile locations for both site establishment and earthworks operations would be specified prior to the commencement of construction activities. Diversion drains and erosion and sediment control measures would be in place prior to the commencement of any stockpiling activities. Material would only be stockpiled in designated stockpiling areas.	1 – 17
Contamination and Spills		
SW38	Site specific controls would be developed to reduce the potential for environmental releases of potentially harmful chemicals and to reduce the risk of any such releases entering local waterways. Storage of hazardous materials such as oils, chemicals and refuelling activities would occur in bunded areas.	All
Monitoring and Implementation		
SW40	A qualified environmental officer would be employed to advise on appropriate controls and to monitor the implementation and maintenance of mitigation measures.	All
SW41	All site staff would be engaged through toolbox talks or similar with appropriate training on soil and water management practices.	All
SW42	A surface water quality monitoring program for the construction period would be implemented to monitor water quality upstream and downstream of the construction areas. The monitoring programme would commence prior to commencement of any construction works and would build on available water quality data.	1 – 17
SW43	Surface water and water quality monitoring would be carried out periodically and after rainfall events. Monitoring would examine a range of appropriate indicators in accordance with standard guidelines.	1 – 17
SW44	Inspection of water quality mitigation controls (eg sediment fences, sediment basins) would be carried out regularly and following significant rainfall to detect any breach in performance.	All
SW45	A stormwater management plan that identifies the appropriate design standard for flood mitigation based on the duration of construction, proposed activities and flood risks would be developed for each construction site. The plan would develop procedures to ensure that threats to human safety and damage to infrastructure are not exacerbated during the construction period.	All

*Site 1 - Epping Services Facility, Site 2 – NOT USED, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 - Showground Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility and Tunnels

CHAPTER 19

ASSESSMENT OF NON-KEY ISSUES

19 ASSESSMENT OF NON-KEY ISSUES

This chapter presents an assessment of the potential impacts of non-key environmental issues during the operation and construction works and identifies measures to mitigate these impacts. Non-key issues have been determined as aspects that are unlikely to cause significant changes or where impacts arising from operation and construction would be negligible. Both positive and adverse impacts have been considered in this determination. The non-key issues addressed include:

- Air quality
- Waste management

These issues are discussed in the following sections to illustrate the existing environment, anticipated impacts and recommend any mitigation measures required.

19.1 Air Quality

19.1.1 Introduction

This section describes the existing air quality within the study corridor and assesses the potential air quality impacts during the operation and construction of the project.

19.1.2 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 19.1 sets out the Director-General's Requirements (DGR), the Conditions of Approval (CoA) and Statement of Commitments (SoC) as they relate to air quality, and indicates where each item is addressed within this chapter.

Table 19.1 Director-General's Requirements, Conditions of Approval and Statements of Commitment

DGR Reference	Description	Addressed
N/A		
CoA Reference	**Description**	**Addressed**
N/A		
Statement of Commitments	**Description**	**Addressed**
N/A		

19.1.3 Methodology

The assessment of air quality for the operation and construction of NWRL was undertaken using various steps to ensure relevant and accurate information was obtained. The assessment addresses:

- Identification of ambient air quality assessment criteria and air pollutants of concern during operation and construction. Applicable ambient air quality criteria specified in Approved Methods for Modelling and Assessment of Air Pollutants in NSW (DEC 2005) were used based on the protection of human health. Outcomes of reviewing this information are included in Section 19.1.4.
- To determine the air quality of the existing environment, OEH air quality monitoring data has been used. OEH air quality monitoring data are considered to be indicative of air quality in the overall Sydney Basin. Given the absence of major industrial air emissions sources within the study corridor, the OEH air quality monitoring data have been used to establish the background air quality data for this assessment. There are no air quality monitoring stations located within the study area, however, data at Lindfield (Bradfield Road), Vineyard and Prospect have been used to provide an indicative description of air quality of the area. Potential major sources of air emissions within the vicinity were investigated and it was concluded that there are no sources that would significantly alter localised air quality.

The assessment for both operations related and construction related air quality impacts is qualitative and has been undertaken at a strategic level, i.e to ascertain overall air quality impacts resulting from the NWRL. The approaches used for both operation and construction assessment of air quality impacts are outlined below:

- Identify the sources of air emissions during operation and construction.
- Examine key factors that influence emissions from identified sources
- Evaluate the likely changes to emission sources due to the operation and construction of the project.
- Relate the likely changes in emission sources to potential air quality impacts at local and regional scales, taking account of existing background levels and relevant air quality objectives.
- Outline appropriate mitigation measures to ensure air quality objectives are not exceeded (See Section 19.1.8).

19.1.4 Air Quality Assessment Criteria

The NSW ambient air quality criteria applicable to this assessment are specified in *Approved Methods for Modelling and Assessment of Air Pollutants in NSW* (DEC 2005). These assessment criteria are designed to maintain an ambient air quality that provides for the adequate protection of human health.

The air pollutants of concern during both operation and construction include:

- Particulate matter with diameter less than or equal to 10 microns (PM_{10})
- Deposited dust
- Total suspended particles (TSP)
- Sulphur dioxide (SO_2)
- Nitrogen dioxide (NO_2)
- Carbon monoxide (CO).

The above pollutants are referred to as 'criteria' pollutants and are general indicators of air quality. Excessive levels of these pollutants may contribute to adverse health effects. Deposited dust, TSP and PM_{10} are all measures of airborne particulates. Diesel combustion emits a number of particulate compounds including CO, SO_2 and NO_2. The criterions for the relevant pollutants are shown in **Table 19.2** along with the existing level of pollutants as measured by OEH.

19.1.5 Existing Environment

As the NWRL traverses a mostly urban environment, background air quality is largely governed by regional background air quality. Regional air quality is subject to factors such as seasonal variations, wind and temperature effects, varying pollutant sources such as vehicular emissions and industry and event type pollutant loads such as bushfires. Consequently, regional air quality can be highly variable in nature and impacted by events occurring a significant distance away.

Ambient air in the vicinity of the study area is regarded as typical of a primarily developed and developing residential and commercial area. The ambient air quality is largely affected by motor vehicle emissions, commercial businesses (for example service stations and smash repairs), domestic activities (including backyard burning, wood fired home heaters, lawn mowing) construction and event based emissions (for example bushfires, pollen or dust storms).

There are no notable heavy industrial or extractive operations or other operations that may generate significant amounts of air pollution in the immediate vicinity of the study area. Some construction activities are underway or are due to commence within the next few years within the immediate vicinity of the rail alignment. This may have the effect of decreasing air quality from dust and exhaust emissions independently from the NWRL.

OEH air quality monitoring data are considered to be indicative of air quality in the overall Sydney Basin. Given the absence of major industrial air emissions sources within the study corridor, the OEH air quality monitoring data have been used to establish the background air quality data for this assessment.

A summary of air quality monitoring data measured by OEH at the closest locations is provided in **Table 19.2**. The air quality criteria relevant to the assessment are shown within the table adjacent to the pollutant label.

Table 19.2 OEH Air Quality Monitoring Data

Date	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SO_2 maximum 1h average [pphm] Criterion - 20 pphm*											
Lindfield	4.2	4.4	2.1	2.9	2	-	-	-	1.6	-	1.7
Vineyard	1.6	2.4	1.3	1.4	1.6	1.7	1.4	2.9	1.4	1.4	2
Prospect									1.4	1.7	1.8
NO_2 maximum 1h average [pphm] Criterion - 12 pphm*											
Lindfield	5.4	5.4	5.1	4.4	4.6	-	-	-	3.3	5.3	3.8
Vineyard	3.5	4	4.9	3.4	4.1	4.1	4.8	3.7	3.2	4.8	2.9
Prospect	-	-	-	-	-	-	-	-	-	5.8	4.3
CO maximum 8h rolling average [ppm] Criterion - 9 ppm**											
Lindfield	-	-	-	-	-	-	-	-	-	-	-
Vineyard	-	-	-	-	-	-	-	-	-	-	-
Prospect	-	-	-	-	-	-	-	2	1.5	2.3	1.9
OZONE maximum 1h average Criterion - 10 pphm*											
Lindfield	9.3	16.1	13.3	8.1	10.4	-	-	-	7.5	10.9	8.2
Vineyard	10.9	11.1	14	13.6	10.4	11.7	10.4	12.7	8.1	10	9
Prospect									10.7	12.6	10.4
PM_{10} maximum 24h average [$\mu g/m^3$] Criterion - 50 $\mu g/m^3$***											
Lindfield	40.1	103.9	93.2	132.4	-	-	-	-	38.8	1596.3	48.2
Vineyard	35.4	82.4	160.9	209.7	43.4	49.1	70	45.1	38	1698.9	39.7
Prospect	-	-	-	-	-	-	-	46.3	41.8	1680.3	40.1

Source: OEH (2011) and DEC (2005)
*pphm – concentration in parts per hundred million
**ppm – concentration in parts per million
*** $\mu g/m^3$ - micrograms per cubic metre

The table shows that air quality in the vicinity of the NWRL is below the assessment criteria for SO_2, NO_2 and CO at all sites for the data available. The following exceedances for ozone and PM_{10} are noted:

- Ozone at Lindfield from 2001, 2002, 2004, 2009.
- Ozone at Vineyard from 2000-2007.
- Ozone at Prospect from 2008-2010.
- PM_{10} at Lindfield 2001-2003, 2009.
- PM_{10} at Vineyard 2001-2003, 2006, 2009.
- PM_{10} at Prospect 2009.

Elevated levels of PM_{10} in 2009 are attributable to severe dust storms and extensive bushfires in the Sydney basin.

The key features of the existing air quality environment in the study corridor are:

- Good air quality with concentrations of most pollutants well below the air quality goals except ozone and PM_{10}.
- Air quality within the study corridor is considered to be mainly influenced by regional air emissions.

The air quality is not anticipated to change significantly between the commencement of construction to the commencement of rail operations.

19.1.6 Impact Assessment – Operation

Any impacts to air quality that would result from the operation of the NWRL would be widely dispersed and not confined to specific sites.

There is the potential for minor air quality impacts from operation through:

- Indirect emissions by the off-site generation of electricity.
- Beneficial changes in regional transport emissions from changes in motor vehicle use due to the availability and access to rail services.
- Concentration of motor vehicles at large park and ride facilities.

Overall, air emission impacts associated with operation would be permanent and generally beneficial through the reduction in private vehicle trips on a region-wide scale.

Train Operation

As the NWRL would be powered by electricity, regional emissions generated during operation are expected to be minimal and dispersed. Emissions from ventilation shafts may include small amounts of particulate matter (PM_{10}) created by braking trains. Small volumes of exhaust may also be emitted through tunnel ventilation systems during maintenance activities, although quantities are expected to be negligible.

Air quality may be impacted off-site at the source of power generation. Overall, the air quality impacts from increased power generation to run the trains would be offset by the reduced number of vehicles on the roads as a result of modal changes for the daily commute. Power stations already have mitigation measures in place to reduce emissions resulting in overall beneficial impacts to air quality due to NWRL operation.

Tunnel and Station Ventilation System

The ventilation system operates to ensure fresh air is circulated through the tunnel and prevents the build-up of heat. Fresh air is drawn through the entrance of the tunnel and discharged through ventilation shafts ensuring that air discharged from the tunnel is well diluted and dispersed into the outdoor air. Minor quantities of particulate matter (PM_{10}) emissions would be generated in underground tunnels, mainly due to train brake pad wear, vaporisation of metals due to sparking, wear of steel due to friction between wheels and rail, and recirculation of particulates from tunnel walls. Most of these emissions would be vented through ventilation shafts in very low concentrations. Vented air is likely to comprise minor concentrations of CO_2, Volatile Organic Compounds (VOCs) and NO_x as well as ash and soot particulates. The ventilation outlet air would contain small quantities of particulates at low concentrations due to the large volumes of exhaust air. Given the low concentrations of particulates, the ventilation system is very unlikely to have air quality impacts on the surrounding environment, including sensitive receivers.

The ventilation system would also respond to emergency conditions such as fire incidents where smoke-laden air would be discharged through the emergency ventilation system to prevent smoke

entering stations or recirculating through ventilation shafts or tunnel portals. The design and location of the ventilation shafts at stations would ensure sensitive receptors were not unnecessarily affected and suitable emergency plans would be in place for these circumstances.

Stabling Yard Activities

Diesel plant would be used at the Tallawong Stabling Facility for train stabling and maintenance activities. Diesel machinery has the potential to cause emissions containing VOCs, CO and NO_x. Emissions arising from these activities however would be negligible, particularly when compared to emissions arising from surrounding major roads.

Motor Vehicles

The NWRL would result in changes to motor vehicle use and emissions at both local (within close proximity to stations) and regional scales arising from changes to the availability and access to rail services.

It is expected that there would be redistributed traffic movements surrounding station precincts, particularly for those stations with park and ride facilities, associated with passengers accessing the station. As such, localised areas surrounding stations may experience a minor decline in air quality as a result of a concentration of vehicle emissions. This impact is not expected to be noticeable at the human scale and would not result in adverse health effects.

Overall there may be a slight decrease in traffic volumes as mode share shifts from road to rail. This reduction in traffic would produce air quality benefits, particularly centred around major roadways used by potential commuters.

The NWRL would be consistent with protecting and improving air quality across the Sydney Basin by supporting the recognised need to curb growth in transport emissions while maximising transport choice. The encouragement of Transit Oriented Development around NWRL stations would see the amount of required trips decrease with access to services and facilities within walking distance. Decreased trips would see the number of vehicles on the road decline, thereby minimising vehicle emissions.

Based on projections of modal shift related to the NWRL project, beneficial air quality impacts arising from the operation of NWRL can be identified as follows:

- Reduced need for car ownership in areas served by the NWRL (reduction of 6.2 million vehicle kilometres travelled by car between 2021 and 6.9 million vehicle kilometres travelled by car in 2036).
- Reduced local health impacts associated with improved air quality (reduction of 15 tonnes of PM_{10} and 70 tonnes NO_x emissions in 2021, with further reductions to 16 tonnes of PM_{10} and 120 tonnes NO_x emissions in 2036).

Operational Air Quality Summary

Predicted changes to train movements and motor vehicle use during NWRL operation are unlikely to affect air quality. The proposed design and location and positioning of air vents, car parks and kiss and ride facilities ensure no local air quality impacts on sensitive receivers. Particulate matter concentrations would be well below air quality criteria, ensuring negligible risk to workers and commuters within stations, the tunnels and work places. Minor beneficial residual effects are predicted on air quality over the medium term through reductions in motor vehicle use when compared to the NWRL not proceeding. Overall there are no adverse air quality impacts anticipated from the operation of the NWRL, with potential that regional air quality may improve from mode changes from private vehicles to trains. Impacts are expected to be minor with the implementation of the mitigation measures presented in Section 19.1.8.

19.1.7 Impact Assessment – Construction

This section describes the likely air quality impacts expected from the construction of the NWRL stations, station precincts, services facilities, stabling facility and rail infrastructure and systems.

The majority of potential adverse impacts to air quality would result from major civil works construction activities and have been addressed in EIS 1. To a lesser extent a number of activities associated with the construction works for EIS 2 have the potential to impact on local air quality. These activities include building and precinct construction, minor earthworks, and exhaust emissions from construction equipment and vehicles.

Emissions associated with construction work would depend on a number of factors including meteorological conditions and construction methodologies employed. The impacts would be temporary and confined to the construction period. As a consequence impacts have been assessed qualitatively with respect to the sources of emissions from construction sites.

The main impacts on surrounding air quality during the EIS 2 construction works are discussed separately below.

Dust Generation

Activities with the highest potential to generate dust emissions during construction works include:

- Minor Earthworks
- Minor Spoil storage and transport.

The quantity of dust generated is dependent on the type of machinery used, the construction technique employed, the type, particle size and moisture content of material, size of the exposed area and meteorological conditions (in particular wind conditions).

As the majority of the dust generating works would be completed prior to the construction activities assessed in this EIS coming into effect, dust impacts would be largely confined to the areas surrounding stations and service facilities. Impacts would be temporary and are expected to be minor with the implementation of mitigation measures as outlined in Section 19.1.8.

Earthworks

Above ground earthworks may be associated with re-establishing sites and station precincts left over from the initial construction period that are no longer needed.

The dust generating construction activities associated with earthworks would include:

- Operation of excavators, front end loaders, bulldozers, dump trucks and other plant on exposed surfaces.
- Loading/unloading trucks with spoil and aggregate.
- Wind erosion from exposed surfaces and stockpiles.
- Wheel-generated dust from vehicular traffic on unsealed roads and work site access points.

The degree of risk of potential impacts at each construction site would depend on the intensity of activities, scale of operations and duration of earthworks.

There are a number of sensitive receivers in the immediate vicinity of the construction sites which may be impacted by dust emissions associated with the above ground earthworks. All construction sites would be surrounded by hoardings which would help confine dust to the construction area. Additionally, mitigation measures outlined in Section 19.1.8 would be implemented to reduce impacts on nearby receivers. An air quality and dust monitoring program would be undertaken to monitor and further mitigate these impacts as required during the construction works.

Spoil Storage and Transport

Relatively small quantities of spoil would be stockpiled at station and service facility construction sites.

Spoil stockpiling has the potential to create particulate matter which may impact on nearby sensitive receivers. Appropriate mitigation measures would be implemented to minimise dust emissions such as the installation of water spray systems.

Heavy vehicle movements around construction sites and along haulage routes have the potential to result in wheel generated dust. In particular, the large number of vehicles required to load and unload the spoil would require dust mitigation measures to reduce these emissions where practicable.

Vehicular and Plant Emissions

Activities generating exhaust emissions associated with the construction works include:

- Emissions from construction vehicles
- Emissions from construction equipment, generators and other plant.

The main sources of emissions from heavy vehicles, mobile excavation machinery and stationary combustion plants would be related to diesel combustion. The quantity of emissions from construction vehicles and machinery is dependent on the type of fuel used and the hours of operation.

Construction Vehicles

The movement of heavy vehicles associated with the transport of spoil and delivery and installation of equipment, may potentially impact the local air quality as a result of gaseous and particulate emissions. Concrete delivery would also require a significant number of vehicle movements. Particulate emissions would be confined to areas surrounding stations and services facilities as well as the stabling facility.

Mitigation measures are routinely adopted to mitigate these impacts as outlined in Section 19.1.8.

Construction Equipment, Generators and Other Plant

Typical plant and construction machinery which are likely to be used during the construction works include excavators, bulldozers, scrapers, rollers, graders, dump trucks, front end loaders, compactors, water carts, jackhammers, mobile cranes, generators and concrete pumps. This plant would generally be diesel powered and would emit gaseous and particulate matter into the air.

The construction contractor would ensure that all equipment complies with the emissions concentration limits outlined in the *Protection of the Environment Operations (Clean Air) Regulation 2010*. As such, vehicular and plant emissions arising from the construction works are not likely to have a significant impact on the surrounding air quality.

19.1.8 Mitigation Measures

Mitigation measures have been developed to avoid, reduce and manage identified potential impacts to air quality during both operation and construction. These mitigation measures and their application to the construction sites for the NWRL are presented in **Table 19.3** and **Table 19.4** respectively.

Mitigation Measures – Operation

Mitigation Measures – Construction

The Environmental management Framework provided in Appendix B details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

Dust and exhaust emissions generated during the construction works can largely be controlled through operational and physical mitigation measures, which are routinely adopted during similar construction projects.

Mitigation measures have been developed to avoid, reduce and managed identified potential impacts. These mitigation measures and their application to the construction sites for NWRL are presented in **Table 19.4**.

Table 19.3 Mitigation Measures - Operational Air Quality

No.	Mitigation Measure	Applicable Sections
OpA1	Develop an OEMP including an Air Quality section	All
OpA2	Location and design of air ventilation, car parks and kiss and ride facilities to consider avoidance of air quality impacts on sensitive receivers.	Stations Service facilities

Table 19.4 Mitigation Measures - Construction Air Quality

No.	Mitigation Measure	Applicable Sites*
General		
A1	Working face and areas of open excavation would be kept to a minimum, where feasible and reasonable.	All
A2	Water suppression would be used for active earthwork areas, stockpiles, gravel roads and loads of soil being transported to reduce wind-blown dust emissions.	All
A3	Waste or any other material would not be burnt on construction sites.	All
A4	The amount of excavated material held on site would be minimised.	All
A5	Areas of exposed earth would be minimised by staging construction activities and progressively landscaping and vegetating completed areas as the construction activities proceed, where feasible and reasonable.	All
A6	Enclosed rubble chutes and conveyors would be used where feasible and reasonable. Drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment would be minimised and/or water used to suppress dust emissions from such equipment.	All
A7	Cutting, grinding or sawing equipment would only be used in conjunction with suitable dust suppression techniques such as water sprays or local extraction.	All
A8	Wind breaks, which may include site hoardings, would be constructed, where construction works are in close proximity to sensitive receptors and where feasible and reasonable.	All
A9	Dust generating activities would be assessed during periods of strong winds and rescheduled, where required.	All
A10	All vehicles carrying loose or potentially dusty material to and/or from the site would be covered.	All

No.	Mitigation Measure	Applicable Sites*
Spoil Stockpiles		
A11	Stockpiles would be located away from sensitive receivers, where feasible and reasonable, and protected from the elements through barriers, covering or establishing a cover crop.	All
Haul Roads		
A12	Longer term and/or heavily used haul roads would generally be sealed. The criteria for sealing haul roads would be defined during detailed construction planning. Sealed haul roads would be regularly cleaned.	All
A13	Unsealed haul roads would be regularly damped down with fixed or mobile sprinkler systems.	All
A14	Vehicular and foot traffic would be restricted to designated areas.	All
A15	Appropriate site speed limits would be imposed and signed on haul routes.	All
A16	Wheel-wash facilities or rumble grids would be provided and used near site exit points, and a street-cleaning regime would be implemented to remove any dirt tracked onto roads.	All
Vehicles and Equipment		
A23	Engines of onsite vehicles and plant would be switched off rather than left idling for extended periods of time.	All
A24	Low emission vehicles and plant fitted with catalysts, diesel particulate filters or similar devices would be used, where feasible and reasonable.	All
A25	Plant would be well maintained and serviced in accordance with manufacturers' recommendations.	All
A26	Haul routes and plant (including generators) would be sited away from sensitive receivers, such as dwellings and schools, where feasible and reasonable.	All
A27	Vehicle emissions would be minimised through methods such as using alternative modes of transport, such as encouraging car pooling by construction workers, and maximising vehicle utilisation by ensuring full loading and efficient routing.	All
A28	Precautions would be implemented to prevent the occurrence of smoke emissions or fumes from site plant or stored fuel oils.	All

Site 1 - Epping Services Facility, Site 2 – Not Used, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 - Showground Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility, and Tunnels

19.2 Waste Management

19.2.1 Introduction

The effective management of waste is of paramount importance during both operational and construction phases. With growing awareness of issues surrounding the sustainability of waste management practices, all feasible measures should be taken to reduce the amount of waste sent to landfill. Waste is therefore a consideration for the operation and construction of the NWRL. This section aims to identify key waste production sources and waste management methods during operation and construction.

Waste production is intrinsically linked to resource consumption. Reducing the amount of resources used will generally reduce the amount of waste produced which has other beneficial lead-on environmental impacts. In NSW, resource and waste management is prioritised according to the principles of the resource management hierarchy as provided within the *Waste Avoidance and Resource Recovery Act 2001*. Achieving a reduction in waste generation and turning waste into recoverable resources are priorities for NSW. The hierarchy is as follows:

- Avoidance of unnecessary resource consumption.
- Resource recovery.
- Disposal.

Avoidance

Avoidance is the first priority in waste management and includes actions aimed to reduce the amount of waste generated during operation and construction. This is the preferred option as it avoids the environmental impacts associated with resource use including resource depletion, air pollution and greenhouse gas emissions associated with extraction and processing, transport related emissions and traffic congestion, and waste generation.

Resource Recovery

Resource recovery maximises the options for reuse, recycling, reprocessing and energy recovery at the highest net value of the recovered material. This encourages the efficient use of recovered resources while supporting the principles of improved environmental outcomes and ecologically sustainable development. Resource recovery can also embrace new and emerging technologies. Reuse is preferable to recycling as it does not require any processing, however both processes avoid extracting raw materials and the associated manufacturing/processing required. In this process, the energy, water and fuel used to extract/process the materials, as well as any waste/pollution produced, may also be avoided from the outset.

Disposal

Disposal of waste is the least desirable option and needs to be managed carefully to minimise negative environmental impacts. Waste production in Sydney is increasing with a large portion being sent to landfill. Sydney's landfill capacity is diminishing and the economic and environmental costs of transporting waste outside of Sydney are driving government policies to reduce the generation and disposal of waste.

Given these issues and the options to minimise social and environmental impacts associated with resource use and waste, NWRL is committed to ensure that materials are selected considering 'whole of life' costs within the principles of sustainable procurement, and that, where reasonable and feasible, resources are used responsibly, opportunities for reuse are maximised and waste disposal is minimised.

19.2.2 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 19.5 sets out the Director-General's Requirements, the Conditions of Approval and Statement of Commitments as they relate to waste management and indicates where each item is addressed within this chapter.

Table 19.5 Director-General's Requirements, Conditions of Approval and Statements of Commitment

Reference	Description	Addressed
Director General's Requirements		
N/A		
Conditions of Approval		
NA		
Statement of Commitments		
Spoil	Opportunities for beneficial reuse of soil identified.	Waste generation in Sections 19.2.4 and 19.2.5
	Further investigations would be undertaken as part of the design development into the opportunities for beneficial reuse of spoil. As a result of these investigations further assessment of transport options and routes for spoil movement would be undertaken.	Transportation of spoil in Chapter 9 of EIS1.

19.2.3 Methodology

Operation

This section describes the methods used to assess the impact of waste generation on the environment as a result of NWRL operation. Assessment is carried out with the waste management hierarchy as a consideration and identifies:

- Waste streams generated during operation.
- Level of hazard associated with the waste generated.
- Potential waste management related impacts associated with operation.
- Management measures to ensure proper handling of waste.
- Mitigation measures focussed on the priorities of the waste management hierarchy.

Construction

This section outlines the methods used to assess waste impacts and the general waste management that would apply to the project during construction and identifies:

- Waste streams generated during the construction works.
- Potential waste management related impacts associated with construction works.
- Options for the reduction in waste output.
- Wastewater management options.
- Waste management procedures.

19.2.4 Waste Generation – Operation

A variety of solid and liquid wastes are expected to be generated due to the operation of the NWRL, however this is expected to be relatively minor when compared with construction generated waste.

The main types of activities that would generate waste are detailed below. The different types of waste would be typically distributed across the length of the rail route. Specific wastes would be generated along certain sections such as in the tunnel, at stations and at the Tallawong Stabling Facility.

Cleaning Activities: Trains and Stations (Public and Commercial Areas)

General wastes would be collected from cleaning activities on trains and in public and commercial areas. These wastes would include general non-recyclable waste, recyclable wastes such as plastics and aluminium cans and office waste including paper and plastics as well as general litter. Waste would primarily be generated by the general public. There is significant potential, however to minimise waste impacts at this source level by providing the means of disposing of waste into separate waste streams including recyclable disposal for paper, plastics, aluminium and general recycling and non-recyclable disposal. This would ensure less energy expenditure for the separation of wastes at the point of disposal.

Underground Rail Corridor Infrastructure Maintenance

Waste materials generated from infrastructure maintenance activities in the underground rail corridor would be:

- Cable and conduit off-cuts from maintenance of track electrical infrastructure
- Spent spill kit absorbent materials used to clean up spills at refuelling pads/areas
- Solvents, paints adhesives, cleaning fluids, greases, acids and alkali materials.

There is potential for oil leaks and spillages from trains and track maintenance vehicles or debris from accidents in the rail corridor to generate waste. Waste from clean-up activities would be managed in accordance with the incident management procedures to be developed prior to operation commencing.

Tallawong Stabling Facility

Waste materials would be generated from train maintenance carried out at the Tallawong Stabling Facility. These wastes would include:

- Waste oil and greases generated during cleaning, inspection and maintenance activities on the trains
- Train maintenance consumables
- Spent spill kit absorbent materials used to clean up spills
- Solvents, paints, cleaning fluids, greases, acids and alkali materials.

19.2.5 Waste Generation – Construction

The project has the potential to generate a number of different types of solid and liquid waste during the construction works which would require management and disposal in accordance with relevant NSW legislation and policies. Key activities that may generate waste are detailed below:

Green Waste

Any additional clearing and grubbing of vegetation would generate green waste.

Building Works

Building materials associated with the NWRL would be extensive and a detailed list would be compiled during the detailed design phase. Wastes that are likely to be generated from building works would include:

- Scrap metal, steel
- Timber formwork
- Concrete
- Pavements
- Plasterboard, geotextiles and geosynthetic materials
- Cable and pipework offcuts
- Packaging materials including pallets, plastic wrapping, polystyrene and cardboard

Excavation Works

Excavation works could potentially generate spoil which is generally considered to be an inert waste. There is potential however, to uncover ASS or contaminated materials that are to be managed appropriately.

Office and Crib Rooms

Waste would be generated by construction staff in offices and crib rooms and places where food is consumed onsite resulting in mixed waste. Waste would comprise of putrescibles, paper, plastic wrapping, steel and aluminium cans, plastic bottles and containers, glass, food scraps and office waste such as printer cartridges.

Wastewater would be generated from facilities for construction workers including toilets, canteens and kitchens.

Other waste streams anticipated to be generated during the construction works include:

- Waste from operation and maintenance of vehicles and machinery including adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses and tyres.
- Wastewater from other sources including dust suppression and washdown and sewerage/ greywater from construction compounds.

19.2.6 Potential Impacts – Operation

Waste has the potential to cause widespread adverse environmental impacts. Inadequate collection, storage and disposal of waste generated during operation may potentially lead to pollution of the surrounding environment. Solid waste such as litter has the potential of being blown from the stations onto the tracks and into the surrounding environment if adequate bins are not provided or emptied regularly.

The management of waste during operation is not considered a key issue given that impacts may be reduced using standard measures. No significant adverse waste impacts are anticipated to occur during operation of the NWRL.

19.2.7 Potential Impacts – Construction

Potential waste management impacts associated with the construction works include:

- Spoil directed to landfill due to inadequate recycling and beneficial reuse.
- Waste directed to landfill from the inadequate collection, classification and disposal of waste.
- Contamination of soil, surface and/or groundwater from the inappropriate storage, transport and disposal of liquid and solid wastes.
- An increase in vermin from the incorrect storage, handling and disposal of putrescible waste from construction compounds.
- Incorrect classification and/or disposal of waste.
- Excessive amount of materials ordered, resulting in a large amount of left over, unused resources.
- Lack of identification of feasible options for recycling or reuse of resources.

Waste management activities associated with the construction works are considered to pose a minor risk to the environment given that standard construction management measures are available to address waste generation, storage, disposal and re-use in order to reduce impacts.

19.2.8 Mitigation Measures

This section identifies areas by which the operation and construction of the project could be made more sustainable in relation to the use of resources and the management of waste. Measures have been provided that would ensure best practice is carried out to minimise impacts to the environment. Where feasible and practicable, these initiatives, along with more standard waste and resource use minimisation measures, would be implemented during both operation and construction as detailed below.

TfNSW is committed to the objectives of responsible management of waste and would ensure that the project complies with the waste management hierarchy and the legislation relevant to waste management including the *Protection of the Environment Operations Act 1997* and associated regulations, the WARR Act, the Waste Classification Guidelines (DECC 2008) and the NSW Government's Waste Reduction and Purchasing Policy (WRAPP) Guidelines.

Mitigation measures have been developed to avoid, reduce and manage identified potential impacts. These mitigation measures and their application to the operation and construction sites for the NWRL are presented in **Table 19.6** and **Table 19.7** respectively.

Mitigation Measures – Operation

Mitigation Measures – Construction

The project would aim to achieve best practice outcomes with regards to waste management. Targets were set in EIS 1 to ensure this objective is met. These targets would be carried through from the Major Civil Construction Works to apply to the construction of the stations, stabling facility and rail infrastructure and systems as applicable in this EIS. These targets are:

- 100% beneficial reuse of usable spoil.
- 95% beneficial reuse of construction and demolition waste.

The Environmental Management Framework, provided in Appendix B, details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

Mitigation measures have been developed to avoid, reduce and manage identified potential impacts. These mitigation measures and their application to the construction sites for the NWLR are presented in **Table 19.7**.

Table 19.6 Mitigation Measures - Operational Waste and Resource Management

No.	Mitigation Measure	Applicable Areas
OpW1	Develop an Operational Environmental Management Plan including a section on Operational Waste and Resource Recovery Management. This would detail opportunities for avoiding waste generation and responsible disposal methods for different waste streams.	All
OpW2	Design innovation during the detailed design stage of the NWRL would provide opportunities to reduce the amount of resources required for operation.	All

Table 19.7 Mitigation Measures - Construction Waste and Resource Management

No.	Mitigation Measure	Applicable Sites*
W1	All waste would be assessed, classified, managed and disposed of in accordance with the Waste Classification Guidelines (DECC, 2008).	All
W2	All waste materials removed from the sites would only be directed to a waste management facility lawfully permitted to accept the materials.	All
W3	Excavated material and spoil would be beneficially reused on the project site or other sites, where feasible and reasonable, in accordance with the spoil use hierarchy.	All
W4	Appropriate storage, treatment and disposal procedures would be implemented for any contaminated spoil.	All
W5	Cleared site vegetation would be mulched for reuse in rehabilitation and landscaping works. Topsoil generated during site preparation activities would be stockpiled for reuse in landscaping activities.	All
W6	Initial and ongoing education would be provided to staff and sub-contractors regarding the importance of appropriately managing waste.	All
W7	Recyclable wastes, including paper at site offices, would be stored separately from other wastes. Storage facilities would be secure and recyclables collected on a regular basis.	All
W8	Reusable materials would be stored separately, in secure facilities.	All
W9	Worksites would be free of litter and good housekeeping would be maintained.	All
W10	Vermin proof bins would be utilised onsite.	All
W11	Waste oil, other liquid wastes and spillages would be collected and stored in bunded areas.	All
W13	Waste truck loads would be covered, and tailgates secured prior to trucks leaving the worksite.	All
W14	Centralised reporting and auditing of waste volumes and disposal destinations would be employed.	All
W15	Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	All
W16	Materials such as (noise hoarding, site fencing, and so on) would be reused or shared, between sites and between construction contractors where feasible and reasonable.	All

Site 1 - Epping Services Facility, Site 2 – Not Used, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 - Showground Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility, and Tunnels

CHAPTER 20

CUMULATIVE IMPACTS

20 CUMULATIVE IMPACTS

20.1 Introduction

Cumulative impacts are incremental environmental impacts that are caused by past, present or reasonably foreseeable future activities which, when combined, may have a cumulative effect. When considered in isolation, the environmental impacts of any single project upon any single receiver or resource may not be significant. Significant effects may arise, however, when individual effects are considered in combination, either within the same project or together with other projects.

This chapter provides an assessment of the potential cumulative impacts and interactions that may arise as a result of the NWRL Stage 1, NWRL Stage 2 and the construction and operation of other projects concurrent with, and in close proximity to the NWRL.

This chapter examines cumulative impacts under two categories:

- Interaction between impacts associated with Stage 1 major civil construction works and Stage 2 stations, rail infrastructure and systems (internal cumulative impacts).
- Interaction between the NWRL and other projects (external cumulative impacts).

20.2 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 20.1 sets out the Director-General's Requirements (DGR), the Conditions of Approval (CoA) and Statement of Commitments (SoC) as they relate to air quality, and indicates where each item is addressed within this chapter.

Table 20.1 Director-General's Requirements, Conditions of Approval and Statements of Commitment

DGR Reference	Description	Addressed
	Assessment of cumulative impacts of the project on key environmental impact issues, particularly with regard to Stage 1 and 2 construction and interaction with other projects in the surrounding area.	Chapter 20
CoA Reference	**Description**	**Addressed**
N/A		
Statement of Commitments	**Description**	**Addressed**
N/A		

20.3 Internal cumulative impacts

Internal cumulative impacts refer to the combined effect of NWRL Stage 1 (ie. construction of the major civil construction works) and NWRL Stage 2 (ie. construction of stations, rail infrastructure and systems and the operation of NWRL) over space and time.

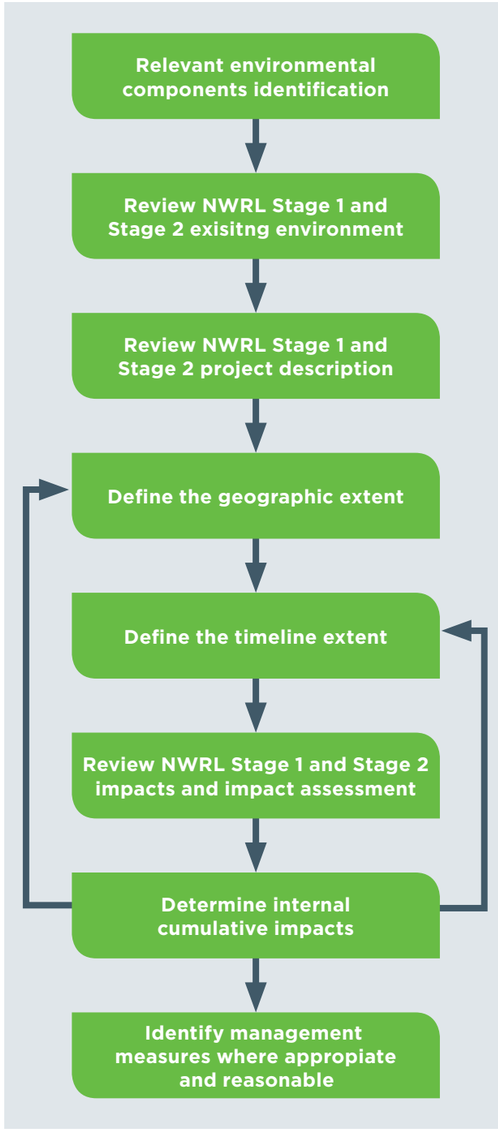
The internal cumulative impacts assessment is concerned with potential cumulative effects on receptors which result from:

- Construction activities at similar locations undertaken concurrently as a result of both the major civil construction works and construction of stations, rail infrastructure and systems, thereby intensifying potential impacts at any one location.
- Construction activities at similar locations undertaken at different stages (either consecutively or not) as a result of both the major civil construction works and construction of stations, rail infrastructure and systems, thereby prolonging potential impacts at any one location.
- Operational activities (i.e. rail operations plus the existence of the constructed project) as a result of the operation of NWRL which may prolong impacts at any one location.

20.3.1 Internal cumulative impacts methodology

The following figure illustrated the methodology followed for identifying and reviewing cumulative impacts.

Figure 20.1 Internal cumulative impacts methodology



Environmental components identification

An environmental component is an aspect of the natural or built environment that was identified as an issue during the preparation of the environmental impact assessments for Stage 1 and Stage 2 of the NWRL. The environmental components considered for the cumulative impact were based on the key issues and other issues covered in the EISs for Stage 1 and Stage 2:

- Traffic
- Noise and Vibration
- Soils and Groundwater
- Non-Indigenous Heritage
- Indigenous Heritage
- Local Business Impacts
- Land-use Planning
- Ecology
- Visual
- Climate Change Adaptation
- Surface Water and Flooding
- Air quality
- Waste.

Review existing environment

The existing environment surrounding the project based on the information provided in the NWRL Stage 1 and Stage 2 EISs and supporting technical papers were reviewed to understand the status and characteristics of each environmental component.

Review project description

A review of the proposed components and activities for stations, rail infrastructure and systems construction works and operations was undertaken for the NWRL Stage 1 and Stage 2 to understand how Stage 1 and Stage 2 components and activities might interact with each other to give rise to cumulative impacts.

Define geographic extent

The definition of a geographical boundary aimed to spatially identify and locate cumulative effects. As a starting point, the project was divided into three geographic sections from east to west as follows:

- From Epping station to before Bella Vista station.
- From Bella Vista station to before Rouse Hill station.
- Rouse Hill Station to Tallawong Road.

The definition of the geographic extent of cumulative impacts varied depending of the environmental component being assessed. For example, the European heritage affected area differs from the area impacted by traffic. In other instances, the spatial distribution of the cumulative impact resulted some distance from the NWRL project (for example GHG emissions).

Define timeline extent

Construction activities for Stage 1 and Stage 2 and the operational stage of the NWRL were placed on a timeline with the aim to identify cumulative effects over the time. Cumulative effects over time considered were:

- Permanent impacts (i.e. occur throughout the whole project life cycle) and impacts occurring during specific project stage(s).
- Impacts that would occur immediately and impacts that would take long time before they are realised.

The following timeline was used for the basis of the assessment. Construction timelines for individual construction sites during Stage 1 and Stage 2 were also utilised (Refer to Chapter 7 of this report and Chapter 7 of EIS 1).

Table 20.2 Indicative construction timeframe for Stage 1 and Stage 2 of the NWRL

Construction activites	Indicative construction timeframe																											
	2013				2014				2015				2016				2017				2018				2019			
NWRL STAGE 1																												
Site Establishment			•	•	•	•	•																					
Station Excavation				•	•	•	•	•	•	•	•																	
Tunnel Excavation (Tunnel Boring Machine – TBM)								•	•	•	•	•	•	•	•													
Tunnel Excavation (Roadheader)				•	•	•	•	•																				
Above ground Linear Works				•	•	•	•	•																				
Epping Services Facility Excavation					•	•	•																					
Cheltenham Services Facility Excavation							•	•	•	•	•	•	•	•	•													
Viaduct and Viaduct Stations Structural Works							•	•	•	•	•	•	•	•														
NWRL STAGE 2																												
Station construction, fit-out and precinct works															•	•	•	•	•	•	•	•	•					
Epping Services Facility fit-out															•	•	•	•										
Cheltenham Services Facility fit-out														•	•	•	•	•										
Trackwork															•	•	•	•	•									
Tunnel systems fit-out																•	•	•	•	•								
Surface and viaduct systems fit-out															•	•	•	•	•									
Testing and commissioning																			•	•	•	•	•					
Operational readiness																					•	•	•	•	•	•	•	
Systems integration																								•	•	•	•	•

Determining internal cumulative impacts

Internal cumulative construction impacts associated with each construction stage within each of the geographic sections were identified in the first instance. Then internal cumulative impacts were identified for the operational stage of the project.

The geographic and timeline extent of the identified cumulative impacts had to be revisited and adjusted in some cases in order to obtain a more accurate description of the impact. For example:

- Some cumulative impacts were confined within a small/greater area of the initial geographic boundary.
- Some cumulative impacts extended over a longer period of time (eg. whole life of the project).

Matrices were used to record the cumulative impacts identified within the geographic extent and timeline for each of the environmental components.

Then, cumulative impacts listed in the matrices were amalgamated, summarised and documented in **"" on page 3**. These summary tables document the identified cumulative effects per environmental component and for each geographical section defined.

Cumulative impacts were also plotted in graphs (where possible) to illustrate how cumulative impacts are distributed in time and space. A logarithmic scale was used for the 'time' axis of the graphs because the level of detail on the project impacts decreases with time.

Management measures

- Measures to manage the internal cumulative effects were formulated where appropriate and reasonable. Identified management measures have considered the following hierarchy:
- Avoidance.
- Mitigation.
- Compensation.
- Monitoring and evaluation.
- At the more strategic level, rules for siting, phasing and managing projects.

20.3.2 Internal cumulative impacts

The following table lists the likely internal cumulative impacts for the NWRL.

Table 20.3 Likely Internal Cumulative Impacts

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
Soils and groundwater				
1	**Eastern and Cattai Creeks groundwater systems**	**Between years 2013 and 2019**	Stage 1 and Stage 2 construction works	The following impacts on the soils and groundwater would be increased for an extended period of time as a result of Stage 1 and Stage 2 construction works: ▪ Soils - Potential to generate erosion and sedimentation impacts. - Potential disturbance of acid sulfate soils and saline soils. ▪ Groundwater - Contamination risk from turbid, saline or contaminated water or spill accidents from the construction sites. Risk of disturbance of contaminated land or groundwater. The cumulative impact would be adverse, direct. It would potentially create a downstream effect on groundwater flows and creeks and would last between 3 and 5 years depending of the construction site.
2	**Eastern and Cattai Creeks groundwater systems, aquifers surrounding the tunnel and station boxes**	**Year 2014 onwards**	Stage 1 and Stage 2 construction works and NWRL operation	The following impacts on the groundwater would extent throughout the life of the project: ▪ Groundwater drawdown localised within a narrow corridor in which the tunnel and station boxes are centred and beneath drainage lines. ▪ A fall in long term local groundwater levels to levels governed by the level of drainage infrastructure. - Groundwater inflows into the tunnel and station boxes. Long-term inflow has been estimated to be about 0.5ML/d. Note groundwater inflows would be collected, transferred and treated at the existing Lady Game Drive water treatment plant. The cumulative impacts would be adverse, direct and permanent. There may be long delays in experiencing impacts and these would potentially create a downstream effect on groundwater flows and the water table.

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
Traffic and transport				
3	**Along construction traffic access roads**	**Between years 2013 and 2019**	Stage 1 and Stage 2 construction works	Traffic volumes along construction traffic routes would be increased for an extended period of time as a result of Stage 1 and Stage 2 construction works. Cumulative traffic impacts would be experienced in the following locations: ▪ Epping to Bella Vista - Beecroft Road - M2 and Kirkham Street - Castle Hill Road and Franklin Road - Old Northern Road, McMullen Avenue and Crane Road - Showground Road and Carrington Road - Norwest Boulevard and Brookhollow Avenue ▪ Bella Vista to Rouse Hill - Celebration Drive - Balmoral Road and Memorial Avenue - Samantha Riley Drive - White Hart Drive and Rouse Hill Drive (connecting to Windsor Road) ▪ Rouse Hill to Tallawong - Cudgegong Road, Tallawong Road and Schofields Road. The cumulative impact would be adverse, direct, frequent and repetitive along the affected roads and would last between 3 and 5 years depending of the construction site. Increased traffic volumes from NWRL Stage 1 and Stage 2 construction would also have an indirect cumulative impact on the performance of the following intersections: ▪ Carlingford Rd/ Beecroft Rd intersection during PM peak periods. ▪ Old Windsor Rd / Celebration Dr during PM peak periods. ▪ The Ponds Boulevard / Schofields Road during AM and PM peak periods. ▪ Cudgegong Road / Schofields Road during AM peak periods. The level of service of these intersections would decrease during the peak periods listed above.

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
4	Construction sites approaches (i.e. Roads, footpaths, cycle paths)	Between years 2013 and 2019	Stage 1 and Stage 2 construction works	Road network changes affecting drivers, pedestrians and cyclists would remain for a longer period of time as a result of Stage 1 and Stage 2 construction works. Main activities causing the impact are described below. ▪ Changes to road network and traffic conditions - Epping to Bella Vista. For example, the creation of new intersections at Castle Hill Road, Glenhope and Franklin Roads surrounding Cherrybrook Station, Old Northern Road at Castle Hill Station; the alteration of Norwest Boulevard and the alteration of Norwest Boulevard / Brookhollow Avenue intersection to traffic signals surrounding Norwest Station. - Bella Vista to Rouse Hill. Alteration of Celebration Drive / Lexington Drive intersection from a roundabout to traffic signals near Bella Vista Station. ▪ Changes to public bus network - Epping to Bella Vista. Modification of Castle Hill bus interchange at Castle Hill; the relocation of Special Event buses for Sydney Olympic Park / Royal Easter Show (Route 5A) and the existing bus stops on Carrington Road at the Showground Station. - Bella Vista to Rouse Hill. T-way road works and relocation bus interchange and bus routes access arrangements surrounding Rouse Hill Station. - Rouse Hill to Tallawong. Re-route of Busways route No T75 along Tallawong Road – Schofields Road. ▪ Pedestrian/cycle paths closures and detours. - Epping to Bella Vista. Detour of pedestrian/cyclists at the Epping services facility site; the western side of Old Northern Road and Arthur Whitling Park (Castle Hill Station site); the route from Carrington Road through the Castle Hill Showground (Showground construction site); and the southern footpath along Norwest Boulevard along the frontage to the Norwest construction site. - Bella Vista to Rouse Hill. Informal east-west pedestrian routes to the Rouse Hill site through the existing T-way interchange would be closed. Rouse Hill cycle lockers located within the existing interchange area would be relocated. - Rouse Hill to Tallawong. No cumulative impacts are anticipated for this area. ▪ Changes to taxi pick up and 'kiss and ride' areas - Epping to Bella Vista. Changes along the section of the Epping Service facility site on Beecroft Road. - Bella Vista to Rouse Hill. Taxi pickup / drop off and 'kiss and ride' would be restricted on Tempus Street adjacent to the Rouse Hill work site. - Rouse Hill to Tallawong. No foreseen cumulative impacts. ▪ Changes to parking conditions. - Epping to Bella Vista. On-site parking restrictions along Franklin Road between Castle Hill Road and the northern boundary of the Cherrybrook Station construction site, and along Brookhollow Avenue at the Norwest construction site; and loss of parking spaces on Old Castle Hill Road (about 10 spaces at the Castle Hill Station work site) and at the Showground car park (about 200 off street car park spaces). - Bella Vista to Rouse Hill. Relocation of Burns T-way bus station car park (159 spaces) and Riley T-way bus station car park (141 spaces). Displacement of car par spaces between Windsor Road and the town centre and north of Rouse Hill Drive (about 170 spaces), and to the north of Rouse Hill Drive, adjacent to Windsor Road (about 240 informal spaces). - Rouse Hill to Tallawong. No foreseen cumulative impacts. The cumulative impact to drivers, pedestrians and cyclist would be adverse, direct, frequent and repetitive along the construction site approaches and would last between 4 and 5 years depending of the construction site.

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
5	Station access roads	From the commencement of operations	Station and station precincts operation	Although the NWRL would not be a traffic-generating development in its own right, traffic volumes along some local access roads would increase as a result of traffic generated by the operation of the stations and station precincts. Cumulative impact is likely to be experienced in the access roads listed below. Note the roads underlined in the list would experience increased traffic volumes from the construction stage (Refer to impact No 1 in this table). Therefore the overall resulting cumulative internal impact would be widespread along the project timeline and from the commencement of the Stage 1 major civil construction works. ▪ **Epping to Bella Vista** - Castle Hill Road, Franklin Road, Old Northern Road / County Drive and Robert Road. - Old Castle Hill Road. - Showground Road, Carrington Road and Victoria Avenue. - Norwest Boulevard and Brookhollow Avenue. ▪ **Bella vista to Rouse Hill** - Celebration Drive, Balmoral Road and Old Windson Road. - Samantha Riley Drive and Newbury Avenue. - Hart Drive, Rouse Hill Drive (connecting to Windsor Road) and Main Street. ▪ **Rouse Hill to Tallawong** - Schofields Road, Tallawong Road and Cudgegong Road. Increased traffic volumes associated with the stations operation would also have an indirect cumulative impact on the performance (i.e. Levels of Service) of the following intersections during AM peak periods: ▪ Crane Road / Terminus Street intersection as a result of kiss and ride trips which would be generated by the Castle Hill Station operation. ▪ Middleton Avenue / Carrington Road and Victoria Avenue / Carrington Road intersections as a result of kiss and ride trips which would be generated by the Showground Station operation. ▪ Norwest Boulevard / Brookhollow Avenue (east) / Columbia Circuit intersection as a result of kiss and ride and park and ride trips generated by the Norwest Station operation. ▪ Old Windsor Road / Balmoral Road / Miami Street as a result of kiss and ride and park and ride trips generated by the Bella Vista Station operation.
6	Sydney north west region	From the commencement of operations	Station transport interchange facilities operation	The operation of the transport interchange facilities would increase the integration and connectivity between transport modes. The increased connectivity for each geographic area is described below. ▪ Epping to Bella Vista - Bus service routes from Cherrybrook, Castle Hill, Round Corner, Dural and the West Pennant Hills Valley areas connecting to Cherrybrook Station. - Bus service routes using the Castle Hill bus interchange at the Castle Hill Station. - Buses using the Doran Drive bus stand at the Showground Station. - Bus service routes from Glenwood and Crestwood areas connecting to Norwest station. - Motor vehicle transport mode via taxi ranks and kiss and ride zones. ▪ Bella Vista to Rouse Hill and Rouse Hill to Tallawong - T-way service. - Motor vehicle transport mode via taxi ranks, kiss and ride zones and park and ride areas. - Pedestrians via bridge links over Old Windsor Road. The transport interchange facilities would also have the following indirect permanent and positive cumulative impacts: ▪ Creation of transport orientated development around station transport interchanges. ▪ Alleviate traffic capacity and congestion issues in Sydney north west area.

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
Noise and vibration				
7	**Sensitive receiver areas surrounding construction sites**	**Between years 2013 and 2019**	Stage 1 and Stage 2 construction works	Airborne noise from construction activities would be experienced for an extended period of time as a result of Stage 1 and Stage 2 construction works. The majority of sensitive receiver areas would generally comply with the adopted noise management levels. However, the following sensitive receiver areas are likely to experience noise levels above the adopted noise management levels during the Stage 1 and Stage 2 construction works: ▪ Epping to Bella Vista - Cheltenham Services Facility. Residences north east of Castle Howard Road, between Murray Road and Lyne Road and the residences on the south west of Castle Howard Road. - Cherrybrook Station. Residences on Robert Road and Oliver Way to the West and North, Kayla Way to the north-east, and south of Castle Hill Road, west of Glenhope Road. ▪ Bella Vista to Rouse Hill - Residences east of Old Windsor Road, from the north section of Arnold Avenue to the north border of the Celebration Drive shopping centre; and residences west of Old Windsor Road, between Newbury Avenue and the north border of the Emmanuel Baptist Church. - Residences east of Old Windsor Road, between the group of residences north east of the Windsor Road/Old Windsor Road junction and Samantha Riley Drive; and residences east of Windsor Road, between Bellcast Road and Sanctuary Drive. ▪ Rouse Hill to Tallawong - OK Caravan Park. The cumulative impact would last between 4 and 5 years depending of the construction site.
8	**Sensitive receiver areas between Epping and Bella Vista**	**Year 2013 onwards**	Construction below ground works and train operation	Receivers located along the underground alignment would experience ground borne noise generated from below ground construction activities. The potential for ground borne noise due to train operation would be acceptable and below adopted noise design objectives. The cumulative impact would therefore be confined to certain activities throughout the construction timeline.
9	**Sensitive receiver areas between Epping and Bella Vista**	**From the commencement of operations**	Train operation along the tunnel	Some sensitive receivers located in close proximity to the proposed tunnel could experience vibration from train operation. However, any vibration levels experienced are likely to be well below those likely to cause damage to building contents or affect the operation of typical equipment.
10	**Sensitive receiver areas between Bella Vista and Tallawong**	**Year 2031 onwards**	Train operation along the viaduct and above ground alignment	Airborne noise trigger level exceedances are likely to occur as a result of the NWRL operation for a number of receivers (refer to Chapter 10).
11	**Sensitive receivers surrounding Tallawong Stabling facility**	**From the commencement of operations**	Tallawong Stabling facility operation	Airborne noise impact from brake testing is likely to be noticeable at the nearest existing receivers. However, the likelihood of potential sleep disturbance is considered to be low.
12	**Sensitive receivers along existing and future access roads**	**From the commencement of operations**	Station and station precincts operation	Traffic generated on existing roads and new roads would add to the traffic noise (i.e. Airborne noise) experienced by sensitive receivers. Traffic noise exceedances above the *NSW Road Noise Policy* criteria for traffic generating developments are likely to occur for a number of receivers (refer to Chapter 10).

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
European heritage				
13	Devlins Creek stone Causeway site	Between years 2013 and 2019	Stage 1 and Stage 2 construction works	The risk of indirect indirect impacts to the 'Stone Causeway' heritage item as a result of the Epping Services Facility Stage 1 and Stage 2 construction works would be prolonged.
14	Castle Howard Road, Beecroft	Year 2013 and year 2016	Stage 1 and Stage 2 construction works	Increased number of heritage listed trees to be removed as a result of the Cheltenham Services Facility Stage 1 and Stage 2 construction works.
15	Stations and above ground alignment	Year 2013 onwards	Stage 1 and Stage 2 construction works NWRL operation	Cumulative adverse visual impacts for the following heritage listed items: ▪ Epping to Bella Vista - Cherrybrook. Minor impact on 'Glenhope' and 'Inala' heritage items. - Castle Hill. Minor impact on ' White House Gallery' and the Arthur Whitling Park heritage items. - Showground. Major impact upon parts of the 'Castle Hill Showground' heritage item. ▪ Bella Vista to Rouse Hill - Bella Vista. There would be a few appreciable adverse impacts upon any known items of European heritage arising from the construction and operation of Bella Vista Station. - Kellyville Station. Minor impact on Old Windsor Road Heritage Precinct No 1. - Old Windsor Road to White Hart Drive. Minor impact on the Old Windsor Road Heritage Precinct No 14; visual impact upon the setting and curtilage of 'Mungerie' heritage item; and major visual impact on the site of the former 'Swan Inn' heritage item. - Rouse Hill. Minor visual impacts on the 'Battle of Vinegar Hill Memorial' heritage item. ▪ Rouse Hill to Tallawong - Windsor Road viaduct. Minor visual impacts on 'former Royal Oak Inn (now Mean Fiddler Hotel)' heritage item.
Indigenous heritage				
No internal cumulative impacts are predicted as a result of the NWRL Stage 1 and Stage 2.				
Land use and community facilities				
16	Locality surrounding construction sites	Between years 2013 and 2019	Stage 1 and Stage 2 construction works	Land use changes at construction sites would be prolonged as a result of Stage 1 and Stage 2 construction works.
17	Locality surrounding Cheltenham and Castle Hill construction sites	Between years 2013 and 2018	Stage 1 and Stage 2 construction works	Stage 1 and Stage 2 construction works would extend the period in which the following facilities are unavailable: ▪ Netball Training Courts at Cheltenham ▪ Arthur Whitling Park at Castle Hill The cumulative impact would last for about 4 to 5 years.

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
18	Locality surrounding construction sites	Between years 2013 and 2019	Stage 1 and Stage 2 construction works	The access, use and/or amenity (e.g. noise and vibration, changes to traffic and parking, visual, and air quality) of the following community facilities would be modified for an extended period of time as a result of Stage 1 and Stage 2 construction works: ▪ Epping to Bella Vista - Epping. Epping Uniting Church and Epping Baptist Church, Arden Anglican School, Our Lady Help of Christians Primary School and Essex Street Scout Hall. - Cheltenham. Cheltenham Oval and Beecroft Reserve. - Cherrybrook. Tangara Infants School, Tangara School for Girls, Inala Rudolf Steiner School, Kindalin Early Childhood Learning, Playdays Pre-School and Inala Dilkara Adult Day Service. - Castle Hill. Castle Hill Senior Citizens Centre, Castle Hill Community Information Centre and St Bernadette's School and bus interchange. - Showground. Carrington Road Pre-School. - Norwest. Hillsong Church. - Bella Vista. Emmanuel Baptist Church and Anglican Technical College Western Sydney. ▪ Bella Vista to Rouse Hill - Samantha Riley Drive to Windsor Road. John XXIII Catholic Primary School and T-way car parking facilities. - Old Windsor Road to White Hart Drive. John XXIII Catholic Primary School and Mungerie House Rouse Hill Visitor Information Centre. - Rouse Hill. Bus interchange and the Castlebrook Lawn Cemetery and Crematorium and facilities. ▪ Rouse Hill to Tallawong - Windsor Road Viaduct. Castlebrook Lawn Cemetery and Crematorium and facilities. - Windsor Road Viaduct to Cudgegong Road. OK Caravan Park. The cumulative impact would last between 3 and 5 years depending of the construction site.
19	Cherrybrook station locality, Bella Vista station location, Kellyville Station locality and Norwest Station locality	From the commencement of operations	NWRL operation	Physical separation between land uses on either side of Castle Hill Road would be further enhanced by the Cherrybrook Station precinct works. Physical separation between land uses on either side of Norwest Boulelvard would be further enhanced by the Norwest Station precinct works Physical separation between land uses on either side of Old Windsor Road would be further enhanced by the Bella Vista and Kellyville Station precinct works
20	Land surrounding the above ground and viaduct alignment	From the commencement of operations	NWRL operation	Land uses in close proximity to the above ground alignment and viaduct would need to consider the rail infrastructure.
21	Sydney north west region	From the commencement of operations	NWRL operation	NWRL operation would contribute to the sustainable population growth in the North West region of Sydney. The cumulative effect would be positive.
22	Station catchment area	From the commencement of operations	Station and station precincts operation	The operation of the stations and station precincts would have the following cumulative effects: ▪ New development opportunity within the station catchment. ▪ Station precincts would contribute to the revitalisation of localities. These cumulative impacts would be positive.

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
Local businesses				
23	Locality surrounding the Epping, Cherrybrook, Castle Hill, Showground and Norwest construction sites	Between years 2013 and 2018	Stage 1 and Stage 2 construction works	Construction impacts on local businesses such as changes to accessibility, reduced visibility and reduced operating amenity may be prolonged for a greater period of time as a result of Stage 1 and Stage 2 construction activities and traffic generated (refer to Chapter 9). The cumulative impact would last between 4 and 5 years depending of the site.
24	Locality surrounding the construction sites	Between years 2013 and 2018	Stage 1 and Stage 2 construction works	Increased local business demand from the flow on effects associated with construction worker activity for retail businesses, cafes, restaurants, fast food outlets as well as some health and community services .This increased demand would occur for a longer period of time as a result of Stage 1 and Stage 2 construction activities. The cumulative impact would be positive and last between 4 and 5 years
25	Epping, Showground and Norwest locality	From the commencement of operations	NWRL operation	An increase in passing trade may result in upward pressure on rental cost to local businesses due to increased demand for shop spaces
26	Epping, Cherrybrook, Castle Hill, Showground, Norwest, Bella Vista and Rouse Hill localities	From the commencement of operations	NWRL operation	Increased accessibility and connectivity at these localities would attract new businesses which would increase competition over existing local businesses.
27	Macquarie Park, Chatswood, North Sydney and CBD corridor	From the commencement of operations	NWRL operation	The NWRL operation would support: ▪ The development of speciality centres along the global economic corridor through providing increased accessibility and connectivity to Castle Hill, Norwest Business Park and Rouse Hill specialised centres. ▪ Increased employment, geographic clustering and concentration of businesses at the Epping, Castle Hill, Showground, Norwest Business Park, Bella Vista localities. ▪ New businesses in the Kellyville and Cudgegong Road localities. The cumulative impact would be positive.
Ecology				
28	Area within 100 m of all construction sites, stations, service facilities, viaduct, above ground alignment and Tallawong Stabling facility	Year 2013 onwards	Stage 1 and Stage 2 construction works and NWRL operation	The following issues would require mitigation: ▪ Potential impact on nearby remnant vegetation communities from weed invasion, hydrological changes and sediment and erosion. ▪ Potential impact on terrestrial fauna due to edge effects, habitat loss/fragmentation and increased noise, vibration and light.
29	Construction sites, stations and service facilities in close proximity to riparian corridors and Creeks	Year 2013 onwards	Stage 1 and Stage 2 construction works and NWRL operation	The following issues would require mitigation: ▪ Groundwater discharge. ▪ Weed invasion.w ▪ Polluted surface water runoff. ▪ Increased velocity of surface runoff. ▪ Surface erosion and sedimentation. ▪ Altered fluvial hydrology.
30	Construction sites	Between years 2013 and 2018	Stage 1 and Stage 2 construction works	The low risk of injury/mortality rates of fauna due to collision with construction equipment or static infrastructure would be maintained for a longer period of time as a result of the Stage 1 and Stage 2 construction works.

No	Geographic extent	Timeline extent	Action / project component	Internal cumulative impact
31	Cheltenham Services Facility, Showground Station, viaduct section	Between years 2013 and 2018	Stage 1 and Stage 2 construction works	Risk of impacting GDE and any groundwater related aquatic environments would be in place for an extended period of time as a result of Stage 1 and Stage 2 construction works. The risks include: ▪ Moderate risk of loss of aquatic habitat for river base flow systems (i.e. sections of Devlins Creek, Cattai Creek, Elizabeth Macarthur and Caddies Creeks). ▪ Moderated risk of contamination of groundwater for terrestrial vegetation. ▪ Moderated risk of contamination of groundwater for river base flow systems (i.e. sections of Devlins Creek, Cattai Creek, Elizabeth Macarthur and Caddies Creeks). Note proposed mitigation measures would avoid, reduce and manage the likelihood and consequence of these impacts. The cumulative impacts would last for about 4 to 5 years.
Greenhouse gas emissions				
32	Atmosphere	Between years 2013 and 2018	Stage 1 and Stage 2 construction works	GHG emissions generation increased as a result of Stage 1 and Stage 2 construction works.
33	Atmosphere	From the commencement of operations	NWRL operation	NWRL operation would reduce transport related GHG emissions compared to a scenario where the NWRL project does not proceed.
Air quality				
34	Construction site localities with sensitive receivers	Between years 2013 and 2018	Stage 1 and Stage 2 construction works	Air quality impacts on sensitive receivers located in close proximity to the construction sites would be experienced for a longer period of time as a result of Stage 1 and Stage 2 construction works. The cumulative impacts would last between 4 and 5 years depending of the site.
35	Atmosphere	From the commencement of operations	NWRL operation	The operation of the NWRL would emit minor concentrations of CO2, VOCs, NOx, ash and soot particulates into the atmosphere. Note these emissions are unlikely to have air quality impacts on the NWRL surrounding environment, including sensitive receivers.
Visual impacts				
36	Mungerie House and Schofield Road	Year 2013 onwards	Stage 1 and Stage 2 construction works and NWRL operation	High adverse visual impact to views from Mungerie House would be extended throughout the life of the project. Views from Schofield Road would have a high adverse visual impact as a result of the Tallawong Stabling facility would be extended throughout the life of the project.

20.4 External cumulative impacts

20.4.1 Methodology

The assessment of external cumulative impacts is focused on the known key environmental issues associated with the construction (Stage 1 and Stage 2) and operation of the NWRL and their interaction with other projects in the vicinity of the alignment.

In terms of their interaction with impacts from other projects, the relevant environmental components considered were the key issues and other issues covered in EIS for Stage 1 and Stage 2:

- Traffic.
- Noise and Vibration.
- Soils and Groundwater.
- Non-Indigenous Heritage.
- Indigenous Heritage.
- Local Business Impacts.
- Land-use Planning.
- Ecology.
- Visual.
- Climate Change Adaptation.
- Surface Water and Flooding.
- Air quality.
- Waste.

Other projects were identified taking into account:

- Location: located in close proximity to the NWRL (i.e. located within suburbs intersected by or adjacent to the NWRL alignment)
- Project timeframe: projects likely to be under construction concurrent with the NWRL construction and/or operation were considered.
- Project size: projects were identified by virtue of being listed on the DP&I Major Projects Register and through consultation with the NWRL project team. Some residential projects listed on the DP&I Major Projects Register were excluded from the assessment (e.g. advertising signage, 'senior living' developments).

Table 20.4 lists projects identified after applying the above criteria. It includes the location and a brief description of the project, project status, construction timeframe and likely environmental impacts based on the information available.

Table 20.4 Projects with potential cumulative impacts with NWRL Major Civil Construction Works

Ref	LGA	Project	Description	Status and Indicative Construction Timing	Assumed Key Impacts based on Current Knowledge
1	Blacktown City The Hills Shire	Water related services for North West Growth Centre	Overview: Construction and operation of drinking water and wastewater infrastructure to service North West Growth Centre second release precincts. Main elements: ▪ Construction of water pipeline from Stanhope Gardens suburb to join Old Windsor Road, running along Old Windsor Road/Windsor Road. Turning west into Area 20 and Riverstone Precincts along Rouse Road, Worcester Road, Macquarie Road, Tallawong Road and Schofields Road. ▪ Construction of Cudgegong Road Reservoir in the area between Cudgegong Road and Worcester Road incorporating surface water and recycled water storage and water pumping stations. ▪ Construction method: pipelines would be installed underground using a combination of open trenching and boring techniques. Open trenching is the preferred method with boring being used when engineering or environmental constraints (eg major creek, road and rail crossings) necessitate it.	Status at September 2012: DP&I determined and approved the project on 6 August 2012. Indicative timing: 2012-2015	▪ Flora and fauna ▪ Aboriginal heritage ▪ Water quality and hydrology ▪ Aquatic ecology ▪ Soils and groundwater ▪ Non-Aboriginal heritage ▪ Air quality ▪ Noise and vibration ▪ Traffic and transport ▪ Human health ▪ Hazards and risk ▪ Land use and services ▪ Waste management ▪ Visual amenity ▪ Greenhouse and energy. (Source: North West Growth Centre Second Release Precincts Environmental Impact Assessment, October 2011)
2	Blacktown City	Parklea Markets	Overview: Redevelopment of Parklea Markets to include hotels, exhibition centre and growers market and associated car parks and road works on a 17ha site with frontage to Sunnyholt Road and Almona Street, Glenwood. Located close to junction of Sunnyholt Road and Old Windsor Road. The site is divided by Caddies Creek which runs through the centre of the site in a north-south direction. Main elements: ▪ Retention of existing Parklea Markets. ▪ Construction of a 12 storey, 336 room 4.5 star hotel. ▪ Construction of exhibition/convention centre (approximately 21,000 m^2). ▪ Car parking for approximately 3,310 underground spaces and 550 at grade spaces. ▪ Associated road works.	Status at September 2012: DP&I issued DGRs on 2 December 2010. Indicative timing: Unknown	▪ Public domain and open space ▪ Environmental and residential amenity ▪ Car parking, transport and access ▪ Noise impacts ▪ Economic impacts ▪ Drainage, water management and flooding ▪ Potential impacts on Caddies Creek riparian zone during construction. (Source: Application to consider Parklea Markets Special Precincts as a Major Project, July 2010; DP&I DGRs, December 2010)
3	Hornsby Shire	Northern Sydney Freight Corridor – Epping to Thornleigh Third Track	Overview: Construction of additional track on western side of existing Main North Line between Epping and Thornleigh including associated station and bridge works and rail systems. Main elements: ▪ Construction of new rail infrastructure including track, signalling, electrical, overhead wiring and other systems. ▪ Construction of new maintenance access roads. ▪ Construction compounds to be located in the corridor at locations to be confirmed. ▪ Widening of cutting at various locations and construction of embankment and retaining walls ▪ Diversion of utilities. ▪ Platform adjustment at Epping Station. ▪ Viaduct to be constructed over the sectioning hut to the north of Epping Station and viaduct over Devlins Creek (immediately south of M2 Motorway). ▪ New bridge span over M2 Motorway	Status at September 2012: EIS received Indicative timing: 2013-2016	▪ Ecology impacts due to vegetation clearance. ▪ Construction and operational noise and vibration impacts due to introduction of third track closer to adjacent receivers. ▪ European and Aboriginal heritage impacts. ▪ Property and infrastructure impacts. ▪ Design and visual impact of new viaducts, bridges and station works. ▪ Access, traffic and transport including traffic impacts due to construction of new bridge over M2 motorway. ▪ Disturbance due to construction related traffic. ▪ Property and infrastructure impacts. ▪ Air quality. ▪ General construction impacts. (Source: Epping to Thornleigh Third Track Project State Significant Infrastructure Application Supporting Document, January 2012; DP&I DGRs, March 2012)

Ref	LGA	Project	Description		Status and Indicative Construction Timing	Assumed Key Impacts based on Current Knowledge
4	Hills Shire	Castle Towers Shopping Centre Upgrade	Overview: Expansion and redevelopment of Castle Towers Shopping Centre Main elements: ▪ Expansion and upgrade of existing centre on land between Old Northern Road, Showground Road and Pennant Street, Castle Hill. ▪ Redevelopment of the former primary school site on the western side of Pennant Street for retail and retail related purposes, with pedestrian and vehicle over bridge connections to the existing centre. ▪ Demolition of some existing buildings on site.	▪ Provision of additional car parking spaces. ▪ Closure of Castle Street between Pennant Street and Old Northern Road, and the closure of the southern section of Kentwell Avenue. ▪ Changes to the existing access and parking arrangements as well as new access points, tunnels under existing roads and adjustments to the existing road network in the vicinity of the site.	Status at March 2012: Approved by Council February 2011 Indicative timing: unknown	▪ Heritage impacts within the Heritage Precinct. ▪ Disturbance during construction due to construction related traffic and construction related noise and vibration. ▪ Impacts on amenity and traffic network due to road closures. ▪ Operational traffic and access. ▪ Visual impacts. (Source: Development application for Stage 3 Extension of Castle Towers Shopping Centre, August 2007, Hills Shire Council web site)
5	Hills Shire	Showground Road Upgrade	Overview: Widening of Showground Road to at least 4 lanes between Carrington Road and Old Northern Road and modifications to intersections. Main elements: ▪ Widening of Showground Road to at least four lanes between Carrington Road and Old Northern Road. ▪ Modifications to the intersection of Showground Road and Old Northern Road. ▪ Modifications to the intersection of Showground Road and Pennant Street. ▪ A new set of traffic signals at the intersection of Showground Road, Kentwell Avenue and Cheriton Avenue.	▪ A new set of traffic signals at the intersection of Showground Road and Rowallan Avenue. ▪ Bus priority measures at the intersection of Showground Road and Carrington Road, as well as other key signalised intersections. ▪ Left-in/left-out restrictions at the intersection of Showground Road and Britannia Road. ▪ Provision of off-road cycle facilities along Showground Road. These works form part of the conditions of the development consent for the proposed expansion of the Castle Towers shopping centre.	Status at September 2012: Project announced in RMS' website Indicative timing: Unknown	▪ Potential direct impact on adjacent properties. ▪ Disturbance during construction due to construction related traffic and construction related noise and vibration. (Source: RMS website)
6	Blacktown City	Schofields Road Upgrade and Extension	Overview: Upgrade of Schofields Road in three stages: (i) Windsor Road to Tallawong Road, (ii) Tallawong Road to Veron Road, and (iii) Veron Road to Richmond Road. Main elements: ▪ An upgrade from a two lane to a four lane divided road with a wide central median for future widening to six lanes if required in the future. ▪ Provision of a tree lined transit boulevard, in a typically 43 metre wide corridor. ▪ Ten new signalised intersections at The Ponds Boulevard, Ridgeline Drive, Hambledon Road, Alex Avenue, Junction Road, Railway Terrace, Veron Road, Camarvon Road, Fermoy Road and Richmond Road.	▪ Left-in/left-out access at Cudgegong Road and Schofields Farm Road. ▪ Schofields Road extended from Railway Terrace through South Street to Richmond Road. ▪ Underpass crossing of the Richmond Rail Line. ▪ Five bridges at Second Ponds Creek, First Ponds Creek, a tributary east of Railway Terrace, Eastern Creek and Bells Creek. ▪ Designated turning lanes. ▪ Off-road shared paths for cyclists and pedestrians.	Status at September 2012: Stage 1 approved May 2009. Indicative timing: Stage 1 construction to commence late 2012	Construction impacts ▪ Flora and fauna. ▪ Disturbance during construction due to construction related traffic. ▪ Construction noise and vibration. ▪ European and Aboriginal heritage. ▪ Water quality. Operational impacts ▪ Visual amenity and landscape ▪ Land use ▪ Access and traffic (Source: Schofields Road Project Documents, RMS website)
7	Hills Shire	Rouse Hill Town Centre Northern Frame	Overview: Mixed use development of Northern Frame adjacent to existing Rouse Hill Town Centre		Status at March 2012: unknown Indicative timing: 2014-2015	▪ Disturbance during construction due to construction related traffic and construction related noise and vibration. ▪ Ecology impacts due to clearance of vegetation. ▪ Potential construction related impacts on Caddies Creek.

20.4.2 Potential Cumulative Impacts

Table 20.4 presented indicative construction timings for projects where these are available. It is not certain when or if these projects will start and the extent and nature of any related impacts. The likely impacts of many of these projects will be assessed as part of the relevant development consent process and what is known about the projects at that time.

The projects identified in **Table 20.4**, when considered with the construction and operation of the NWRL, may result in cumulative environmental impacts. These projects and their likely cumulative impacts can be described by geographic area, as set out in **Table 20.5**.

Table 20.5 Cumulative Impacts by Geographic Area

Area	Projects interacting with the NWRL
Beecroft Road area between Epping Station and M2 Motorway, Epping.	Northern Sydney Freight Corridor Epping to Thornleigh Third Track
Old Windsor Road area between Samantha Riley Drive and Sunnyholt Road including the suburbs of Stanhope Gardens and Glenwood.	Redevelopment of Parklea Markets Water related services for North West Growth Centre
Old Windsor Road/Windsor Road area between Samantha Riley Drive and White Hart Drive including the suburbs of Kellyville Ridge and Beaumont Hills.	Water relates services for North West Growth Centre
Showground Road and Castle Towers area, Caste Hill	Castle Towers Shopping Centre Upgrade Showground Road Upgrade
Rouse Hill area and area west of Windsor Road and north of Schofields Road incorporating Area 20 and parts of Riverstone Precinct.	Water related services for North West Growth Centre Rouse Hill Town Centre Northern Frame Schofields Road Upgrade

Table 20.6 identifies potential cumulative impacts in each of these areas.

Table 20.6 Potential cumulative impacts with NWRL Major Civil Construction Work

Area	Potential Cumulative Impact with NWRL
Beecroft Road Area between Epping Station and M2 Motorway	Construction The Northern Sydney Freight Corridor Epping to Thornleigh Third Track project is likely to commence between 2012 and 2015. Therefore there would be a construction timeline overlap between projects. The predicted cumulative impacts during construction are presented below: ▪ Noise and vibration impacts to receptors along Beecroft Road as a result of construction activities and related traffic. ▪ Cumulative disruption to traffic along Beecroft Road as a result of construction related traffic. Increased construction traffic volumes on the M2. ▪ Increased parking restrictions along Beecroft Road in close proximity to the construction sites. ▪ Increased number of European heritage items and known Aboriginal items impacted. Indirect heritage impacts to the stone causeway over Devlins Creek. The preliminary environmental assessment of Northern Sydney Freight Corridor notes that works to construct a new bridge over the M2 would be located in close proximity to the existing causeway, although it does not identify potential impacts. ▪ Impacts to bushland on the road reserve on Beecroft Road between Carlingford Road and Kandy Avenue. The NWRL construction works would impact the middle and western portion of the bushland. Northern Sydney Freight Corridor works would take place immediately to the east with potential to impact the remaining eastern portion of bushland in this area. ▪ Visual impacts along Beecroft Road as a result of construction hoarding and acoustics sheds at Epping Service Facility and Epping Decline construction sites along with construction of viaduct over the sectioning hut to the north of Epping Station and over Devlins Creek (immediately south of M2 Motorway). ▪ Water quality impacts on Devlins Creek. Devlins Creek runs along the western boundary of the Epping Services Facility construction site and to the north of the Epping Decline construction site. The Creek runs beneath the Main North Line just south of the M2 motorway and therefore could potentially be impacted by the Northern Sydney Freight Corridor works. ▪ Increased amount of spoil and waste generated.

Area	Potential Cumulative Impact with NWRL
Old Windsor Road Area between Samantha Riley Drive and Sunnyholt Road	Construction It is noted the construction and operation timeline for the Parklea Markets project is unknown. The cumulative assessment presented below made the conservative assumption that this project will be executed and that there will be construction timeline overlaps. ▪ Noise and vibration impacts to receptors in the area bounded by Old Windsor Road, Sunnyholt Road and Cattai Creek as a result of construction and related traffic1. ▪ Disruption to traffic along Old Windsor Road and Sunnyholt Road as a result of construction related traffic. ▪ Visual impact due to construction hoarding, elevated building structures associated with Parklea Markets redevelopment as well as the NWRL viaduct structure. ▪ Water quality impacts on Caddies Creek/Cattai Creek as a result of potential pollution of stormwater run-off from construction activities. Cattai Creek runs through or alongside the Parklea Markets redevelopment and the Water Services project as well as the NWRL major civil construction works. Operation ▪ The NWRL would increase the sustainable travel plan choices made by the Parklea Markets patrons.
Old Windsor Road/Windsor Road Area between Samantha Riley Drive and White Hart Drive	Construction The indicative construction timeline for the Water relates services for North West Growth Centre project is likely to overlap with the NWRL Stage 1 and Stage 2 constriction period. Cumulative impacts would include: ▪ Noise and vibration impacts to receptors alongside Windsor Road as a result of construction and related traffic1. ▪ Disruption to traffic along Windsor Road (and other local roads) as a result of construction related traffic. ▪ Visual impact due to construction hoarding and the NWRL viaduct structure. ▪ Water quality impacts on Tributaries 3, 4 and 5 as a result of potential pollution of stormwater run-off from construction activities. Tributaries 3, 4 and 5 cross the construction of the Water Services project, which follows Old Windsor Road/Windsor Road, flowing to the east of Old Windsor Road/Windsor Road and crossing the construction sites for the major civil construction works. ▪ Cumulative clearing of vegetation and disruption of terrestrial fauna species. ▪ Increased number of European heritage items and known Aboriginal items impacted. Operation ▪ Complement the provision of public infrastructure services (reticulated water supply and sewerage, public transport, public roads) to the North West Growth Centre.

Area	Potential Cumulative Impact with NWRL
Showground Road and Castle Towers Area	It is noted the construction and operation timeline for the Castle Towers Shopping Centre Upgrade and the Showground Road Upgrade projects is unknown. The cumulative assessment presented below made the conservative assumption that the projects will be executed and that there will be construction timeline overlaps. Construction ▪ Noise and vibration impacts to receptors along Showground Road and Old Northern Road particularly where they are in close proximity to the shopping centre1. ▪ Noise and vibration impacts to receptors along Showground Road and other local roads as a result of construction related traffic. ▪ Disruption to traffic along various roads as a result of construction related traffic. ▪ Visual impact due to construction hoarding and elevated building structures associated with the Castle Towers Shopping Centre Upgrade. ▪ Increased accessibility issues to businesses and patrons entering the Castle Towers Shopping Centre and its car parks. ▪ Cumulative increase in the demand for goods and services may be expected. The businesses which are most likely to experience this demand are the eateries, food outlets and local retailers along Old Northern Road and within Castle Towers Shopping Centre due to the flow-on effects of construction workers. Operation ❖ Increased opportunity for new Castle Towers Shopping Centre business to attract patron activity as a result of the operation of the road upgrade and the NWRL. ❖ The three projects would indirectly support employment and residential growth in the Castle Hill locality.

Area	Potential Cumulative Impact with NWRL
Rouse Hill area and area west of Windsor Road and north of Schofields Road incorporating Area 20 and parts of Riverstone Precinct	Construction It is likely the Water related services for North West Growth Centre and Schofields Road upgrade construction timelines would overlap with the NWRL construction timeline. Cumulative external impacts during construction would include: ▪ Noise and vibration impacts to receptors throughout the area including those along Windsor Road, Schofields Road, Tallawong Road, Cudgegong Road, Rouse Road, Macquarie Road and Hambledon Road, as a result of construction and related traffic1. ▪ Disruption to traffic along various roads, including Schofields Road as a result of construction related traffic. ▪ Visual impact due to construction hoarding and construction activities as well as the NWRL viaduct structure. ▪ Water quality impacts on Second Ponds Creek and First Ponds Creek as a result of potential pollution of stormwater run-off from construction activities and construction of creek crossings. ▪ Cumulative clearing of vegetation and disruption of terrestrial fauna species within the North West Growth Centre area. ▪ Increased number of European heritage items and known Aboriginal items impacted. Operation ▪ Complement the provision of public infrastructure services (reticulated water supply and sewerage, public transport, public roads) to the North West Growth Centre. ▪ Likely cumulative increase on airborne noise levels from road traffic, train, stabling facility and pump stations noise. ▪ Further support to the transformation of the lands along the Schofields Road and NWRL and improvement of travel conditions, connectivity and easy traffic congestion.

1 Construction Noise and Vibration modelling for NWRL is based on a "realistic worst case" approach - as required in the Interim Construction Noise Guideline. The guideline recommends that the realistic worst case or conservative noise levels from the source should be predicted for assessment locations representing the most noise exposed residences or other sensitive land uses. For most construction activities, it is expected that the construction noise levels will be lower than predicted in the Construction Noise and Vibration Assessment. Since the construction noise predictions in the Construction Noise and Vibration Assessment are already based on a realistic worst case assessment, and at the nearest sensitive receivers to the NWRL construction works, it is unlikely that noise or vibration from another project would generate even higher levels if undertaken at the same time.

20.5 Management and mitigation measures

Construction

Internal and external cumulative impacts for the NWRL Stage 1 and Stage 2 construction works would be managed and mitigated through a project wide Construction Environmental Management Framework . NWRL Contractors would be required to implement and adhere to the requirements of this Construction Environmental Management Framework when constructing the NWRL works.

The Construction Environmental Management Framework, provided in full in Appendix B of this report and Appendix C of the EIS1 report, would provide a linking document between the planning approval documentation and the CEMP to be developed by the construction contractors relevant to their scope of works.

The requirements of this Construction Environmental Management Framework would be included as a contract document in all construction contracts related to the NWRL.

The CEMP prepared by all NWRL Contractors would be relevant to the scale and nature of the nominated scope of works and would be prepared consistent with Guideline for the Preparation of Environmental Management Plans (DIPNR, 2004).

The CEMP would cover the requirements of the relevant EIS/s, the project approval conditions, the conditions of all other permits and licences, the Contractor's corporate Environmental Management System, the environmental provisions of the contract documentation and the Construction Environmental Management Framework.

The purpose of the CEMP would be to detail how the project would deliver the environmental requirements and how issues that arise are handled.

.

The Construction Environmental Management Framework as well as the CEMP would be made publicly available on a dedicated project website.

As part of the CEMP TfNSW would identify all other significant developments occurring in the vicinity of the construction sites and identify environmental impacts to be monitored during construction which have the potential for cumulative effects to occur. TfNSW would review environmental impacts every six months during the construction phase. Any new impacts identified during construction would be addressed appropriately to reduce the cumulative effects and reported.

Subject to the preparation and implementation of the CEMP, no additional mitigation measures would be required.

Operation

Internal and external cumulative impacts for the operation of the NWRL would be managed and mitigated through a project wide OEMP. The Plan would aim to minimise impacts associated with the operation of the NWRL at adjacent receivers and to the environment and would be consistent with the approach and elements of the AS/NZS 14001 (Environmental management systems).

The Plan would consolidate commitments at the operational stage from relevant EIS/s, the project approval conditions, the conditions of all other permits and licences, the owner/operator corporateEnvironmental Management System , and other relevant operational environmental management measures to be implemented.

Subject to the preparation and implementation of the OEMP, no additional mitigation measures would be required.

CHAPTER 21

ENVIRONMENTAL RISK ANALYSIS

21 ENVIRONMENTAL RISK ANALYSIS

21.1 Purpose of environmental risk analysis

The purpose of this environmental risk analysis is to:

- Identify potential environmental risks and issues to be considered as part of this EIS.
- Identify any issues not included in the DGRs, or the Concept Plan Conditions of Approval and Statement of Commitments to enable appropriate assessment.
- Identify the residual environmental impacts after the implementation of the mitigation measures described in this EIS. This provides early identification of significant residual impacts to allow a focus on these areas during the refinement of the design and the development of construction methodologies.

This Environmental Risk Analysis is intended to identify broad environmental risks associated with the project. Activity and site-specific risks are detailed within each individual chapter.

21.2 Key issues identified

Various environmental risk identification and analyses have been undertaken throughout the development of the project (refer to Chapter 3 for a summary of the planning history of the project). Of most relevance to this current Environmental Risk Analysis is the risk analysis undertaken as part of the NWRL Environmental Assessment and Concept Plan (GHD, 2006), the subsequent Concept Plan Approval issued by the then Minister for Planning (2008) and the risk analysis undertaken during the EIS for Major Civil Construction Works (EIS 1).

These documents, along with the assessments undertaken as part of this EIS identified the key environmental issues associated with the project as:

- Construction management.
- Soils and groundwater.
- Construction traffic (including public transport, parking and access).
- Construction noise and vibration.
- European Heritage.
- Indigenous Heritage.
- Local business impacts
- Land use and community facilities.
- Ecology.
- Visual amenity.
- Greenhouse gas and climate change.
- Surface water and hydrology.

This EIS includes a detailed assessment of all of these key issues as they relate to the proposed project, and the potential construction and operational related impacts. Further, this EIS proposes a suite of mitigation measures to reduce the identified potential impacts.

The risk analysis also includes the non-key issues identified by this EIS including air quality and waste management.

21.3 Risk analysis framework

The environmental risk analysis has been undertaken in accordance with the principles of the *Australian and New Zealand standard AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk analysis involved:

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

The first step involved the identification of the consequence, should an impact occur. Definitions of the consequence used as a guide are provided in **Table 21.1**.

The following step in the risk analysis involved an assessment of the likelihood of the consequence, considering the frequency of activities that are to occur. The definitions of likelihood used as a guide are provided in **Table 21.2**.

Table 21.1 Risk analysis consequence definitions

Consequence Level	Definition
Catastrophic	Long term (greater than three months) and irreversible impacts. Resulting in a major prosecution under relevant environmental legislation.
Major	Medium term (between one and three months) and potentially irreversible impacts. Resulting in a fine or equivalent penalty under relevant environmental legislation.
Moderate	Moderate and reversible impacts, or medium term (between one and three months).
Minor	Minor and reversible impacts, or short term impacts (less than one month).
Insignificant	Minor, negligible impacts.

Table 21.2 Risk analysis likelihood definitions

Likelihood	Definition	Probability
Almost certain	The event is almost certain to occur in the course of normal or abnormal construction or operational circumstances.	>90%
Likely	The event is more likely than not to occur in the course of normal construction or operational circumstances.	51% – 90%
Possible	The event may occur in the course of normal construction or operational circumstances.	26% – 50%
Unlikely	The event is unlikely to occur in the course of normal construction or operational circumstances.	5% – 25%
Very unlikely	The event may occur in exceptional construction or operational circumstances only.	< 5%

The risk rating was then determined by combining the consequence and likelihood according to the matrix in **Table 21.3**.

Table 21.3 Risk Matrix

Consequence	Likelihood				
	Very unlikely	Unlikely	Possible	Likely	Almost certain
Catastrophic	15	19	22	24	25
Major	10	14	18	21	23
Moderate	6	9	13	17	20
Minor	3	5	8	12	16
Insignificant	1	2	4	7	11

Based on the risk rating score obtained above, risks were then categorised from low to extreme as shown in **Table 21.4**.

Table 21.4 Risk rating categories

Risk rating score	Risk category	Comments
23 - 25	Extreme	Assessment and planning is necessary to avoid these potential impacts to the greatest extent possible
19 – 22	Very High	Detailed assessment and planning is necessary to develop appropriate measures to mitigate the potential impacts wherever possible
13 – 18	High	Detailed assessment and planning is necessary to develop appropriate measures to mitigate the potential impacts.
8 – 12	Moderate	Potential impacts can be mitigated through the application of relatively standard environmental mitigation measures
1 - 7	Low	Potential impacts either require no specific mitigation measures or are adequately mitigated through other working controls (such as detailed design requirements, normal working practice, quality and safety controls)

21.4 Environmental risk analysis

Using the risk framework in Section **21.3**, an environmental risk analysis has been undertaken for the operation of the project (**Table 21.5**), and the construction of the stations and rail systems (**Table 21.6**). The environmental risk analysis included consideration of the key issues as well as a workshop process involving the EIS team, and consultation with various government agencies and other stakeholders during the consultation and EIS process.

The analysis is structured towards risk minimisation outcomes. The residual risk rating is arrived at after the application of mitigation measures developed and recommended by this EIS (refer to Chapters 8 to 20).

Table 21.5 Operations environmental risk analysis

Issue	Potential Adverse Impacts	Consequence	Likelihood	Risk Rating	Proposed Mitigation Measures	Residual Consequence	Residual Likelihood	Residual Risk Rating
Soils and groundwater	Ongoing local and regional water table drawdown from previous tunnelling and other excavation	Moderate	Unlikely	9 Moderate	Chapter 8	Minor	Unlikely	5 Low
	Ongoing settlement / ground movement from previous tunnelling activities and other excavation	Moderate	Unlikely	9 Moderate	Chapter 8	Minor	Unlikely	5 Low
	Potential bed cracking and loss of surface flow from previous tunnelling activities beneath waterways	Moderate	Unlikely	9 Moderate	Chapter 8	Minor	Very Unlikely	3 Low
Traffic and transport	Reduced performance of the surrounding road network from the introduction of vehicle movements around the new station precincts	Moderate	Almost Certain	20 Very High	Chapter 9	Insignificant	Almost Certain	11 Moderate
	Safety of pedestrians and cyclists within and around the station precincts	Major	Almost Certain	23 Extreme	Chapter 9	Moderate	Very Unlikely	6 Low
Noise and vibration	Airborne noise impacts on local residents and other sensitive receivers from the operation of trains along above ground sections	Moderate	Almost Certain	20 Very High	Chapter 10	Minor	Possible	8 Moderate
	Airborne noise impacts on local residents and other sensitive receiver from the operation of the station precincts and services facilities	Moderate	Almost Certain	20 Very High	Chapter 10	Minor	Possible	8 Moderate
	Ground-borne noise and vibration from the operation of trains in tunnels and underground stations	Minor	Almost Certain	16 High	Chapter 10	Minor	Unlikely	5 Low
	Noise impacts on local residents and sensitive receivers from induced operational traffic around station precincts	Moderate	Almost Certain	20 Very High	Chapter 10	Minor	Likely	12 Moderate
	Noise impacts to sensitive receivers from the operation of the train stabling facility	Moderate	Almost Certain	20 Very High	Chapter 10	Minor	Likely	12 Moderate
European heritage	Impacts on European heritage sites, including damage or alterations to items of heritage or archaeological significance	Moderate	Very Unlikely	6 Low	Chapter 11	Minor	Very Unlikely	3 Low
	Impacts to the curtilage of European heritage items	Moderate	Very Unlikely	6 Low	Chapter 11	Minor	Very Unlikely	3 Low
Indigenous heritage	Impacts on known indigenous heritage artefacts or sites	Major	Very Unlikely	10 Moderate	Chapter 12	Minor	Very Unlikely	3 Low
	Impacts to unidentified indigenous objects and places	Major	Very Unlikely	10 Moderate	Chapter 12	Minor	Very Unlikely	3 Low
Local business impacts	Impacts to the operations of local businesses	Moderate	Almost Certain	20 Very High	Chapter 13	Minor	Likely	12 Moderate
Land use and community facilities	Tunnel protection area impacting on future developments	Minor	Almost Certain	16 High	Chapter 14	Insignificant	Likely	7 Low
	Ineffective integration of corridor and station precinct planning with wider land use planning	Major	Likely	21 Very High	Chapter 14	Minor	Very Unlikely	3 Low
	Impacts to the functionality and use of community facilities	Moderate	Almost Certain	20 Very High	Chapter 14	Minor	Likely	12 Moderate

Issue	Potential Adverse Impacts	Consequence	Likelihood	Risk Rating	Proposed Mitigation Measures	Residual Consequence	Residual Likelihood	Residual Risk Rating
Ecology	Impacts to EECs	Major	Possible	18 High	Chapter 15	Major	Very Unlikely	10 Moderate
	Impacts to threatened flora species	Major	Unlikely	14 High	Chapter 15	Major	Very Unlikely	10 Moderate
	Impacts to threatened fauna species from noise, light spill and collision	Major	Possible	18 High	Chapter 15	Moderate	Unlikely	9 Moderate
	Weed invasion	Moderate	Almost Certain	20 Very High	Chapter 15	Minor	Possible	8 Moderate
	Impacts to aquatic ecosystems from water discharge	Minor	Likely	12 Moderate	Chapter 15	Insignificant	Likely	7 Low
	Impacts to GDEs resulting from potential bed cracking	Moderate	Unlikely	9 Moderate	Chapter 15	Minor	Unlikely	5 Low
Visual amenity	Impact on visual amenity due to the introduction of built elements including the viaduct and station buildings, and the removal of vegetation	Minor	Almost Certain	16 High	Chapter 16	Insignificant	Almost Certain	11 Moderate
Greenhouse Gas & climate change	Emissions of greenhouse gases contributing to climate change	Minor	Possible	8 Moderate	Chapter 17	Insignificant	Unlikely	2 Low
	Impact of climate change on rail operations and infrastructure	Catastrophic	Unlikely	19 Very High	Chapter 17	Moderate	Unlikely	9 Moderate
Surface water and hydrology	Pollution of watercourses from discharge of stormwater runoff	Major	Possible	18 High	Chapter 18	Minor	Unlikely	5 Low
	Impacts to water quality from discharge of treated groundwater	Major	Possible	18 High	Chapter 18	Minor	Unlikely	5 Low
	Impacts to water quality from stabling facility activities	Major	Possible	18 High	Chapter 18	Minor	Possible	8 Moderate
	Contamination of water through spills of fuels or chemicals	Major	Possible	18 High	Chapter 18	Minor	Possible	8 Moderate
	Increased flood levels from introduction of new infrastructure and impervious surfaces	Catastrophic	Likely	24 Extreme	Chapter 18	Minor	Possible	8 Moderate
	Impacts from flood risk to stations and other rail infrastructure	Catastrophic	Likely	24 Extreme	Chapter 18	Minor	Possible	8 Moderate
	Impacts of change to flood peaks from site drainage	Major	Likely	21 Very High	Chapter 18	Minor	Possible	8 Moderate
Air quality	Localised impacts to surrounding receivers from exhaust emissions from plant and traffic operating around station precincts	Minor	Likely	12 Moderate	Chapter 19	Minor	Unlikely	5 Low
Waste management	Impacts associated with the management of waste material	Moderate	Possible	13 High	Chapter 19	Moderate	Very Unlikely	6 Low
	Excessive waste directed to landfill	Moderate	Likely	17 High	Chapter 19	Moderate	Unlikely	9 Moderate
Resource use	Increased demand for potable water for use in the train wash facility	Minor	Almost Certain	16 High	Chapter 17 Chapter 4	Minor	Unlikely	5 Low
	Increased electricity consumption	Moderate	Almost Certain	20 Very High	Chapter 17 Chapter 4	Minor	Likely	12 Moderate

Table 21.6 Stations, Rail Infrastructure and Systems construction environmental risk analysis

Issue	Potential Adverse Impacts	Consequence	Likelihood	Risk Rating	Proposed Mitigation Measures	Residual Consequence	Residual Likelihood	Residual Risk Rating
Soils and groundwater	Interface with existing contaminated sites such as former petrol stations and other hazardous industries	Moderate	Likely	17 High	Chapter 8	Minor	Likely	12 Moderate
	Uncovering and subsequent release of contaminated groundwater	Major	Very Unlikely	10 Moderate	Chapter 8	Moderate	Very Unlikely	6 Low
Construction traffic	Reduced performance of the surrounding road network from the introduction of vehicle movements or temporary lane / road closures	Minor	Almost Certain	16 High	Chapter 9	Insignificant	Almost Certain	11 Moderate
	Removal of parking spaces and use of public parking spaces by construction workforce	Minor	Almost Certain	16 High	Chapter 9	Minor	Possible	8 Moderate
	Disruption to existing public transport, eg T-Way operations and bus interchanges around construction work sites	Major	Almost Certain	23 Extreme	Chapter 9	Minor	Possible	8 Moderate
	Disruption to existing pedestrians and cyclists facilities	Moderate	Almost Certain	20 Very High	Chapter 9	Insignificant	Almost Certain	11 Moderate
Construction noise and vibration	Airborne noise impacts on local residents and other sensitive receivers from construction activities	Moderate	Almost Certain	20 Very High	Chapter 10	Minor	Almost Certain	16 High
	Noise impacts on local residents and sensitive receivers from construction traffic	Minor	Almost Certain	16 High	Chapter 10	Minor	Likely	12 Moderate
	Noise impacts to sensitive receivers from works undertaken outside of standard construction hours	Minor	Almost Certain	16 High	Chapter 10	Minor	Possible	8 Moderate
	Damage to buildings from vibration	Minor	Possible	8 Moderate	Chapter 10	Minor	Unlikely	5 Low
	Impacts on sensitive receivers from vibration (human comfort levels)	Minor	Likely	12 Moderate	Chapter 10	Insignificant	Likely	7 Low
European heritage	Impacts on European heritage sites, including damage or alterations to items of heritage or archaeological significance	Moderate	Very Unlikely	6 Low	Chapter 11	Minor	Very Unlikely	3 Low
Indigenous heritage	Impacts on known indigenous heritage artefacts or sites	Major	Very Unlikely	10 Moderate	Chapter 12	Minor	Very Unlikely	3 Low
	Impacts to unidentified indigenous objects and places	Major	Very Unlikely	10 Moderate	Chapter 12	Minor	Very Unlikely	3 Low
Local business impacts	Impacts to the operations of local businesses	Moderate	Almost Certain	20 Very High	Chapter 13	Minor	Possible	8 Moderate
Land use and community facilities	Construction works / footprint impacting on existing land-use and future land-use plans	Major	Almost Certain	23 Extreme	Chapter 14	Minor	Likely	12 Moderate
	Impacts to the functionality and use of community facilities	Moderate	Almost Certain	20 Very High	Chapter 14	Minor	Likely	12 Moderate

Issue	Potential Adverse Impacts	Consequence	Likelihood	Risk Rating	Proposed Mitigation Measures	Residual Consequence	Residual Likelihood	Residual Risk Rating
Ecology	Impacts to EECs	Major	Possible	18 High	Chapter 15	Major	Very Unlikely	10 Moderate
	Impacts to threatened flora species	Major	Unlikely	14 High	Chapter 15	Major	Very Unlikely	10 Moderate
	Impacts to threatened fauna species	Major	Unlikely	14 High	Chapter 15	Major	Very Unlikely	10 High
	Impacts to aquatic ecosystems	Moderate	Almost Certain	20 Very High	Chapter 15	Minor	Possible	8 Moderate
Visual amenity	Impact on visual amenity due to the introduction of individual construction sites, hoardings and acoustic sheds	Moderate	Almost Certain	20 Very High	Chapter 16	Insignificant	Almost Certain	11 Moderate
Greenhouse Gas & climate change	Emissions of greenhouse gases during construction contributing to climate change	Minor	Almost Certain	16 High	Chapter 17	Insignificant	Almost Certain	11 Moderate
Surface water and hydrology	Pollution of water courses from sediment laden surface water runoff	Major	Possible	18 High	Chapter 18	Minor	Possible	8 Moderate
	Contamination of water through spills of fuels or chemicals	Major	Possible	18 High	Chapter 18	Minor	Possible	8 Moderate
	Increased flood levels from temporary construction sites and activities located on floodplains	Moderate	Possible	23 High	Chapter 18	Minor	Unlikely	5 Low
Air quality	Impacts to surrounding receivers from dust and exhaust emissions	Minor	Likely	12 Moderate	Chapter 19	Insignificant	Possible	4 Low
Waste management	Impacts associated with the management of waste material	Major	Unlikely	14 High	Chapter 19	Moderate	Very Unlikely	6 Low
	Excessive waste directed to landfill	Moderate	Likely	17 High	Chapter 19	Moderate	Unlikely	9 Moderate
Resource use	Increased demand on local and regional resources including sand and aggregate	Major	Almost Certain	23 Extreme	Chapter 17 Chapter 4	Minor	Likely	12 Moderate
	Increased electricity and diesel consumption	Moderate	Almost Certain	20 Very High	Chapter 17 Chapter 4	Minor	Likely	12 Moderate
Cumulative impacts	Impacts to local community and the environment compounded by other concurrent construction activities in the vicinity of the project	Major	Almost Certain	23 Extreme	Chapter 20	Minor	Likely	12 Moderate
	Potential for overlap of Stage 1 and Stage 2 construction activities increasing intensity of construction impacts	Major	Almost Certain	23 Extreme	Chapter 20	Minor	Likely	12 Moderate
	Construction impacts continuing over a longer time period as a result of Stage 1 and Stage 2 construction activities	Major	Almost Certain	23 Extreme	Chapter 20	Minor	Possible	8 Moderate
	Potential effects on surface water, groundwater and air catchments	Major	Almost Certain	23 Extreme	Chapter 20	Minor	Possible	8 Moderate

21.5 Conclusion and Next Steps

21.5.1 Operation

The Environmental Risk Analysis has identified there are no issues that would present a high or greater level of residual risk for NWRL after the incorporation of standard mitigation measures.

The majority of issues would have a moderate residual risk, including:

- Traffic and transport.
- Noise and vibration.
- Local business impacts.
- Land use and community facilities.
- Ecology.
- Visual amenity.
- Greenhouse gas and climate change.
- Surface water and hydrology.
- Waste management.
- Resource use.

The level of assessment undertaken for these issues has determined the likely extent of impacts and recommended appropriate mitigation required to ensure that the risk would be abated.

Soils and groundwater, European heritage, Indigenous heritage and air quality impacts have a low residual risk. It is expected that these issues can be routinely managed through detailed design and operational procedures, and by the implementation of standard management measures aimed at ensuring that all necessary environmental criteria and guidelines would be achieved.

21.5.2 Construction

The Environmental Risk Analysis has identified that construction noise and vibration would present a high or greater level of residual risk for NWRL Stage 2 construction works after the incorporation of standard mitigation measures. This suggests that an increased focus would be required on this aspect throughout the construction of the project to meet an acceptable risk level.

For example, NWRL Contractors would be required to implement the Construction Noise and Vibration Strategy which includes identification of additional measures during detailed construction planning to minimise the demand noise impacts which would result in a lowering of this residual risk to a more acceptable level.

- Other issues that would have a moderate residual risk include:
- Soils and groundwater.
- Construction traffic.
- Local business impacts.
- Land use and community facilities.
- Ecology.
- Visual amenity.
- Greenhouse gas and climate change.
- Surface water and hydrology.
- Waste management.
- Resource use.
- Cumulative impacts.

The level of assessment undertaken for these issues has determined the likely extent of impacts and recommended appropriate mitigation required to ensure that the risk would be abated.

European heritage, Indigenous heritage and air quality impacts have a low residual risk. It is expected that these issues can be routinely managed through detailed design and construction, and by the implementation of standard management measures aimed at ensuring that all necessary environmental criteria and guidelines would be achieved.

CHAPTER 22

PROJECT JUSTIFICATION AND CONCLUSION

22 PROJECT JUSTIFICATION AND CONCLUSION

22.1 Introduction

This chapter outlines the justification for the NWRL project. Justification is based on the strategic need for the project and, in particular, how it would fulfil the project objectives outlined in section 2.6. The project justification also takes into account the alternatives to the project, public interest, project benefits and the principles of Ecologically Sustainable Development (ESD).

Schedule 1 of the EP&A Regulation 2000 provides the content requirements for an EIS (Section 7 of Part 3). In particular, the requirement for (per Section 7 Subsection 1(f)):

"The reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development."

It should be noted that the justification for the project has been established in detail in the Environmental Assessment and Concept Plan (TIDC, 2006), which was approved in May 2008.

22.1.1 Need for the Project

The NWRL would make a major contribution towards addressing four critical strategic challenges:

- Maintaining Sydney's economic growth.
- Accommodating Sydney's growing population in a manner that protects Sydney's status as a world-class city.
- Improving poor transport access to, from and within the city's north west corridor; and thereby
- Making Sydney a more sustainable city.

Maintaining Sydney's economic growth

The north west, is a fast growing area that has a high proportion of managerial and professional workers. The NWRL would support economic growth by ensuring that appropriately qualified workers living in the north west are provided with significantly improved access to key employment areas within Sydney's Global Economic Corridor, such as the Sydney CBD and North Sydney.

Sydney's existing Global Economic Corridor is expected to provide over 800,000 jobs by 2036. As shown in the Figure 22-1, the NWRL would provide rail access to Sydney's Global Economic Corridor from the north west. The North West Subregion of Sydney is also expected to play an important role in accommodating Sydney's employment growth. The NWRL would allow Sydney's Global Economic Corridor to extend further to the north west. Approximately 30 per cent of workers living in the part of the corridor west of Epping are expected to work in the extended Global Economic Corridor, contributing to the labour force depth required to sustain Sydney's economic growth.

The NWRL would also improve business connectivity, including within and to an extended Global Economic Corridor to encompass Rouse Hill, Norwest and Castle Hill as well as Macquarie Park, Chatswood, St Leonards, North Sydney, the Sydney CBD and through to Port Botany and the airport.

Accommodating Sydney's growing population

By 2031 Sydney's population is expected to grow by more than 1.3 million people. To accommodate this growth approximately 570,000 more homes and 600,000 more jobs will be needed by 2031 (NSW Government, 2012, *Sydney over the next 20 years. A Discussion Paper*). The high levels of population growth present challenges to maintaining/improving the 'liveability' of the city, such as higher levels of congestion, environmental degradation and loss of social cohesion.

Accommodating Sydney's increasing population in a sustainable manner requires a systematic response through integrated land use and transport planning. Urban transport infrastructure in Sydney will require significant upgrades over the next decade to adjust to the pressures of this strong population growth and address a backlog of infrastructure provision. The rail network is an ageing and complex system with many 'bottlenecks' that effectively slow down the whole network. The NWRL would be the first part of a new rapid transit network for Sydney, a modern high frequency rail network, which is part of Sydney's Rail Future - a long term plan to transform and modernise Sydney's rail network so that it can grow with the population and meet the needs of customers now and into the future.

Ten precent of Sydney's population growth over the next 25 years is planned to be in the north west. The population in the north west sub-region is expected to grow from around 347,000 in 2011 to 432,000 in 2021 and 554,000 by 2036.

The NWRL would be the essential mass transit link needed to serve one of Sydney's fastest growing regions and would provide rail services to existing suburbs in the Hills District, as well as to new areas of growth in the north west.

The NWRL would supply the high capacity public transport 'backbone' around which the North West Growth Centre has been planned. The North West Growth Centre comprises 16 precincts of which 11 have been released for development. The released precincts provide capacity for around 50,000 dwellings and an estimated population of about 140,000.

The NWRL is a vital transport project that would enable the growth in the north west to continue, as well as supporting the intensification of economic activity along the corridor. It is an essential requirement to meet the objectives of metropolitan planning, including:

- Accommodating Sydney's population growth in a planned way.
- Facilitating intended rapid growth in the north west.
- Increasing housing choice and affordability.
- Reducing the separation between where people live and where they work.

The section of the NWRL west of Epping is closely associated with the centres for growth identified in the metropolitan planning processes, including the North West Growth Centre itself (which has always been planned to be served by a major high capacity public transport service). Strategic centres identified as focal points for growth in the north west that are designated station sites for the NWRL include Castle Hill and Rouse Hill as major centres and Norwest as a specialised centre. Other station sites along the route are planned to provide opportunities to develop new local centres and provide greater residential capacity.

The NWRL and its strong integration with planned population growth is fully consistent with the Australian Government's policy direction: that is, the project is part of the wider planning framework for Metropolitan Sydney and would contribute to the 'integrated planning of land use, social and economic infrastructure through investing in urban passenger transport' as set out in *Our Cities, Our Future – A National Urban Policy for a Productive, Sustainable and Liveable Future (Council of Australian Governments (COAG), 2011).*

Improving poor transport access from the north west and approaching the CBD

There is very strong demand for a reliable public transport solution along the NWRL corridor. The road based system is currently at capacity, and without improvement in public transport service provision, the deficiencies in the transport network would impact negatively on the ability of North West Sydney, and the city as a whole, to achieve its economic potential.

North West Sydney currently relies on road-based public transport services (buses), has one of the highest car ownership levels in NSW and has the largest daily distance travelled by motor vehicle per household in Sydney. Without improvements in public transport, road congestion would increase and result in slower speeds and longer travel times. Furthermore for a proportion of the population private vehicles are not available as an option. If not addressed properly, this transport problem has the potential to undermine the productivity, sustainability and liveability of the North West subregion area and the wider Sydney metropolitan region.

Buses are affected by road congestion and other traffic issues in a similar way to cars, and trips can be of long duration owing to this congestion, stops for passengers, and distances involved. Network constraints for buses are most acute on the approach to and within the Sydney CBD, particularly on the Harbour Bridge and around Wynyard Station. These constraints mean that growth in bus services, particularly those that connect to the CBD, cannot accommodate the expected growth in public transport demand. Capacity constraints on the road network demonstrate the need for a mass transit system to facilitate continued growth.

Without improvements in public transport, it is predicted that by 2021 road congestion would increase travel times from the North West Subregion of Sydney by more than 50 per cent (and in some cases more than 70 per cent) .The NWRL is in the public interest, as it would provide reliable and regular services which would result in reduced travel times for many users and also reduced travel times on the road network as a result of transport mode shift from road onto rail.

The NWRL would have a dramatic impact on travel conditions in the north west and through to the CBD. Forecast travel time savings of around 10 to 30 per cent between the north west and key employment destinations at Macquarie Park, Chatswood and through to the CBD are expected by 2021. There would be much improved travel time reliability compared with bus and private car.

Congestion on the wider rail network would be relieved through attracting some passengers to the NWRL from existing rail services, including reductions of the equivalent of around two train loads in 2021 in the morning peak period on the congested Western lines, rising to approximately three train loads by 2036. In the longer term, once the NWRL has been extended to the CBD and further south, rail capacity would be significantly increased, providing substantial benefits to customers throughout the network.

Reduced congestion on inner city roads, especially across the Harbour Bridge and in the CBD, could be substantial, with many fewer buses expected to be operating in the morning peak period each day from the north west into the CBD by around 2021. Buses from other areas in the north would benefit from faster and more reliable travel times as a result of less congested roads. The road space freed up by the NWRL also presents an opportunity for additional bus services to be provided from north of the Harbour.

Making Sydney a more sustainable city

The NWRL would generate significant potential environmental, social and economic benefits to the wider community. Public transport is important in a large urban area to enable access by the population to the various regions, and associated employment, services, commercial, lifestyle and other opportunities. Rail transport in particular enables efficient movement of large numbers of people across large distances and avoids much of the congestion experienced on roads and the associated negative implications of cars (e.g. noise, fumes, crashes, car parking needs and cost).

The NWRL has the potential to make a significant difference on a regional scale to the sustainability of Sydney. It would do so by attracting transport users from their cars onto a rail service.

The NWRL is also likely to be a catalyst for more sustainable urban development featuring lower resource use, greater social interaction and more use of active transport modes such as walking and cycling that help to promote good health in an area which performs poorly in these regards.

Achieving the Government's strategic transport plan

NSW is actively supporting the strategic planning process as a way to manage sustainable growth. This process supports the continued development of consistent and integrated land use, transport and budgetary planning focused on the city's future over the short, medium and long terms and through programs for improved investment with infrastructure.

The NWRL project supports, and conversely is supported by, various Government policies and strategic plans, such as:

- the ten year plan *NSW 2021: A Plan to Make NSW Number One* (NSW Government, 2011), which specifically includes building the NWRL as a priority action.
- the 20 year Metropolitan Strategy (discussions paper released for public comment in May 2012), which specifically refers to delivering the NWRL as a current focus.
- the 20 year NSW Long Term Transport Master Plan (draft released for public comment in September 2012), which specifically refers to construction of the NWRL as an action to be completed in the short term.

The draft *Long Term Transport Master Plan* is accompanied by *Sydney's Rail Future* (released June 2012), which is a new long term strategy for Sydney's rail network. *Sydney's Rail Future* is a customer focused plan to transform and modernise Sydney's rail network so that it can grow with the population and meet the needs of customers now and into the future.

Sydney's Rail Future includes delivering the NWRL as the first part of a new, modern mass transit train network (referred to as the rapid transit train network). The rapid transit train network would offer a comfortable, frequent, fast and high capacity rail link between suburban regions and busy inner city areas using single deck trains.

22.2 Alternatives

The justification of the project is also based on the absence of feasible alternatives that could address the project need and objectives as effectively and efficiently as the NWRL. Since 1998, evaluation of transport options to serve the North West region and address the region's transport challenges has been on-going. Numerous studies have been completed to assess the feasibility of the NWRL, including assessments of alternative modes, alignment options and various station locations.

Alternatives were considered by the NSW Government against the need to determine which option would best meet the transport, land use, environmental and social objectives and provide the best value for money. Alternative modes considered included road network improvements, bus augmentation/improvements, light rail and a metro style railway.

A staged approach was undertaken to evaluate alternatives, with a preliminary qualitative assessment followed by more detailed quantitative multi criteria analysis incorporating evaluation of cost and patronage. The Concept Plan (now a Staged Infrastructure Approval under Part 5.1 of the EP&A Act) which was approved in May 2008 provides detailed information on the alternatives which were considered since 2002.The project history is summarised in Section 1.2 of this EIS.

Studies have repeatedly demonstrated the need for a mass transit system, with heavy rail identified as the most cost effective option. The studies found that only a heavy rail or metro rail based alternative could potentially satisfy the project objectives, particularly those relating to the need to relieve existing and future road congestion. In 2002 and then again in 2005, heavy rail was shown to be the most economically viable against alternative modes. The choice of rail as the preferred mode was tested and confirmed again in 2011 using updated information and assumptions.

Following the initial announcement of the NWRL project in 1998, assessments on the most appropriate alignment and station locations have been carried out. Many alignment and station alternatives have been considered and assessed (having regard to biophysical, economic and social considerations) using strategic multi criteria assessment processes. The alignment and station locations have been carefully selected in consultation with residents and stakeholders to provide the most appropriate public transport solution. Since April 2010, the NSW Government has been consulting widely with the community, local businesses and industry groups. The consultation feedback has been an important part of defining the project and as a result two extra railway stations (at Bella Vista and Cudgegong Road) and additional commuter car parking spaces have been incorporated into the project.

If the NWRL does not proceed, the consequences for Sydney would be particularly adverse. The NWRL provides the opportunity to continue to untangle Sydney's rail network, introduce new technologies and a new operator.

In the absence of the NWRL, morning peak on-road times between the north west and the CBD would increase substantially. This would have significant negative implications for economic activity, employment and productivity along the Global Economic Corridor, with flow-on effects that are likely to extend across Sydney.

As the population of the north west continues to grow, the absence of a heavy rail spine would restrict the region's capacity to establish liveable centres and manage the pressures of population growth through integrated land use and transport planning. This would have potentially significant implications for quality of life in the north west, including higher levels of transport disadvantage and social isolation.

22.3 Achieving objectives

22.3.1 Project objectives

As discussed earlier in Section 2.6, six key objectives have been identified for the NWRL. The following provides a summary of how the NWRL project would meet these objectives.

The project objectives that have guided the development of the NWRL are:

- ❖ Ensure customer needs are met through provision of a safe, high quality, integrated and affordable transport service.
- ❖ Link existing communities and new growth areas in north west Sydney with jobs and services in the Global Economic Corridor (Macquarie Park –Chatswood – North Sydney – CBD).
- ❖ Deliver stage 3 (Rapid Transit System) of Sydney's Rail Future to improve transport network reliability by facilitating a shift from road to rail for trips to and from the north west, to reduce bus/road congestion and improve amenity in Sydney CBD.
- ❖ Deliver a transport service that has been informed by engagement with communities and stakeholders and demonstrates evidence based decision making.
- ❖ Support the Government's challenge to accommodate population growth in the north west by increasing the potential for a range of housing and employment opportunities.
- ❖ Contribute to environmental, social and economic sustainability by improving liveability, minimising our impact on the environment and the community, and delivering value for money.

OBJECTIVE 1:
Ensure customer needs are met through provision of a safe, high quality, integrated and affordable transport service

- ❖ To meet customer needs the NWRL would provide frequent and reliable rapid transit rail services (every 10 minutes throughout the day and every 5 minutes during peak periods) operating seven days a week from early morning until late evening. The total estimated journey time from Cudgegong Road to Chatswood is expected to be approximately 37 minutes.
- ❖ The NWRL would provide access to affordable public transport, particularly for users without access to private transport, including pensioners and students. NWRL fares would be in line with the wider rail network.
- ❖ The NWRL would be part of an integrated network of bus, rail, cycling and walking options that would together improve access and movement within, to and from the North West Subregion. The stations would be integrated with other modes of transport (bus, bicycle, taxi and car) so the rail line can act as the spine of the transport system and be complemented by a reconfigured, enhanced bus network and expanded cycle and pedestrian links. To ensure the NWRL provides an integrated transport solution:
  - NWRL services would connect directly into and incorporate the ECRL. To facilitate this, the ECRL would be converted to rapid transit train standards. Customers would be able to interchange at Epping Station onto Northern, Central Coast and Newcastle rail line services.
  - Until completion of the second rail harbour crossing and new CBD line, NWRL customers would be able to cross the platform at Chatswood train station to board a train on the existing rail network for travel into the city via the North Shore line. Train timetables would be organised to ensure passengers only need to wait a few minutes to switch from a NWRL train to another train into the city.
  - Bus interchanges or bus transit facilities would be provided at or near the rail stations. The existing bus network in the North West would be reconfigured to complement and support the NWRL.
  - All stations would provide taxi ranks and "kiss and ride" (passenger drop off) facilities.
  - Infrastructure such as cycling facilities (parking and storage), paths and access routes would also be provided to support bicycle and pedestrian traffic at some stations.
  - Park and ride spaces are proposed at Cherrybrook, Showground, Bella Vista, Kellyville and Cudgegong Road stations.

OBJECTIVE 2:
Link existing communities and new growth areas in north west Sydney with jobs and services in the Global Economic Corridor (Macquarie Park –Chatswood – North Sydney – CBD).

- ❖ NWRL services would continue through Epping Station enabling direct rail access to the Global Economic Corridor and the wider metropolitan area.
- ❖ Until completion of the second rail harbour crossing and new CBD line, NWRL customers would be able to interchange at Chatswood station and board a train to St Leonards, North Sydney and the CBD.
- ❖ The eight new rail stations would form the focus of an enhanced bus, pedestrian and cycle network to provide seamless journeys from all areas of the North West, linking with the rest of Sydney, as well as with destinations within the North West.

OBJECTIVE 3:
Deliver stage 3 (Rapid Transit System) of Sydney's Rail Future to improve transport network reliability by facilitating a shift from road to rail for trips to and from the north west, to reduce bus/road congestion and improve amenity in Sydney CBD.

- The NWRL would be part of *Sydney's Rail Future*, which is a long term plan to improve the customer's experience. A central aim of the plan is to transform and modernise Sydney's rail network so that it can grow with the population and meet the needs of customers now and into the future.
- The NWRL would be the first part of Sydney's rapid transit network. The single deck trains (with three wide doors per car) have the advantage of being easier and quicker to board and alight from in comparison to the existing double deck trains, facilitating and supporting more trains per hour on any given rail line.
- The NWRL would provide reliable and frequent services in response to travel demand, and would be linked into other transport modes. The NWRL would provide rail access to approximately 400,000 residents in the North West. Once the NWRL is operational, more than 47,000 people would live within one kilometre walking distance of a station. Transport modelling results indicate that in 2021 around 20 million customer trips would be made on the NWRL.
- Bus congestion in the Sydney CBD would be reduced, as the NWRL would enable almost 86 buses to be removed from the centre of the city in the morning peak alone (in 2021). These buses could be reassigned to the reconfigured bus network to support the NWRL stations.
- The NWRL would improve travel time reliability of journeys compared with travelling by bus and private car.

OBJECTIVE 4:
Deliver a transport service that has been informed by engagement with communities and stakeholders and demonstrates evidence-based decision making.

- As part of the project development process a strategic review was carried out to analyse options which would improve value for money and produce improved project outcomes for the community. For example, the review identified that providing eight stations rather than six would provide additional benefits cost-effectively through extending the reach of the project.
- In 2005 as part of the North West Rail Link Alternatives Study, options to address the transport problems facing the North West were assessed. The options assessment including an economic appraisal (Douglas Economics 2006) concluded that heavy rail would provide a higher cost benefit ratio than light rail or transitway options.
- The delivery model has been subjected to considerable (and ongoing) market sounding to inform the procurement of major construction contracts.
- Extensive community consultation has occurred during the project development phase and has contributed to the design of the project.

OBJECTIVE 5:
Support the Government's challenge to accommodate population growth in the north west by increasing the potential for a range of housing and employment opportunities.

- The NWRL has the potential to act as a catalyst for development (residential and commercial) around the stations and along the corridor. The provision of a rail service integrated with the wider metropolitan area would provide future economic benefits and enhance the appeal of the NWGC for potential residents and commercial ventures. It is projected that the presence of the NWRL would over time encourage more businesses to locate along the corridor, particularly in strategic employment centres of Norwest, Castle Hill, and Rouse Hill.
- The NWRL project has been guided by land use planning and development decisions. Over time, changing patterns of land use can be encouraged by local Councils along the NWRL corridor to ensure that station precincts evolve into vibrant and diverse community assets with a variety of housing choices, well designed public spaces and a range of social and recreational activities.
- By facilitating transport mode changes at rail stations, pedestrian movement through associated areas may change some shopping / retail habits with greater activity in local centres.

OBJECTIVE 6:
Contribute to environmental, social and economic sustainability by improving liveability, minimising our impact on the environment and the community, and delivering value for money.

- The NWRL has the potential to act as a catalyst for development around the stations and along the corridor. This development (business investment and job self-containment) within the region would provide more jobs and services close to residential areas, which may reduce total travel trips and travel times.
- An Environment and Sustainability Policy and a Sustainability Strategy have been developed for the project. The policy provides direction and guidance on the desired environmental and social sustainability outcomes for the project.
- Minimising carbon emissions has been a key aim of the project. A greenhouse gas assessment has been undertaken on the project construction stage to identify the carbon intensive elements of the project's construction and develop mitigation measures which can be implemented to reduce emissions.
- The project would contribute to environmental sustainability by providing a viable alternative mode of non-road based transport. Transport mode shift from road to rail would directly reduce carbon emissions associated with transport in the North West and indirectly reduce carbon emissions associated with congestion.
- The NWRL would enable people to use public rail transport rather than private cars for travel, which could provide long term environmental benefits during the operational period, such as improvement in local urban air quality.
- During the construction and operational stages environmental impacts are anticipated, however, mitigation measures have been developed and would be implemented to avoid, reduce and manage these detrimental impacts. Mitigation measures have been included within the EMF. For example, to reduce noise, the major construction sites would have key activities enclosed in acoustic sheds.

- Using public transport rather than private cars for travel would provide long term social community benefits such as reducing road congestion and enabling productive activities during travel time (e.g. reading, working). There are also community health benefits (e.g. exercise walking to/from station) associated with the use of public transport rather than private vehicles.
- Climate change has been recognised as an important consideration for the NWRL. To enhance the climate change resilience of the project, a detailed climate change risk assessment has been undertaken on the project design and projected climate changes have been incorporated into the project design where applicable (e.g. the sizing of drainage infrastructure).
- To achieve the project objectives and ensure that the project delivery model provides value for money, a risk management system has been developed and is being implemented throughout the project stages. Risk-based techniques have been used to inform key decisions relating to project delivery as well as development of time and cost contingencies.

22.3.2 Environmental Planning and Assessment Act objectives

The objects of the EP&A Act provide a policy framework within which the justification of the project can be considered. **Table 22.1** outlines those objects and provides comment on their relevance to the project.

Table 22.1 Environmental Planning and Assessment Objects

EP&A Act Objects	Comments
Encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment	This EIS identifies impacts and with a focus on managing impacts, proposes mitigation and management measures. The NWRL has been developed with a focus on sustainable development and is supported by a project specific Environmental and Sustainability Policy and Sustainability Strategy.
Encourage the promotion and coordination of the orderly and economic use and development of land.	The integration of the project with surrounding land uses has been addressed through a concurrent master planning process.
Encourage the protection, provision and coordination of communication and utility services.	The project has been designed to minimise impacts on communications and utility services.
Encourage the provision of land for public purposes.	The project would create or improve a number of areas of public land, including station complexes. New pedestrian links would be created as part of the overall project and there is potential to incorporate community facilities within the station precincts.
Encourage the provision and coordination of community services and facilities.	A planning process that has been underway as part of the project development has addressed ways that the stations can provide focus points for community development.
Encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.	The project impacts on terrestrial and aquatic ecology have been assessed in detail and measures to avoid, mitigate and offset potential impacts on native animals and plants have been developed. Further details are provided in Chapter 15 (Ecology).
Encourage ESD.	Sustainability has been a key driver for the project. A Sustainability Strategy has been developed as well as an Environment and Sustainability Policy (see Chapter 4). Section 22.4 below provides details of how the project addresses the principles of ESD.
Encourage the provision and maintenance of affordable housing.	The project does not involve the provision of affordable housing. However, it does provide a public transport link to future growth areas and an affordable transport option for future residents. An objective of the project is to support the NSW Government challenge to accommodate population growth by opening up the North West to a range of housing and employment opportunities.
Promote the sharing of the responsibility for environmental planning between the different levels of government in the state.	The responsibility for environmental planning and approval in relation to the project rests primarily with the NSW Government with additional Federal Government approval requirements relating to the EPBC Act. Consultation has, however, occurred across all levels of government including councils for the three LGAs through which NWRL passes – Hornsby Shire Council, Blacktown City Council and The Hills Shire Council.
Provide increased opportunity for public involvement and participation in environmental planning and assessment.	The project development process has involved extensive consultation with the community and stakeholders. An objective of the project is to deliver a transport service that has been informed by engagement with communities and stakeholders.

22.4 Ecologically Sustainable Development

Ecologically Sustainable Development (ESD) is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The principles of ESD have been an integral consideration throughout the development of the project and a series of sustainability targets have been developed for the project, supported by sustainability design workshops and a sustainability register.

The EP&A Act recognises that ESD requires the effective integration of economic and environmental considerations into decision making processes. There are four main principles supporting the achievement of ESD:

- Precautionary principle.
- Intergenerational equity.
- Conservation of biological diversity and ecological integrity.
- Improved valuation and pricing of environmental resources.

These are discussed in the following sections.

22.4.1 Precautionary principle

The precautionary principle: If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

- Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment.
- An assessment of the risk-weighted consequence of various options.

Project Application

The lack of full scientific certainty has not been used as a reason for postponing measures to prevent environmental degradation. As detailed in each impact assessment chapter, mitigation measures have been proposed to manage identified risks/threats of environmental damage. For example targeted threatened species which were not found during the field surveys have, in line with the precautionary principle, been assumed to be present in the study area.

This EIS documents the careful evaluation of environmental impacts associated with the project and has been undertaken using the best available technical information and adoption of best practice environmental standards, goals and measures to minimise environmental risks. The impact assessments have been undertaken in collaboration with key stakeholders and relevant statutory and agency requirements.

22.4.2 Intergenerational equity

Inter-generational equity: The present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

Project Application:

One of the key objectives of the project is to improve the transport network efficiency by facilitating a transport mode shift from road to rail. The project would provide an important transport alternative for the benefit of current and future generations. Minimising greenhouse gas emissions to limit and avoid irreversible climate change is a critical intergenerational equity issue.

The project would provide an alternative transport mode for the existing and future residents in the area. Private car use currently represents approximately 35% of average household greenhouse gas emissions in Australia (Australian Government, 2011, *Securing a clean energy future The Australian Government's Climate Change Plan*). The Federal Government has acknowledged that climate change poses significant environmental and economic threats and in committing to reducing emissions has set the following targets:

- 5% emission reduction from 2000 levels by 2020, irrespective of commitments made by other countries.
- 15% or 25% emission reduction from 2000 levels by 2020, if commitments are made by other countries.
- 80% emission reduction from 2000 levels by 2050.

Significant changes to carbon and energy policy (and legislation) are currently occurring in Australia which aim to shift electricity generation from coal fired to renewable sources. As more electricity is generated from renewable sources, the climate change mitigation benefits of electric rail would be improved.

A detailed GHG assessment has been undertaken for the construction and operational stages of the project. The assessment results show that the construction elements of the *Stations, Rail Infrastructure and Systems* stage of the project would generate greenhouse gas emissions equivalent to 0.45% of NSW's annual state emissions in 2010. The annual operational greenhouse gas emissions (e.g. electricity used to power trains and stations) would be equivalent to 0.04% of NSW's annual state emissions in 2010. A range of measures to mitigate GHG emissions have been developed and would be implemented, such as integrating renewable energy into station buildings and offsetting a portion of annual operational emissions (refer to Chapter 17 for further details).

The construction and operation of such an extensive rail infrastructure project would involve activities that have the potential to degrade the health, diversity and productivity of the environment. The proposed impact mitigation and management measures significantly decrease the potential for any long-term environmental impacts.

Conservation of biological diversity and ecological integrity

Conservation of biological diversity and ecological integrity: Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Project Application:

One of the key objectives of the project is to *contribute to environmental… sustainability by... minimising impacts our impact on the environment* (objective 6). The Sustainability Strategy also includes a biodiversity specific objective: *to achieve a net improvement in ecological value at the project site.* Conservation of biological diversity and ecological integrity has been considered throughout the project planning and design stages and where practical the project construction footprint has been set to avoid impact to areas of high ecological value. Detailed assessments carried out to identify flora and fauna impacts and impacts on riparian and in-stream ecology have identified a range of mitigation measures which would be implemented.

Improved valuation and pricing of environmental resources

Improved valuation and pricing of environmental resources: Environmental factors should be included in the valuation of assets and services. Such as;

- Polluter pays (i.e. those who generate pollution and waste should bear the cost of containment, avoidance, or abatement)
- The users of goods and services should pay prices based on the full life cycle of costs of providing the goods;
- Environmental goals, having been established, should be pursued in the most cost effective ways.

Project Application:

Economic appraisal of the project draws on a number of established methodologies which provide for the valuation of externalities, including environmental externalities, and their inclusion in the appraisal process. Environmental parameters which can be valued include air pollution, GHG emissions, noise pollution, water run-off, nature and landscape and urban separation. Valuations typically adopt broad average values.

The value placed on the environment is evident in the development of project design features and also in the extent of environmental investigations. In addition the costs associated with the planning and design of measures to avoid/minimise adverse environmental impacts and the costs to implement them have been

built into the overall project costs. For example, the project would involve the acquisition of biodiversity off-sets to mitigate impacts on protected areas and these costs have been factored into the overall project costs.

Ongoing and detailed design of the project together with specific issue-based management plans would represent further commitment to the recognition of the value of protecting environmental resources.

22.5 Conclusions

The NWRL would be the first part of *Sydney's Rail Future*, a customer focused public transport plan to modernise Sydney's rail network and trains. The NWRL has been identified as a key priority railway transport infrastructure project which would provide a significant expansion to Sydney's rail network in an area of future population and jobs growth.

The project would be the first part of a new, modern high frequency rail network. The rapid transit trains would run every 10 minutes across the day and every 5 minutes during peak periods. The project would provide access to reliable non-road based public transport and be integrated with existing rail and bus networks.

In addition the project would provide commuter car parking spaces at dedicated park and ride facilities at the proposed Cherrybrook, Showground, Bella Vista, Kellyville and Cudgegong Road stations. The NWRL would reduce the need to use private cars for travel, in particular along congested road routes into North Sydney and the Sydney CBD.

As well as its transport function the NWRL would be a catalyst for increased urban development activity, particularly in proximity to the stations.

Overall, the NWRL would provide the following benefits:

- Be the first part of Sydney's rapid transit train network, a new and modern high frequency rail network. The rapid transit train network would offer a comfortable, frequent, fast and high capacity rail link between suburban regions and busy inner city areas using single deck trains.
- Rail access for approximately 400,000 residents in the North West to Epping, Macquarie Park, Chatswood, St Leonards, North Sydney and the CBD.
- Delivering new rapid transit rail services to existing suburbs in the Hills District as well as future areas of growth planned for the North West.
- Improve travel time reliability compared with bus and private car.
- Result in significant travel time savings for travel from many areas of the North West area to the Sydney CBD and Macquarie Park.
- Reduce bus congestion in the Sydney CBD in the long term.
- Increase public transport services to the Macquarie University and Macquarie Park area.
- A more sustainable public transport and decreased GHG emissions.

Extensive consultation has occurred over the last ten years on the provision of a rail link to the North West. The first significant consultation activities occurred in 2002 and from April 2010 consultation recommenced with the community, local business and industry groups. Consultation is planned to be ongoing throughout the exhibition of the EIS to ensure that the community and interested parties are able to make informed responses to the EIS.

22.6 Next Steps

The NWRL project has been declared to be State Significant Infrastructure under Part 5.1 of the EP&A Act. This EIS will be assessed and determined by the Minister for Planning and Infrastructure under Part 5.1 of the EP&A Act.

This EIS will be publicly exhibited for a period of at least 30 days. During this period, any person (including a public authority) will be able to make a written submission to the Director-General of the DP&I concerning the matter. The submissions received will be documented and considered by TfNSW as part of a Submissions Report. Further detail on this process can be found in Chapter 3 and on the DP&I website (www.planning.nsw.gov.au).

GLOSSARY AND REFERENCES

GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Definition
AADT	Average Annual Daily Traffic
ABS	Australian Bureau of Statistics
AEC	Area of environmental concern
AHD	Australian Height Datum
AHMP	Aboriginal Heritage Management Plan
AHIMS	Aboriginal Heritage Information Management System
Airborne noise	Airborne noise is the most common form of noise experienced by people. Airborne noise results from noise propagating between the source and the receiver, primarily through the air.
Aquifer	A geological formation that is made up of porous materials such as sand and gravel that allows the storage and transmission of significant volumes of water.
ARI	Average recurrence interval
AS	Australian Standard
ASS	Acid Sulfate Soil
ATP	Automatic Train Protection
ATR	Automatic Train Regulation
BCR	Benefit/cost ratio
BOM	Bureau of Meteorology
BTEX	Benzene, toluene, ethylbenzene and xylene
Bulk power	Electrical supply points from Distribution Network Service Provider(s) to provide electrical energy.
$CaCO^3$	Calcium Carbonate
CBD	Central business district
CCTV	Closed Circuit Television
CEEC	Critically endangered ecological community
CEMF	Construction Environmental Management Framework
CEMP	Construction Environmental Management Plan A document setting out the management, control and monitoring measures to be implemented during construction of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
CLM Act	Contaminated Land Management Act 1997
CMP	Conservation Management Plan
CNVIS	Construction Noise and Vibration Impact Statement
CNVS	Construction Noise and Vibration Strategy
CO	Carbon monoxide
CoA	Condition of Approval
Construction site	Land required for construction activities associated with the project (including storage, amenities, site offices, etc), and may be required for the construction and commissioning phases.
COPC	Contaminants of potential concern
Crossover	Points and track enabling a train to switch from one track to another, made up of two connected turnouts.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CPTED	Crime Prevention Through Environmental Design
CTMP	Construction Traffic Management Plan
dBA	Decibel
DC	Direct Current
DCP	Development Control Plan
DEWHA	The former Commonwealth Department of Environment, Water, Heritage and the Arts (now known as Department of Sustainability, Environment, Water, Population and Communities)
Director-General's Requirements (DGRs)	Requirements for an environmental assessment issued by the Director-General of the Department of Planning in accordance with the *Environmental Planning & Assessment Act 1979.*
DoS	Degree of Saturation

Term	Definition
Down	Railway direction for a train travelling away from Central Station
DPI	Department of Primary Industries
DP&I	Department of Planning and Infrastructure
DTIRIS	NSW Department of Trade and Investment, Regional Infrastructure and Service
EC	Electrical Conductivity
ECRL	Epping to Chatswood Rail Link
ECRTN	Environmental Criteria for Road Traffic Noise
EEC	Endangered ecological communities
EIS	Environmental Impact Statement
EIS 1	EIS for Stage 1: Major Civil Construction Works
EIS 2	EIS for Stage 2: Stations, Rail Infrastructure and Systems
ENMM	Environmental Noise Management Manual
EPA	Environment Protection Authority
Environmental assessment	Generic term for describing the undertaking of an assessment of environmental impacts
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPI	Environmental planning instrument
EPL	Environment Protection Licence
ESD	Ecologically Sustainable Development. Using, conserving and enhancing the community's resources so that the ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased.
FSR	Floor Space Ratio
FTE	Full Time Equivalent
GDEs	Groundwater dependent ecosystems
GDR	Geotechnical Data Report
GIR	Geotechnical Interpretive Report
Geotechnical	Of or related to the soil and bedrock.
Global Economic Corridor	Macquarie Park – Chatswood – North Sydney – CBD

Term	Definition
Greenhouse gas (GHG)	A gas that absorbs and emits reflected infrared radiation (heat) from the Earth's surface.
Ground-borne noise	Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces.
Ground-borne vibration	Generated by wheel/rail interaction and is transmitted from the trackbed, through the tunnel structure, via the ground and into the adjacent building structures.
Groundwater	Water located under the earth's surface in underground streams and aquifers.
Heavy rail	The structures and vehicles of railways not falling under the description of trams, light rail, medium capacity system, or rapid transit.
Hills M2	The Hills Motorway Limited, the company responsible for the operation and maintenance of the M2 Motorway. Hills M2 is a wholly owned subsidiary of Transurban Limited.
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
IPCC	Intergovernmental Panel on Climate Change
In situ	In the ground, undisturbed.
IPCC	Intergovernmental Panel on Climate Change
Kiss and Ride	A passenger drop off area near a public transport stop
L_{Aeq}	The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.
L_{A1}	The noise level exceeded for 1 per cent of the 15 minute interval.
L_{Amax}	The maximum A-weighted noise level.
LALC	Local Aboriginal Land Council
Laydown area	An area that has been designated for the temporary storage of equipment and supplies.
LEP	Local environmental plan
LGA	Local government area
LINSIG	A form of analysis which provides an estimate of intersection performance
LoS	Level of Service
L/s/km	Litres per second per kilometre

Term	Definition
µ	micro
M2 Motorway	M2 Motorway, which extends from the M7 Motorway/Abbott Road to the Lane Cove Tunnel including carriageways, ramps and associated structures and infrastructure
ML	Megalitre
NES matters	matters of National Environmental Significance
NO_2	Nitrogen dioxide
NOW	New South Wales Office of Water
NML	Noise management level
NSW State Plan 2021	NSW 2021: A Plan to Make NSW Number One (NSW Government, 2011)
NWGC	North West Growth Centre
NWRL	North West Rail Link
OCP	Organochlorine pesticide
OEH	Office of Environment and Heritage
OEMP	Operational Environmental Management Plan A document setting out the management, control and monitoring measures to be implemented during operations to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
PA	Public Address
PAD	Potential archaeological deposit
PAH	Polycyclic aromatic hydrocarbons
Park and Ride	A car park provided near public transport for use by commuters
PASS	Potential Acid Sulfate Soil
PCB	Polychlorinated biphenyl
PM_{10}	Particles less than or equal to 10 micrometres or microns in diameter
PMF	Probable Maximum Flood
POEO Act	Protection of the Environment Operations Act 1996
Place Managers	Representatives of the project team appointed to liaise with residents, businesses and community organisations.

Term	Definition
Precautionary principle	Where there is a threat of serious or irreversible environmental damage, the absence of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation.
Precinct	Stations and land in vicinity of the stations, including station design and amenity, integrated transport facilities, pedestrian links and access facilities, traffic and parking, public domain amenities and improvements, retail and commercial development associated with rail, other development, and other matters ancillary to the operation of rail/ associated transport.
Q	Quarter of a year (For example Q1 = January to March)
Rail Possession	Closure of the rail line to allow works to be safely undertaken on or adjacent to the existing infrastructure.
RAPs	Registered Aboriginal Parties
RBL	Rating Background Level
Regenerated noise	Where energy is converted to noise away from the primary source.
RHTC	Rouse Hill Town Centre
ROL	Road Occupancy Licence
RL	Reduced level
RNP	NSW Road Noise Policy
RMS	Roads and Maritime Services
Running tunnels	The portion of tunnel that would house the operational alignment. Other tunnel types include tunnels for crossovers and turnbacks, cross passages and connections to maintenance facilities.
SEPP	State Environmental Planning Policy
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
Shaft	Vertical or inclined access to the surface
SAC	Stone Artefact Concentration
SLR	Strategies and Land Release (of DP&I)
SO_2	Sulfur dioxide
SOC	Statement of Commitment
Spoil	Material produced by tunnelling, caverns and station excavation activities.
SRB	Sulphate Reducing Bacteria

Term	Definition
SRD SEPP	State Environmental Planning Policy (State and Regional Development) 2011
SSI	State Significant Infrastructure
Stabling Facility	A facility for the stabling of trains
Station planning	Process to ensure the long-term integration and compatibility of land use surrounding each of the stations.
Stub tunnels	A short section of tunnel which links to a main tunnel.
Substation	A facility that controls the flow of electricity by switching, changing, or regulating electric voltage.
TCA	NSW Transport Construction Authority
t CO_{2-e}	tonnes of carbon dioxide-equivalent
TCA	Transport Construction Authority (now Transport Projects Division of TfNSW)
TCP	Traffic control plan
TDS	Total dissolved solids
TfNSW	Transport for New South Wales
TIDC	Transport Infrastructure Development Corporation (now Transport Projects Division of TfNSW)
TMC	Transport Management Centre
TMP	Traffic management plan
TOD	Transit Oriented Development
TOM	Traffic Operations Manager
TPD	Transport Projects Division (of TfNSW) (Formerly Transport Construction Authority and Formerly Transport Infrastructure Development Corporation)
TPH	Total Petroleum Hydrocarbon
TSC Act	Threatened Species Conservation Act 1995
TSP	Total suspended particles
T-way	North West Transitway
Up	Railway direction for a train travelling toward Central Station
V	Volts
VMS	Variable Message Sign
VOC	Volatile Organic Compound
VPD	Vehicles Per Day
WRAPP Guidelines	NSW Government's Waste Reduction and Purchasing Policy Guidelines

REFERENCES

AECOM (2011). *NWRL Preliminary Geotechnical Interpretive Report.* 9 Dec 2011

AECOM (2011). *NWRL Draft Ground Movement Report.* 16 Dec 2011

AECOM (2011). *NWRL Draft Tunnel Waterproofing Options Report.* Nov 2011

AECOM (2011). *NWRL Draft Groundwater Inflow Management Strategy Report.*6 Dec 2011

AECOM (2011). *Preliminary Constructability Report.* 13 Oct 2011

AECOM (2012). *Existing Building and Structures Report.* 10 Feb 2012

AECOM (2011). *M2 Upgrade Environmental Assessment*

ALS Laboratory Group (2010) *Lady Game Drive Water Treatment Plant Discharge Quality Requirements for Transport Infrastructure Development Corporation.* Final Report June 2010

Australian Academy of Technological Sciences and Engineering. 2011. *New Power Cost Comparisons Levelised Cost of Electricity for a Range of New Power Generating Technologies.* ATSE. Melbourne, Victoria.

Australian Bureau of Statistics (ABS) (2006). *2006 Census of Population and Housing.*

ABS (2006). *Australian and New Zealand Standard Industrial Classification (ANZSIC)*

ABS (2009). C*ounts of Australian Businesses, including Entries and Exits, June 2007 - June 2009*, Cat no. 8165.0

ABS (2011). *Regional Population Growth, Australia*, Cat No. 3218.0

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. (2000). *Australian and New Zealand Guidelines for Water Quality Monitoring and Reporting*

Australian Government (2011). *Securing a clean energy future: the Australian Government's Climate Change Plan.*

Blacktown City Council (2006). *Blacktown Development Control Plan 2006.*

Blacktown City Council (2008). *Water Quality and Quantity Monitoring Program 2008 – 2012*

Boscardin M.D. And Cording E.J (1989). B*uilding Response to Excavation-Induced Settlement*, Journal of Geotechnical Engineering, ASCE.

Boyd and Bodhinayake (2006). *WBNM Runoff Routing Parameters for South and Eastern Australia. Australian Journal of Water Resources*, Vol 10 Issue 1.

Bureau of Meteorology (BOM) 2003). *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method.*

BOM (2008) *www.bom.gov.au*, Bureau of Meteorology, Commonwealth of Australia

Burland J.B., Broms J.B. and de Mello VFB (1977). Behaviour of Foundations and structures, *SOA Review Session 2, Proceedings of 9th International Conference*, SMFE, Tokyo.

Casey and Lowe (2006). *Heritage Review: North West Rail Link – Epping to Rouse Hill*, prepared for GHD Pty Ltd on behalf of Transport for Infrastructure Development Corporation, October 2006.

Clive Lucas, Stapleton and Partners (2005). W*indsor Road and Old Windsor Road Conservation Management Plan.* Prepared for NSW Roads and Traffic Authority.

Coffey Geotechnics (2009). *North West Metro Contract 136, Preliminary Contamination Assessment Report 27.*

Coffey Geotechnics (2012). *NWRL Geotechnical Services Monthly Groundwater Report No.1.*

CSIRO (2011). *Climate Change: Science and Solutions for Australia,* CSIRO Publishing, Australia

CSIRO and Bureau of Meteorology (2012). *State of the Climate 2012 Report*

Council of Australian Governments (COAG), (2011). *Our Cities, Our Future – A National Urban Policy for a Productive, Sustainable and Liveable Future.*

Department of Environment and Conservation (DEC) (2005). *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales.*

DEC (2005). *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation*

DEC (2006). *Assessing Vibration – a technical guideline*

DEC and Department of Primary Industries (2005). *Draft Guidelines for Threatened Species Assessment*

Deloitte Access Economics (prepared for the Australasian Railway Association) (2011). *The True Value of Rail* (available at: http://ara.net.au/UserFiles/file/Publications/TVOR_Report.pdf Date accessed: 02022012)

Department of Climate Change, October (2005). *The National Carbon Accounting Toolbox* (NCAT).

Department of Climate Change and Energy Efficiency (DCCEE), *March Quarter 2012, Quarterly Update of Australia's National Greenhouse Gas Inventory.*

DCCEE, CFI Reforestation Tools (available at: http://ncat.climatechange.gov.au/cfirefor/ Date accessed: 02022012)

DCCEE, October (2011). *Estimating the Cost of Abatement Framework and Practical Guidance.* Commonwealth of Australia.

DCCEE (2012). *National Greenhouse Accounts (NGA) Factor*s. Commonwealth of Australia.

DCCEE (April 2012). *Australia's National Greenhouse Gas Accounts: State and Territory Greenhouse Gas Inventories, 2009-10*

Department of the Environment (2010). *Survey Guidelines for Australia's Threatened Frogs*. Water, Heritage and the Arts - Australian Government.

Department of Environment, Climate Change & Water (DECCW) (2010). *Aboriginal cultural heritage consultation requirements for proponents*.

Department of Environment and Conservation (DEC) (2004). *Threatened Biodiversity Survey and Assessment Guidelines (working draft)*

Department of Environment and Climate Change (DECC)(2007). *Practical Consideration of Climate Change – Floodplain Risk Management Guideline*.

Department of Environment and Climate Change (DECC) (2007). *Interim Guideline for Assessment of Noise from Rail Infrastructure Projects (IGANRIP)*

DECC (2008). *NSW Waste Classification Guidelines Part 1: Classifying Waste*. Department of Environment and Climate Change NSW, Sydney.

DECC (2008). *NSW Government Sustainability Policy,*

Department of Environment and Climate Change (DECC) (2008). *BioBanking Operational Manual*

DECC (2009). *Interim Construction Noise Guideline*

Department of Environment Climate Change and Water (DECCW) (2009a). *Interim Construction Noise Guideline*

DECCW (2009b). T*hreatened species, populations and ecological communities of NSW. Threatened Species Website. NSW Department of Environment and Climate Change.* Available from:http://www.threatenedspecies.environment.nsw.gov.au/index.aspx NSW Department of Environment and Climate Change

DECCW (2011). *NSW Road Noise Policy*.

Department of Infrastructure, Planning and Natural Resources (DIPNR) (2002). *Guidelines to Accompany Map of Salinity Potential in Western Sydney*.

DIPNR (2004). *Riparian Corridor Management Study*.

Department of Land and Water Conservation (1998). *Guidelines to the Use of Acid Sulfate Soil Risk Maps*

Department of Land and Water Conservation / Australian Water Technologies (2001). *Surface Water Quality Assessment of the Hawkesbury-Nepean Catchment 1995-1999 Data Information Report*

Department of Land and Water Conservation (2001). *Geomorphic Categorisation of Streams in the Hawkesbury Nepean Catchment*

Department of Planning (DoP) (2005). *Sydney Metropolitan Strategy, titled City of Cities: A Plan for Sydney's Future*

DoP (2007c). *North West Subregional Strategy*

Department of Planning, North West Rail Link Concept Plan Approval. 6 May 2008.

Department of Planning (2008). *Development Near Rail Corridors and Busy Roads - Interim Guideline*

DOP (2010). *Blacktown City Council Growth Centres Precincts – Development Control Plan 2010. V15/11/2010.*

Department of Trade and Investment, Regional Infrastructure and Service (DTIRIS), *Resources and Energy – Geoscience Information Services*. DTIRIS, TAS Map http://www.dpi.nsw.gov.au/minerals/titles/online-services/tasmap accessed 07 Feb 2012. DTIRIS, MinView http://www.dpi.nsw.gov.au/minerals/geological/online-services/minview accessed 09 February 2012

Environment Protection Authority (EPA) (1997). *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*

EPA (1999). *Environmental Criteria for Road Traffic Noise*

EPA (2000). *Industrial Noise Policy*

Fairfull and Witheridge (2003a). *Guidelines for Design of Fish and Fauna Friendly Waterway Crossings*

Fairfull and Witheridge (2003b). *Fish Passage Requirements for Waterway Crossings*

GHD Pty Ltd (2006) North West Rail Link Environmental Assessment and Concept Plan prepared for Transport Infrastructure Development Corporation. November 2006.

GHD Pty Ltd (2006). *North West Rail Link Preferred Project Report,* prepared for Transport Infrastructure Development Corporation.

GHD Pty Ltd (2010). *Report for Schofields Road Concept Design Creek Crossing Preliminary Design Report.*

GHD Pty Ltd (2010). *Report for Riverstone and Alex Avenue Precincts Post Exhibition Flooding and Water Cycle Management (incl. Climate Change Impact on Flooding)*. Prepared for Department of Planning. May 2010.

Golder Associates (2007). *North West Rail Link, Epping to Rouse Hill Stabling, Contract 111 Technical Advisor Preliminary Site Investigation and Geological Advice, Contamination Desktop*

Golder Associates (2008). *North West Rail Link, Epping to Rouse Hill Stabling, Contract 111 Technical Advisor, Preliminary Site Investigation and Geological Advice, Preliminary Contamination Assessment and Contingency Management Plan*

Greening Australia, (2010). *Investment in Natural Infrastructure to Offset the Environmental Impact of Future Development of Built Infrastructure* (available at: http://www.infrastructureaustralia.gov.au/publications/files/Infrastructure_Australia_Consultancy_Report_Greening_Australia_Final.pdf Date accessed: 02022012)

Hornsby Shire Council (2009). *Water Quality Monitoring Program – 2008-2009* Annual Report Water Catchments Team

Hornsby Shire Council (2010). *Water Quality Monitoring Program – 2009-2010* Annual Report Water Catchments Team

Infrastructure Australia (2010). *Reform and Investment Framework Templates for use by proponents.*

Infrastructure NSW (2012), *Draft Infrastructure Strategy*

Institution of Engineers, Australia (1987). *Australian Rainfall and Runoff*.

Institution of Engineers Australia (2000) *Australian Rainfall and Runoff*

Institution of Engineers Australia (2005) *Australian Runoff Quality*

Institution of Lighting Engineers (UK) (2005). *Guidance for the reduction of obtrusive light*

Intergovernmental Panel on Climate Change (IPCC) (2006). *Guidelines for National Greenhouse* Gas Inventories

IPCC (2007). *Fourth Assessment Report: Climate Change 2007* (AR4)

IPCC (2007). *Special Report on Emissions Scenarios* (SRES).

International Organisation for Standardisation (ISO) 1*4064-2:2006 Greenhouse gases – Part 2: Specification with guidance at the project level for quantification and reporting of greenhouse gas emission reductions and removal enhancements*.

Jo McDonald CHM Pty Ltd (2006). *Archaeological Assessment of Indigenous Heritage for the North West Rail Link*. Consultancy report prepared for GHD.

JWP (2010). *Area 20 Precinct, Rouse Hill. Water Cycle Management Strategy Report Incorporating Water Sensitive Urban Design Techniques*. Prepared for Department of Planning.

LFA (Pacific) Pty Ltd (2011). *Area 20 Precinct Land Use and Rail Integration Study*. August 2011.

Landcom (2004 and 2006). *Managing Urban Stormwater – Soils and Construction* Volumes 1 and 2

Maunsell (2005a). *North West Transitway Section 5: Drainage Southern End Final Design* Revision 03

Maunsell (2005b). *North West Transitway Section 5: Drainage Northern End Final Design* Revision 03, Maunsell Australia.

Milford, R.L, Allwood, J.M. (2010). *Assessing the CO2 impact of current and future rail track in the UK*. Transportation Research (Part D) 15, 61-72.

NSW Heritage Council. (2002). *NSW Heritage Manual - Assessing Heritage Significance*

NSW Government (2005). *Floodplain Development Manual.*

NSW Government (2011). *NSW 2021: A Plan to Make NSW Number One (NSW State Plan 2021)*

NSW Government (2011a). *NWRL Project Definition Report*, Transport for NSW Submission to Infrastructure Australia.

NSW Office of Water (2011). *Controlled Activities – Guidelines for Riparian Corridors NSW*

NSW Office of Water (2010). *Controlled Activities – Guidelines for Watercourse Crossings*

NSW Office of Water (2010). *Controlled Activities – Guidelines for Instream Works*

NSW Office of Water (2011). *Controlled Activities – Guidelines for Laying Pipes and Cables in Watercourses*

NSW Office of Water (2010). *Controlled Activities – Guidelines for Outlet Structures*

NSW Water Resources Council (1993). *NSW State Rivers and Estuaries Policy*

Office of Environment and Heritage (2011). *Air*. http://www.environment.nsw.gov.au/air/index.htm. Accessed November 2011.

Patterson Britton (2005). *Kellyville Ridge Dam Second Ponds Creek Schofields Road – Dam Hazard Assessment*. Prepared for Landcom.

Roads and Traffic Authority (RTA) (2001). *Environmental Noise Management Manual*

RTA (2002). *Guide to Traffic Generating Development*

Sinclair Knight Merz (2009). *Rouse Hill Integrated Stormwater Strategy Review – Hydrology, Hydraulics and Water Quality Review*

Transport Authorities Greenhouse Group (2011). *Greenhouse Gas Assessment Workbook for Road Projects*.

Transport Construction Authority (2010). *Greenhouse Gas Inventory Guide for Construction Projects*.

Transport Infrastructure Development Corporation (2008) *North West Rail Link Supplementary Submissions Report*

Transport for NSW (2011). *North West Rail Link Project Overview*. July 2011.

Transport for NSW (2011). *Project Overview Issues Report*. November 2011.

Transport for NSW (2012),.*The Sydney's Rail Future: Modernising Sydney's Trains*. June 2012 (now part of the Draft NSW Long Term Transport Master Plan)

Transport for NSW (2012). *Draft NSW Long Term Transport Master Plan*, September 2012.

World Commission on Environment and Development (1987). *Our Common Future*, commonly referred to as the Brundtland Report

World Resources Institute and World Business Council for Sustainable Development (WRI &WBCSD) (2004). *The Greenhouse Gas Protocol A Corporate Accounting and Reporting Standard*, Revised Edition.

WRI &WBCSD (2005). *The Greenhouse Gas Protocol for Project Accounting.*

WRI &WBCSD (2006). *The Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting.*

WRI &WBCSD (2009). *Scope 3 Accounting and Reporting Standard, Supplement to the GHG Protocol Corporate Accounting and Reporting Standard* (currently a DRAFT document, to be finalised).

WRI&WBCSD, (2011). *The Greenhouse Gas Protocol: Corporate Value Chain (Scope 3) Accounting and Reporting Standard.*

APPENDIX A

Director General's Requirements, Conditions of Approval and Statement of Commitments

Office of the Director General

Mr Rodd Staples
Project Director- North West Rail Link
Transport for NSW
PO Box K659
Haymarket NSW 1240

12/02423

Attn: Mr Brendon Baker

Dear Mr Staples

North West Rail Link
Staged State Significant Infrastructure Modification (MP 06_0157)
State Significant Infrastructure Application – Major Civil Construction Works (SSI-5100)

I refer to your recent request regarding environmental assessment requirements for both the proposed modification to the Staged State Significant Infrastructure (SSI) approval and the SSI application for the North West Rail Link – Major Civil Construction Works stage.

As you are aware, the existing Staged SSI project provides both in principle approval for a broad rail corridor in North West Sydney and sets environmentral assessment requirements for future construction and operational applications. Within this context the Department has reviewed the request for both applications in consultation with relevant government authorities and taking into account existing environmental assessment requirements and the statement of commitments.

The Department advises that a number of additional requirements are recommended given amendments to the project and to ensure both statutory compliance and a contemporary assessment. These supplementary requirements should be read in conjunction with the existing environmental assessment requirements of the staged SSI approval and associated statement of commitments.

A copy of the supplementary requirements for the modification request is attached (Attachment 1). These primarily relate to the justification of the modification and additional impacts associated with the proposed changes.

A copy of the supplementary requirements for the Major Civil Construction Works is attached (Attachment 2). I have also attached a copy of the government authorities' comments for your information and consideration (Attachment 3).

The Department understands that the modification and Major Civil Construction Works assessments are likely to be submitted as a single Environmental Impact Statement (EIS). Prior to exhibiting the EIS, the Department will review the document to determine if it addresses the attached environmental assessment requirements. The Department may consult with other relevant government authorities in making this decision. Please consult with the Department to determine the number of copies of the EIS required to assist this review.

Bridge St Office 23-33 Bridge St Sydney NSW 2000 GPO Box 39 Sydney NSW 2001 DX 22 Sydney
Telephone: (02) 9228 6111 Facsimile: (02) 9228 6191 Website planning.nsw.gov.au

If your proposal is likely to have a significant impact on matters of National Environmental Significance, it will require an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This approval would be in addition to any approvals required under NSW legislation and it is your responsibility to contact the Department of Sustainability, Environment, Water, Population and Communities to determine if an approval under the EPBC Act is required for your proposal (http://www.environment.gov.au or 6274 1111).

Your contact officer for this proposal, Ms Diane Sarkies, can be contacted on 9228 6370 or via email at diane.sarkies@planning.nsw.gov.au. Please mark all correspondence regarding the proposal to the attention of the contact officer.

Yours sincerely

SHaddad

Sam Haddad
Director General

3/2/2012.

Attachment 1
Staged State Significant Infrastructure Approval (MP 06_0157) Modification
Supplementary Environmental Assessment Requirements

Director General's Environmental Assessment Requirements

Section 115ZI of the *Environmental Planning and Assessment Act 1979*

Application Number	Staged State Significant Infrastructure (SSI) Modification (MP 06_0157)
Project	North West Rail Link
Modification Proposal	Modification to the North West Rail Link Staged SSI approval (MP06_0157), including changes to the project definition to a heavy rail line, project staging, alignment (vertical and horizontal), stabling facility, and altered and additional station locations.
Location	Generally between Epping and Rouse Hill.
Proponent	Transport for NSW
Date of Issue	February 2012
Modification Requirements	The modification assessment shall provide details of the proposed changes to the staged SSI approval, including its change to a heavy rail line, and describe the strategic context of the project in relation to relevant State and regional strategies. The modification shall also address the following matters: • consideration of any changed or additional impacts as a result of the proposed modifications to the Staged SSI approval, including those that are related to the proposed Construction and Operation of Stations, Rail Infrastructure and Systems stage, at a conceptual level; • consideration of the Area 20 Precinct proposed land uses, infrastructure and strategies, taking into account *Development in special area – Cudgegong Station Area* (Appendix 6 - Area 20 Precinct Plan); and • a discussion of potential extensions of the project beyond Cudgegong Road.
Consultation	The modification assessment shall document consultation undertaken with relevant government agencies and the community in its preparation, with a focus on the proposed changes, and how matters raised during consultation have been considered.

Attachment 2
State Significant Infrastructure Application - Major Civil Construction Works
Supplementary Environmental Assessment Requirements

Director General's Environmental Assessment Requirements
Section 115Y of the *Environmental Planning and Assessment Act 1979*

Application Number	SSI- 5100
Proposal	North West Rail Link - Major Civil Construction Works. Construction activities for the North West Rail Link, such as site establishment, enabling works, cut and cover construction activities, service facilities, tunnels, spoil management and disposal, worksite deliveries, bulk earthworks and construction of cuttings, embankments and viaducts.
Location	Generally between Epping and Rouse Hill.
Proponent	Transport for NSW
Date of Issue	February 2012
General Requirements	The Environmental Impact Statement (EIS) shall be prepared in accordance with, and meet the requirements of Part 3 of Schedule 2 of *the Environmental Planning and Assessment Regulation 2000*.
Staged SSI Approval Requirements	The EIS shall include an assessment of the project generally in accordance with the Staged SSI approval (MP 06_157), as modified, and in particular, Section 3 Project Applications and Specific Requirements, and Statement of Commitments.
Supplementary Requirements	In addition to the above matters, the EIS shall also have consideration of the following supplementary matters, including associated management and mitigation measures (as relevant): **State Significant Infrastructure Application Report** Further assessment identified in the Report (*North West Rail Link - Stage 1Major Civil Construction Works*). **Project Design** Interaction with future land use plans in relation to under ground components of the project, in consultation with relevant Councils, including the Epping Town Centre Study. As part of the ancillary infrastructure components assessment, matters relating to safety and emergency access, and associated impacts. **Growth Centres Biodiversity Certification** Consideration of biodiversity measures outlined in the Growth Centres Biodiversity Certification Order. Where necessary, clearing of existing native vegetation within non-certified areas of Growth Centres should be offset in accordance with the relevant biodiversity measures in the Biodiversity Certification Order. **Indigenous Heritage** Detail consultation undertaken with Aboriginal stakeholders and describe how their views and values have been considered. The assessment shall demonstrate that an appropriate archaeological assessment methodology, including research design, (where relevant) has been undertaken, including results. Archaeological investigation works shall be done in consultation with the EPA and the Department.

	Non-Indigenous Heritage Potential visual and cultural landscape impacts on Rouse Hill House Estate. **Noise** The assessment of construction noise shall have consideration of the *Interim Construction Noise Guideline* (DECC, 2009). **Air Quality and Emissions** Construction air quality impacts on sensitive receptors. A Scope 1 greenhouse gas assessment (as defined by the Greenhouse Gas Protocol). **Soils and Mineral Resources** Spoil and waste generation and associated impacts, including: storage, handling and disposal; soil erosion and associate water course impacts, soil salinity and acid sulphate soils; and potential mineral resource and mine subsidence impacts, including consultation with NSW Trade and Investment and the Mine Subsidence Board.
Consultation	The EIS shall document consultation undertaken with relevant government agencies and the community in its preparation and how matters raised during consultation have been considered.

Concept Plan Approval

Section 75O of the *Environmental Planning and Assessment Act 1979*

I, the Minister for Planning, under the *Environmental Planning and Assessment Act 1979* determine:

a) pursuant to section 75O of the *Environmental Planning and Assessment Act 1979,* to grant concept plan approval for the proposal referred to in Schedule 1, subject to the modifications in Schedule 2; and

b) pursuant to section 75P(1)(a) of the *Environmental Planning and Assessment Act 1979*, the further environmental assessment requirements for the proposal, referred to in Schedule 1, under Part 3A of the *Environmental Planning and Assessment Act 1979.*

Frank Sartor MP
Minister for Planning

Sydney 6 May 2008 File No: 9040496

SCHEDULE 1

Application No:	06_0157
Proponent:	Transport Infrastructure Development Corporation
Approval Authority:	Minister for Planning
Land:	Land required for the construction and operation of the proposal, generally between Epping and Rouse Hill.
Proposal:	The western portion of the North West Metro, being the construction and operation of a new electrified passenger rail line between Epping and Rouse Hill, including: • six new stations at Cherrybrook, Castle Hill, Hills Centre Norwest, Kellyville and Rouse Hill; • stabling facilities; and • associated ancillary infrastructure.
Part 3A Project:	On 7 April 2006, the Minister for Planning formed the opinion that the proposal is of State and regional environmental planning significance and declared that Part 3A of the *Environmental Planning and Assessment Act 1979* applies to the proposal.
Concept Plan Authorisation:	On 12 July 2006, the Minister for Planning authorised the submission of a concept plan for the proposal.

KEY TO CONDITIONS

SCHEDULE 2

DEFINITIONS

Ancillary Infrastructure	Permanent or temporary infrastructure required for the construction and operation of the proposal, including tunnel support facilities such as emergency ventilation and egress facilities and temporary construction sites.
Concept Plan	The proposal described in Schedule 1.
Conditions of Approval	The conditions of approval detailed in this, the Minister of Planning's concept plan approval for the proposal.
Construction	All pre-operation activities associated with any project related to the concept plan approval **other than** survey, acquisitions, fencing, investigative drilling or excavation, building/ road dilapidation surveys or other activities determined by the Proponent to have minimal environmental impact including (but not limited to) minor clearing (except where threatened species, populations or ecological communities would be affected), establishing temporary construction sites (in accordance with the requirements of any project approvals related to this concept plan approval), establishing minor access roads and minor adjustments to services/ utilities.
DECC	NSW Department of Environment and Climate Change.
Department, the	NSW Department of Planning.
Director-General, the	Director-General of the NSW Department of Planning (or delegate).
DWE	NSW Department of Water and Energy.
DPI	NSW Department of Primary Industries.
ECRL	Epping to Chatswood Rail Link formerly known as the Parramatta Rail Link, comprising a new underground passenger rail line from Epping to Chatswood.
GCC	NSW Growth Centres Commission.
MoT	NSW Ministry of Transport.
Operation	When trains commence operating on any project related to this concept plan approval but excluding commissioning activities.
Project, the	Any project(s) related to this concept plan approval.
Proponent	Transport Infrastructure Development Corporation.
Reasonable and Feasible	Consideration of best practise taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. **Feasible** relates to engineering considerations and what is practical to build. **Reasonable** relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
Relevant Council(s)	Hornsby Shire Council, Baulkham Hills Shire Council, Blacktown City Council.
Relevant Government Agencies	Any Commonwealth or State agency that has a statutory or other interest in the Project.
Relevant Stakeholders	A party that would be directly affected by the project or would otherwise have a reasonable interest in the project (excluding relevant Government agencies and relevant Councils) such as affected landowners, utility and service providers, businesses, bus companies and community members.
RTA	NSW Roads and Traffic Authority.

1. ADMINISTRATIVE CONDITIONS

Terms of Concept Approval

1.1 The Proponent shall carry out the concept plan and all related projects generally in accordance with the:
- a) Major Project Application 06_0157;
- b) *North West Rail Link Environmental Assessment and Concept Plan*, dated November 2006, and prepared by GHD Pty Ltd;
- c) *North West Rail Link Preferred Project Report*, dated May 2007, and prepared by GHD Pty Ltd;
- d) *North West Rail Link Supplementary Submissions Report*, dated March 2008, and prepared by the Transport Infrastructure Development Corporation; and
- e) the conditions of approval.

1.2 In the event of an inconsistency between:
- a) any documents listed in condition 1.1a) to 1.1d) inclusive, the most recent document shall prevail to the extent of the inconsistency; and
- b) the conditions of approval and any document listed in condition 1.1a) to 1.1d) inclusive, the conditions of approval shall prevail to the extent of the inconsistency.

Limits of Approval

1.3 To avoid any doubt, this concept plan approval does not permit the construction of any part of the proposal described in Schedule 1, unless and until a project approval is granted with respect to those works.

Provision of Information

1.4 Within 6 weeks of the date of this concept plan approval the Proponent shall place an electronic copy of the documents referred to under condition 1.1 a) to e) of this approval (or details of where hard copies of this information may be accessed by members of the public) on a new website established for the proposal, or dedicated pages within its existing website.

2. PROJECT DESIGN CRITERIA AND PERFORMANCE STANDARDS

Project Design

2.1 The Proponent shall in consultation with relevant Government agencies, relevant Councils and relevant stakeholders, ensure that underground components of the project are designed with regard to existing and/ or planned future underground utilities and infrastructure including the planned extension of the M2 Motorway.

2.2 The Proponent shall in consultation with relevant Councils and relevant Government agencies including (but not necessarily limited to) the GCC, MoT, the Department, Landcom, ensure that surface components of the project are integrated with surrounding landuse (existing and planned future, as relevant) as far as reasonable and feasible, consistent with the objectives of *Integrated Land Use and Transport* (DUAP 2001 or as updated), to minimise the potential for landuse conflicts. In particular:
- a) design of Castle Hill station shall consider the *Castle Hill Draft Master Plan* (or as updated); and
- b) Kellyville and Rouse Hill Stations and stabling facilities are to be integrated with the precinct planning for the Burns Road Release Area, Rouse Hill Regional Centre and the Area 20 precinct of the North West Growth Centre, as relevant.

2.3 The Proponent shall in consultation with relevant Government agencies, relevant Councils and relevant stakeholders ensure that ancillary infrastructure are located and designed to minimise biophysical and/ or amenity impacts, as far as reasonable and feasible.

2.4 The Proponent shall ensure that station precincts across the project provide a high degree of accessibility to all modes-of-access, consistent with the objectives of *Integrated Land Use and Transport* (DUAP 2001 or as updated).

2.5 The Proponent shall ensure that the surface components of the project affecting roads are designed to minimise traffic disruptions as far as reasonable and feasible, in consultation with the RTA and/ or relevant Councils.

Performance Standards

2.6 In relation to operational noise and vibration, the Proponent shall ensure that:
- a) the project rail corridor is designed consistent with the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (DECC, 2007);
- b) the project stabling facilities are designed consistent with the *Industrial Noise Policy* (EPA, 2000); and
- c) the project is designed to consistent with *Assessing Vibration: A Technical Guideline* (DECC, 2006).

2.7 The Proponent shall ensure that any floodplain topography and/ or waterway affected by cut-and-cover construction methodology is re-instated and/ or rehabilitated consistent with pre-construction conditions.

2.8 The Proponent shall ensure that the biodiversity impacts associated with the project are offset consistent with the 'improve and maintain' principles of the *Growth Centres Commission Biodiversity Certification* process, in consultation with the DECC.

3. PROJECT APPLICATIONS AND SPECIFIC REQUIREMENTS

3.1 Pursuant to section 75P(1)(a) of the *Environmental Planning and Assessment Act 1979*, the following environmental assessment requirements apply with respect to any projects related to this concept plan approval:
- a) a detailed project description including:
  - i) confirmation of the alignment, station locations (including feasibility of any additional stations) and stabling arrangements; and
  - ii) the design and location of ancillary infrastructure;
- b) a detailed project-specific statement of commitments, with regard to the statement of commitments prepared for the concept plan, clearly identifying any new or amended commitments relating to the project;
- c) an updated assessment of statutory matters, where the project affects land that has not already been identified in the documents referred to in conditions 1.1 (a) to (d);
- d) an assessment of Matters of National Environmental Significance, as relevant;
- e) an appropriate and justified level of consultation with relevant Councils and relevant Government agencies including (but not limited to) RailCorp, MoT, GCC, Landcom, DECC, DPI (Fisheries), DWE, RTA, including a description of how agency and Council input has been considered in decisions on design and/ or mitigation;
- f) an appropriate and justified level of consultation with relevant stakeholders including a description of how stakeholder input has been considered in decisions on design and/ or mitigation;
- g) assessment of the key issues identified in conditions 3.2 to 3.16 of this approval, including of relevant ancillary infrastructure; and
- h) assessment at an appropriate level of detail of the impacts and mitigation measures associated with any additional key issues of relevance to the project, identified during further design development, that are not specifically identified in this concept plan approval.

Property and Landuse

3.2 The Proponent shall confirm the footprint of the project with respect to alignment, station precincts and ancillary infrastructure as far as reasonable and feasible, and describe the landuse impacts on existing and planned future use associated with any additional land take.

Traffic and Transport

3.3 The Proponent shall review mode-of-access demand and peak traffic predictions at Epping Station taking into account the impact of ECRL operations on patronage distribution; and identify any required changes to mode-of-access arrangements at Epping.

3.4 The Proponent shall confirm mode-of-access arrangements at each new station, with consideration to (but not necessarily limited to) the following matters:

a) at Cherrybrook Station – details of park and ride provisions, road access arrangements (including the feasibility of a signalised intersection between Castle Hill, Glenhope and Franklin Roads); and pedestrian and cycle linkages to the surrounding pedestrian catchments of Cherrybrook and West Pennant Hills;
b) at Castle Hill Station – investigation of options for shared use parking; bus access arrangements; and pedestrian and cycle linkages between the station and residential areas surrounding the Castle Hill town centre, retail areas within the town centre and the Castle Towers shopping centre;
c) at Hills Centre Station - details of park and ride provisions; road access arrangements; and pedestrian linkages to the Castle Hill industrial estate;
d) at Norwest Station - investigation of options for shared use parking; access for buses, kiss and ride and taxis; and pedestrian and bus linkages to the Norwest Business Park and surrounding residential catchments;
e) at Kellyville Station – details of park and ride provisions; bus interchange arrangements which are integrated to the Parramatta to Rouse Hill Transitway; and road, pedestrian and cycle access that are integrated with the planned provisions for the Balmoral Road Release Area; and
f) at Rouse Hill Station - bus interchange arrangements which are integrated to the Parramatta to Rouse Hill Transit way; and road, pedestrian and cycle access that are integrated with the planned provisions for the Rouse Hill Regional Centre.

3.5 The Proponent shall confirm the construction traffic impacts associated with the project, identifying:

a) haulage routes;
b) peak congestion and intersection performance impacts at local and arterial roads considering cumulative impacts from surrounding development and from concurrent construction sites;
c) reasonable and feasible construction options at road crossings to avoid and/ or minimise traffic disruptions; and
d) requirements for road and/ or lane closure and alternative travel arrangements.

Noise and Vibration

3.6 The Proponent shall review the noise and vibration impacts of the project during construction (including construction traffic) and operation, considering all reasonable and feasible mitigation options at existing and planned future receivers.

Geotechnical

3.7 The Proponent shall identify risks to groundwater quality and/ or risks to surface water quality from contaminated groundwater during construction and operation, including measures to avoid, manage, mitigate and monitor impacts.

3.8 The Proponent shall identify the following matters in relation to the bored tunnel components of the project:

a) existing groundwater conditions (level and quality), taking into consideration seasonal variability;

b) local and regional drawdown impacts, including any groundwater users impacted by the project and measures to offset impacts;
c) options for the sustainable use and/or disposal of tunnel inflow;
d) measures to minimise the risk of bed cracking and loss of surface flow when tunnelling below creek lines and contingency measures for restoring affected waterways consistent with pre-construction conditions, including monitoring procedures and performance criteria;
e) impacts to groundwater dependent ecological communities (affected by groundwater drawdown) and to riparian and instream ecology (affected by surface cracking and water flow impacts); and
f) surface locations (and associated infrastructure) above the tunnel alignment that are likely to be at risk to land subsidence or settlement impacts, including relevant settlement design criteria and measures to minimise, monitor and offset impacts.

Surface Water and Hydrology

3.9 For surface components of the project located on floodplains, the Proponent shall identify flood design criteria in accordance with the *Floodplain Development Manual* (2005), describing risks to existing and planned future receivers and infrastructure based on the modelling of a full range of flood sizes up to and including the probable maximum flood.

3.10 For temporary construction sites located on floodplains, the Proponent shall identify reasonable and feasible mitigation measures for mitigating flood risk, including procedures for restoring and monitoring any temporary creek diversions consistent with pre-construction conditions.

3.11 For cut and cover tunnel components which cross creek lines, the Proponent shall describe the proposed construction methodology, identifying measures to minimise the risk of bed cracking and loss of surface flow and contingency measures for restoring and monitoring waterways, consistent with pre-construction conditions.

3.12 The Proponent shall identify impacts to riparian and instream ecology from any direct disturbances to waterways and to flora and fauna from changes to creek flow or flood behaviour, during construction or operation.

Flora and Fauna

3.13 The Proponent shall confirm the ecological impacts associated with the project with consideration to conditions 3.8 e) and 3.12, and identify measures to offset impacts, clearly distinguishing between measures to be provided as part of the *Growth Centres Commission Biodiversity Certification* process and other measures.

The Proponent shall describe how the effectiveness of the offset measures would be monitored, what actions shall be taken if measures are identified to be ineffective, the maintenance responsibilities, and timing of implementation of offset measures.

Indigenous Heritage

3.14 The Proponent shall review the indigenous heritage impacts of the project considering cumulative impacts from surrounding development, consistent with:

a) Steps 1 to 4 of the *Protocol for Aboriginal Stakeholder Involvement in the assessment of Aboriginal cultural heritage in the Sydney Growth Centres* (Context Pty Ltd, 2006a) and the *Precinct Assessment Method for Aboriginal Cultural Heritage in the Sydney Growth Centres* (Context Pty Ltd, 2006a), for land within the North West Growth Centre; and
b) *Guideline for Aboriginal Cultural Heritage Impacts Assessment and Community Consultation* (DECC July 2005), for all other areas.

The Proponent shall identify mitigation priorities with consideration to the regional significance of impacts.

European Heritage

3.15 The Proponent shall review the European Heritage impacts of the project, describing measures to minimise and/ or appropriately manage impacts.

Visual and Urban Design

3.16 The Proponent shall review the visual and urban design impacts and mitigation requirements for the project in accordance with Statement of Commitment 40 to 44; identifying the timing of implementation of urban design and landscaping measures, how the effectiveness of landscaping measures would be monitored, and maintenance responsibilities for relevant urban design and landscape measures.

SOC No.	Statement of Commitment
1	Core sustainability principles would be developed for the design and construction of the project covering the following themes: - Energy - Greenhouse emissions - Water - Community and stakeholder involvement - Biodiversity - Resource recycling/minimisation To develop the principles a benchmarking exercise would be undertaken to enable sustainability goals and objectives to be determined, which would provide clear result areas and targets under each theme
2	Communications processes would be developed and implemented throughout delivery of the project. These would include: - Opportunities to input into the design process such as at station precincts and structures and proposed mitigation measures (e.g. noise barriers) for construction and operations; - Methods to inform the community of the progress and performance of the project and issues of interest to the community; - Processes to receive and manage complaints; and - Consultation with affected property owners.
3	Ongoing consultation would occur with Government agencies regarding issues raised during previous consultation and as identified within the Environmental Assessment and Concept Plan and the Preferred Project Report
4	A construction strategy would be developed confirming detailed construction activities and methodologies at each construction site for the construction of the tunnel.
5	Detailed construction methodologies at each construction site would be developed, including spoil management, with the aim of minimising environmental impacts and informing future impact assessment
6	Consultation with Councils, the Growth Centres Commission, RailCorp and other relevant stakeholders would be undertaken to ensure environmental planning instruments reflect planning, construction and operation of the project and include integrated planning provisions for appropriate development controls within the vicinity of the rail line and stabling facility.
7	Land use and property impacts of the project, including construction sites and all ancillary facilities, would be further assessed in consultation with Councils and surrounding landowners.
8	A Land Asset Management Strategy to address 'land surplus to use', post construction would be developed jointly with the Department of Planning (Land Management Branch) in consultation with Councils, Growth Centres Commission and RailCorp. This strategy would investigate opportunities for land amalgamation of parcels severed by the project and identify opportunities for development that is consistent with surrounding land use planning.
9	Consultation with relevant Councils, government agencies, utility providers, land owners and communities involved in the planning of precincts in the vicinity of each station would be undertaken with the aim of encouraging transit-orientated development around each station. The role of each station within the context of provision of public transport services would be established, including the need and capacity of park and ride facilities, establishing connections with other transport modes (including the potential for integrated ticketing), and integrating pedestrian and cyclist facilities.
10	Further investigations would be undertaken with respect to the planned expansion of the Castle Hill Shopping Centre and integration of the project with the Castle Hill Draft Master Plan
11	At each station, further studies would be undertaken to consider the integration of the station with the local area to ensure that predicted patronage and mode access are catered for during operation. Studies would consider local connectivity requirements; pedestrian modelling (including emergency access); bicycle facilities; the potential impacts of traffic accessing the station from the surrounding road network; parking requirements and the integration of the Transitway and other bus services with the new rail stations. These investigations would be undertaken in consultation with Councils, RailCorp, Ministry of Transport and the Roads and Traffic Authority
12	The location, scale, design and quantum of park-and-ride facilities at the Franklin Road, Hills Centre and Burns Road Station would be reviewed during further design. This is to be undertaken with reference to relevant parking policies and in consultation with Councils, RailCorp and the Ministry of Transport

SOC No.	Statement of Commitment
13	In consultation with Councils, RailCorp, the Ministry of Transport and surrounding landowners, investigate opportunities for 'shared use' or complementary parking facilities adjacent to Norwest Station.
14	In consultation with the RTA and Councils, investigate the feasibility of providing a direct access point to the Franklin Road site from Castle Hill Road and the potential for a signalised intersection at the intersection of Glenhope Road with Castle Hill Road.
15	In consultation with the RTA and Councils investigate potential access improvements to Franklin Road Station from areas to the north.
16	The design of construction activities would consider access points, surrounding intersections, bus routes and pedestrian flows.
17	Traffic modelling and traffic management analysis would be undertaken for the roads and intersections impacted by the project during the project construction and operation. This analysis would consider existing and planned road upgrades
18	A detailed construction methodology for the construction over and/or under roads would be developed in consultation with the RTA and Councils with the aim of minimising traffic disruptions (including construction of the bridge over Windsor Road at Kellyville and cut and cover construction under Norwest Boulevard, Windsor Road and Burns Road).
19	Maintenance access points would be identified and planned in consultation with RailCorp and Councils
20	A detailed noise and vibration assessment of the proposed construction activities, including blasting if required, would be undertaken as part of design development and would include the investigation of the potential need for reasonable and feasible mitigation in accordance with relevant policies and guidelines.
21	Consult with local Councils, Growth Centres Commission and RailCorp in relation to land use planning and development controls to minimise the need for physical noise mitigation
22	In regard to operational noise, the Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects (Department of Planning, 2007) would be used to implement the following activities: - Modelling of operational noise impacts (including ground borne noise) in more detail as part of the design development; - Identification of acoustic mitigation measures to meet, where reasonable and feasible, the design goals; and - Select representative locations for the project at which it is appropriate to later assess compliance.
23	In regard to train stabling operational noise, the following would be undertaken: - Determine the extent of any physical noise mitigation measures in consultation with Department of Environment and Climate Change, RailCorp and Growth Centres Commission; and - Review the results of RailCorp's investigations into addressing horn noise and consider the feasibility in consultation with RailCorp of implementing a low volume horn test.
24	Investigate feasible and reasonable mitigation measures to manage operational vibration in consultation with Councils, the Department of Environment and Climate Change and RailCorp
25	Design of waterway crossings and structures would be undertaken with reference to the Guidelines for Design of Fish and Fauna Friendly Waterway Crossings (Fairfull and Witheridge 2003) and Fish Passage Requirements for Waterway Crossings (2003) and considering the quality of riparian habitat present, in consultation with the Department of Primary Industries (NSW Fisheries) and other relevant Government agencies.
26	The location of structures associated with the rail tunnel, such as ventilation shafts, emergency egress/access points and discharge/runoff outlets, would be assessed with respect to the potential application of SEPP 19.
27	A detailed ecological assessment would be undertaken at all construction sites and along above ground sections of the project corridor. The assessment would identify areas to be avoided (where practicable), construction related impacts and how these can be managed; and, where required, describe measures to offset significant impacts on threatened species and/or endangered ecological communities. This assessment would be undertaken in consultation with the DECC, the Growth Centres Commissions, RailCorp and the Commonwealth Department of Environment and Water Resources as appropriate.
28	'Improve and Maintain' assessments on biodiversity values would be undertaken to identify the potential impacts of the project and benefits from protection measures to be implemented. The methodology adopted for all parts of the project would be consistent with the draft Growth Centres Conservation Plan (GCC, 2007) and DECC's draft Guidelines for biodiversity certification of environmental planning instruments (2007).
29	Further investigations would be undertaken as part of the design development into opportunities for beneficial reuse of spoil. As a result of these investigations further assessment of transport options and routes for spoil movement would be undertaken.
30	Additional research would be undertaken to determine the history and potential heritage significance of the sites identified in Castle Hill. Site-specific archaeological assessments would be undertaken in the event that they are found to have heritage significance.
31	Site-specific archaeological assessments would be undertaken for the two archaeological sites identified along Old Windsor Road and Windsor Road.
32	A view analysis would be undertaken to and from Rouse Hill House and its estate and the Glenhope property. If required appropriate mitigation measures would be identified
33	The Indigenous Heritage protocol and methodology developed for the Growth Centres would continue to be applied as the project progresses, in consultation with DECC and relevant Indigenous groups
34	A detailed assessment would be undertaken in the vicinity of sites identified to have moderate to high archaeological potential. The assessment would identify areas to be avoided, construction related impacts and how these can be managed; and, where required, salvage excavation prior to any subsurface impact on the deposit. Advertising for interested parties would need to be undertaken prior to any subsurface investigation, in accordance with DECC requirements.
35	Detailed geotechnical and groundwater investigations would be undertaken involving site investigations to inform future design development
36	A detailed flood assessment would be undertaken in accordance with appropriate NSW Government guidelines and in consultation with Councils and relevant Government agencies. This would include a two dimensional model of the Caddies Creek confluence to facilitate a better understanding of the discharges at the confluence of the creeks and associated design requirements
37	Investigations into the construction and operational impacts on the Elizabeth Macarthur Creek would be undertaken in accordance with relevant NSW Government guidelines.
38	The floodplain storage impacts would be defined during design development in accordance with the relevant NSW Government guidelines
39	Further investigations into the location, size and treatment levels of a water treatment plant(s) would be undertaken in consultation with DECC, Councils and RailCorp. Investigations would include identifying discharge points, determining the receiving water quality and water re-use/recycling opportunities.
40	The following architectural, landscape and urban design principles would be used to guide the design of the new stations and transport interchanges, civil works (such as noise walls, embankments and the viaduct section) and/or the stabling facility concepts: - Reinforce the role of the station and transport interchange within its surrounding neighbourhood as the principal transport and community facility within the locality. - Stations and the stabling facility would be designed in the context of the scale, character and image of the surrounding area and enhance the presentation of the area to visitors, residents and travellers. - Maintain or improve the links across the project and to surrounding areas and activities. Where a connection between adjacent areas is desirable, pedestrian bridges or underpasses would be considered. - Easy access facilities would be incorporated into the station designs and integrated with the associated transport interchanges. - Movement networks should improve existing, or establish new comfortable and inviting pedestrian environments, including equitable access within the railway station and adjoining areas. - A design theme would be established for bridges/viaduct to link the overall rail design together. The design would ensure that the structures are simple, integrated with the surrounding area and finished to a high quality. Fencing, parapets and any railing on the bridges would also be integrated

SOC No.	Statement of Commitment
	with the overall design. - Establish a hierarchy of access to stations consistent with NSW Govt policy package "*Integrating land –use and transport"* i.e prioritise public transport and other non-car based access to the rail stations and adjoining areas where possible. - Station precinct design should facilitate new development that reflects the highest standards and quality of design.
41	Visual impact assessment of the project would be undertaken as part of design development. This would consider both the existing and future urban environment to identify impacts and potential mitigation measures, such as architectural, landscape and/or urban design treatments. Additional assessments would apply to pedestrian and cycle facilities; proposed bridging structures; cutting and embankment treatments; landscape treatment projects; design of the stations and stabling facility; proposed acoustic treatments; and any visual buffer areas as required
42	Measures to mitigate visual impacts and deliver high quality design outcomes would include: - Where noise walls are proposed, potential visual impacts would be minimised by implementation of urban design measures, developed in consultation with adjacent property owners (mitigation measures might include plantings and high quality facings near residential areas). - Earth mounding would be considered where space allows and where significant vegetation would not be lost. - The design of any civil works, such as noise walls, retaining walls, the viaduct and underpasses would adopt CPTED principles, including the need for unobstructed views into and outside of the underpass, effective drainage and ventilation, wide corridors and good lighting. Light spill would be minimised as much as possible to reduce impacts on surrounding existing and future residents in accordance with relevant standards.
43	TIDC's Design Review Panel would guide the application of architectural, landscape and urban design principles throughout the design development.
44	Public art and interpretation would be incorporated into architectural elements or urban design treatments and would be assessed and implemented with design themes and urban design criteria (eg. graffiti management).
45	An assessment of the potential impacts and benefits of construction and operation on adjacent businesses would be undertaken in consultation with business owners during the design phase.