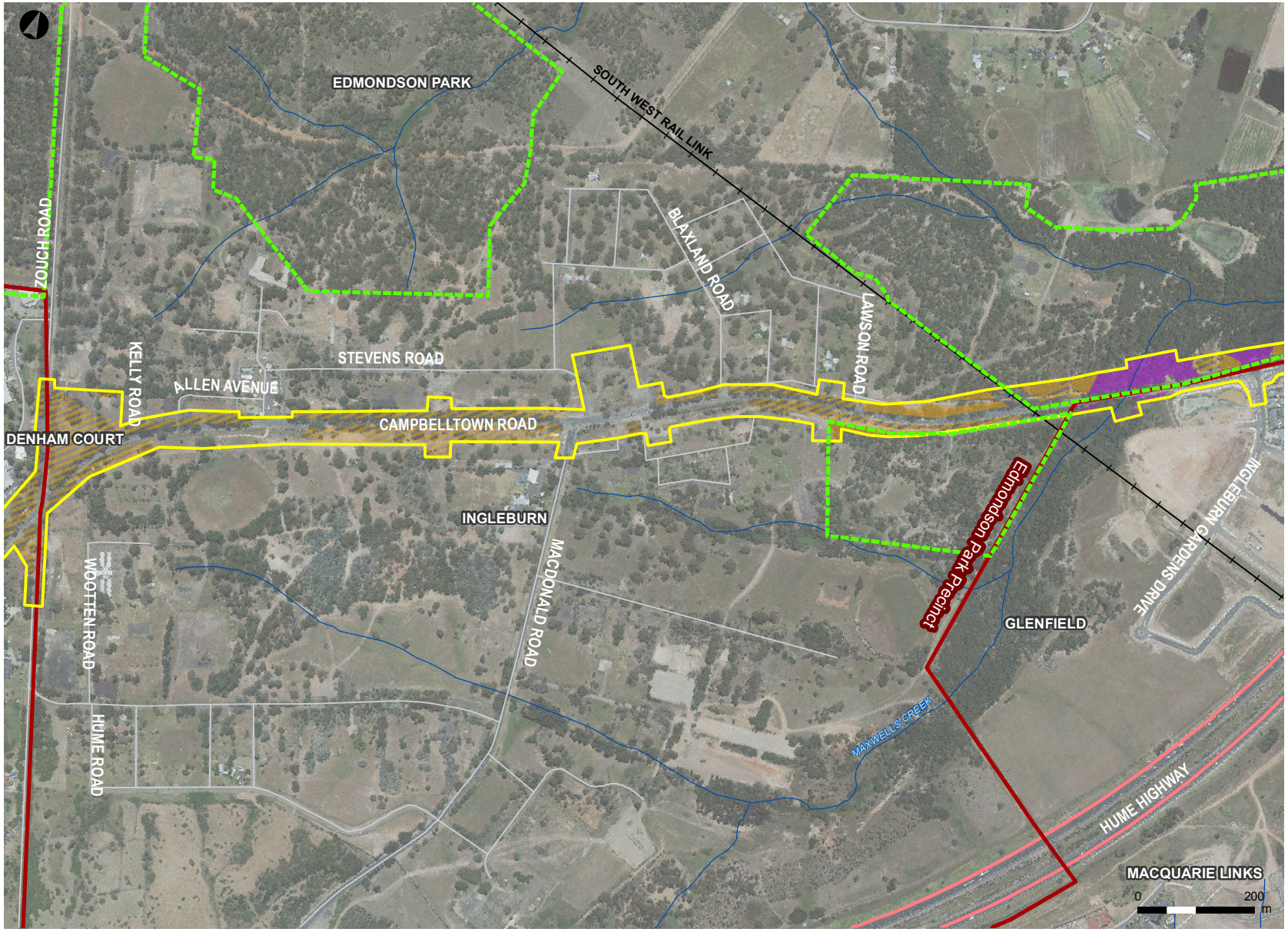

LEGEND

- Proposal Area
- Non-certified Land

Vegetation Community to be cleared

Moderate to Good condition

- Cumberland Plain Woodland
- River-flat Eucalypt Forest

Poor condition

- Cumberland Plain Woodland
- River-flat Eucalypt Forest

DATA SOURCES
RMS, LPI, OEH

Transport Roads & Maritime Services

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

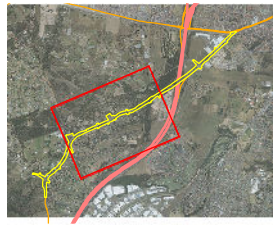

Figure 6-51iii: Vegetation communities to be cleared for the proposal - Ingleburn Gardens Drive to Zouch Road

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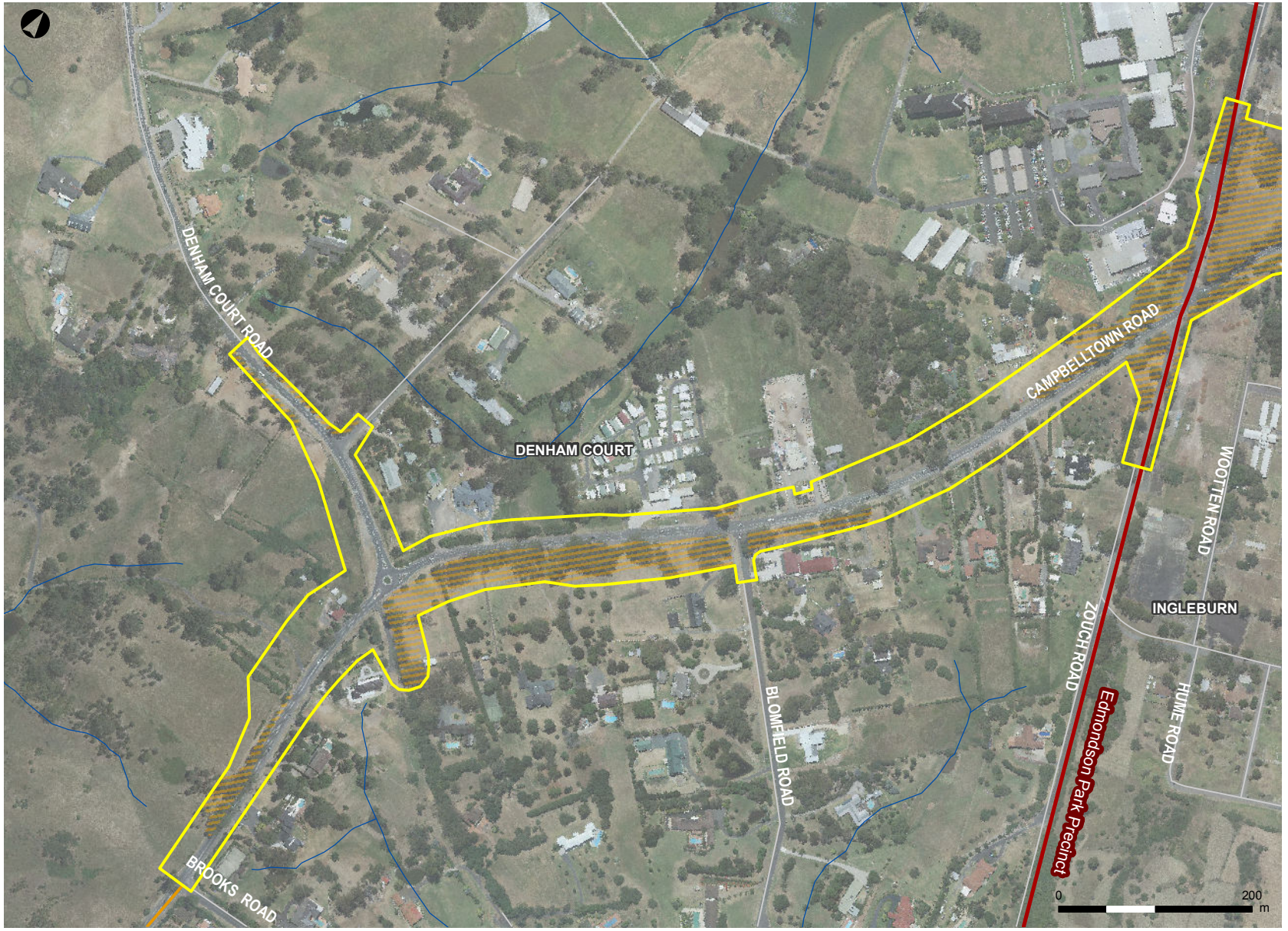
Created by : GC
QA by : LD



LEGEND

- Proposal Area
- Non-certified Land

Vegetation Community to be cleared

Moderate to Good condition

- Cumberland Plain Woodland
- River-flat Eucalypt Forest

Poor condition

- Cumberland Plain Woodland
- River-flat Eucalypt Forest

DATA SOURCES
RMS, LPI, OEH

Transport Roads & Maritime Services

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

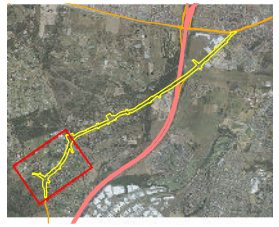


Figure 6-51iv: Vegetation communities to be cleared for the proposal - Zouch Road to Brooks Road

Date: 27/03/2013 Path: \\hc-aus-ns-fs-01\jobs\AA004777\L-GIS\A_Current\B_Maps\REF\AA004777_Figure6-51iv_VegeClearedStage4_08_130327.mxd
Created by : GC
QA by : LD

Habitat loss and fragmentation

Clearing of native vegetation for the proposal would result in the removal of flora and fauna habitat.

While no threatened flora species were recorded in the study area, the proposal would result in loss of potential habitat for threatened flora species in the non-certified areas and proposed Edmondson Regional Park. A total of 1.83 hectares of flora habitat would be removed from the non-certified areas. This flora habitat consists of Moderate to Good condition CPW, Poor condition CPW and Moderate to Good condition RFEF. The Poor condition CPW to be cleared outside of the SWGC was not considered to provide potential habitat for threatened plant species, given that the understorey in this roadside area consists of *Olea europaea* subsp. *cuspidata* and exotic grass species. Appendix K provides further detail on flora habitat suitability.

The areas of each fauna habitat type that would be removed within the proposal area are listed in Table 6-33 and shown in Figure 6-51i-iv.

Table 6-33: Areas of fauna habitat within the proposal area to be removed

Fauna habitat type	Within proposal area (ha)	Outside of SWGC in proposal area (ha)	Within SWGC	
			Within certified areas in proposal area (ha)	Within non-certified areas in proposal area (ha)
Remnant Woodland	2.34	0.00	1.32	1.02
Riparian	0.96	0.00	0.16	0.80
Developed areas	12.45	0.83	11.62	0.00
Cleared and disturbed	23.65	1.59	21.09	0.97
TOTAL	39.40	2.42	34.19	2.79

The removal of vegetation would result in the loss of specific fauna habitat components, including live trees, tree hollows, foraging resources (myrtaceous and flowering trees and shrubs), groundlayer habitats such as ground timber and well-developed leaf litter.

Widening of Campbelltown Road where it transects remnant woodland would increase the gap between existing patches of habitat on either side of the proposal; however, this would not significantly increase the existing extent of fragmentation of habitat. The majority of fauna species recorded within the study were highly mobile bird species and these species would be unlikely to be adversely impacted by barrier effects associated with the road widening.

Species that may be adversely affected include smaller, slow moving species recorded in the study area such as reptiles and amphibians and the Cumberland Plain Land Snail. It is noted that snail populations found on either side of the road may have once comprised a single population that has been fragmented and isolated

by the existing Campbelltown Road. The widening of Campbelltown Road would be unlikely to create a greater barrier to snail movement than presently exists. Existing hydrological regimes are unlikely to change to the degree that existing leaf litter levels would be adversely affected. While the proposal would result in an increase in impervious surfaces, run-off from these surfaces would be conveyed in a similar manner and in a similar direction to current run-off. More information on impacts to hydrological regimes is provided in Section 6.4.4.

The existing culvert offers potential roosting habitat for microbats, including threatened species. Removal of the culvert for the proposed upgrade may result in temporary removal of roosting habitat. Mitigation measures would be implemented to minimise impacts to any roosting bats.

Fauna injury or mortality

Fauna injury or mortality is most likely to occur during vegetation removal activities, but also may result from collisions with vehicles or plant, or accidental entrapment in plant, trenches or other earthworks.

The majority of fauna species recorded within the study were highly mobile bird species and these species are likely to be able to move away from vegetation removal activities during construction quite readily. Fauna inhabiting the hollows in the large hollow-bearing trees in certified areas in the south-west of the study area may be injured during tree-felling. This could potentially include hollow-dependent birds and mammals and threatened microchiropteran bat species.

Cumberland Plain Land Snails would be likely to be impacted where vegetation removal would be undertaken in remnant woodland, particularly where snails have been recorded along the margin of the proposal area. Remnant woodland habitat within the study area is characteristic of preferred habitat for the species; all patches of remnant woodland within the proposal area may support Cumberland Plain Land Snail.

Edge effects

Potential indirect impacts on native vegetation in the study area comprise edge effects associated with the creation of a new road edge, and could include weed invasion, altered hydrology and increased sedimentation and runoff.

A comprehensive review on edge effects and their compensation (Bali 2000 & 2005) suggests that only 60 per cent of the 50 metre strip of edge affected habitat should apply to road corridors. This takes into account that edge effects reduce the quality of habitat, but do not completely remove their habitat values. Therefore indirect impacts as a result of edge effects could potentially affect a 30 metre wide strip adjoining the construction footprint.

The vegetation proposed to be removed from the existing edge of Campbelltown Road is currently subject to edge effects, with disturbed soils, dead and dying trees and large patches of weedy exotic species, particularly closer to the road edge. The widening of the road could potentially result in expansion of the existing edge effects further into areas of native vegetation.

Weeds and pathogens

Fourteen of the 89 exotic species recorded in the study area are listed as noxious

weeds in the Liverpool City Council or Campbelltown City Council LGAs. The noxious weeds of greatest concern in and adjacent to native vegetation in the non-certified areas are *Olea europaea* subsp. *cuspidata* (African Olive), *Asparagus asparagoides* (Bridal Creeper) and *Bryophyllum delagoense* (Mother-of-millions). Invasive exotic grasses such as *Eragrostis curvula* (African Lovegrass), *Ehrharta erecta* (Panic Veld-grass) and *Setaria gracilis* (Slender Pigeon-grass) also represent a threat to native vegetation in the study area. These grasses are currently abundant at the existing road edge and increased movement of people, vehicles, machinery, vegetation waste and soil during and following construction of the proposal may facilitate the introduction or spread of these weeds within the study area.

The proposal has the potential to increase the spread of a number of pathogens that threaten native biodiversity values, including:

- Phytophthora (*Phytophthora cinnamomi*) - Soil borne pathogen that infects roots and is associated with damage and death to native plants.
- Chytrid fungus (*Batrachochytrium dendrobatidis*) Infectious fungus causing disease and death in frogs.
- Myrtle Rust (*Uredo rangelii*) Plant disease caused by the introduced fungus *Uredo rangelli*, attacks young leaves of myrtaceous plants, eventually killing them.

All the listed pathogens are Key Threatening Processes under the TSC Act. No evidence of these pathogens was observed in the study area, but there may be an increased risk of dispersal as a result of the proposal. Safeguards are recommended during construction.

Impacts on aquatic habitat

Construction activities in proximity to the headwaters of Maxwells Creek, particularly the replacement of the existing three-cell box culvert with twin two span 24 metre bridges, have the potential to adversely affect aquatic habitat. An approximately 85 metre section of the creek would be realigned 15 metres to the north of its current location.

The creek realignment would require removal of existing riparian vegetation along the eastern and western banks of the headwaters of Maxwells Creek. Assuming the vegetated riparian zone extends 20 metres either side of the watercourse (NSW DPI 2012), this would result in up to 0.34 hectares of vegetation removal from the vegetated riparian zone. The proposal may also increase the volumes of sediments carried downstream, reducing water quality downstream.

The proposal is considered unlikely to have a significant impact on aquatic threatened species listed under the FM Act and/or the EPBC Act as none were identified or likely to occur within the study area.

The aquatic assessment concluded that the proposed bridge construction and creek alignment as part of the Campbelltown Road upgrade and widening would be unlikely to impact the habitat values of the headwaters of Maxwells Creek. Indirect impacts such as increased sedimentation would be controlled during the construction works. A number of safeguards would be implemented to reduce the potential impact on aquatic habitat values within the study area.

The design of creek and waterway crossings would be consistent with guidelines to maintain adequate fish passage according to fish habitat (Fairfull and Witheridge

2003). No water was observed in Maxwells Creek within the study area after rainfall, therefore the potential to block fish passage is considered unlikely. However, if the proposal temporarily blocks fish passage during construction a permit to block fish passage would be required under Section 220(1) of the *Fisheries Management Act 1994*.

Impacts on threatened species, populations and communities

Assessments of significance were undertaken for all threatened species, populations and communities recorded or considered to have a high or moderate likelihood of occurrence in the non-certified areas within the study area. Assessments of Significance were limited to consideration of impacts within the non-certified areas only. Assessments of significance followed the *Threatened Species Assessment Guidelines* (DECC 2007).

Significant impact assessments using the EPBC Act Significant Impact Criteria (DEWHA 2009a) were undertaken for the threatened species and communities listed under the EPBC Act that were recorded, or for which habitat occurs in the proposed Edmondson Regional Park within the study area. Impact assessments were limited to consideration of impacts within the proposed Edmondson Regional Park and non-certified areas.

The threatened species, populations and communities for which impact assessments were undertaken and the outcomes of the assessments are listed in Table 6-34.

The assessments concluded that the proposal is unlikely to have a significant impact on any threatened species, populations or communities listed under the TSC Act or EPBC Act. Consequently, a species impact statement is not required. A referral to SEWPaC under the EPBC Act is also not required.

Table 6-34: Assessments of significance on threatened species, populations and communities

Threatened entity	EPBC Act Status	TSC Act Status	Likelihood of occurrence	Impacts within non-certified lands/Proposed Regional Park	Likely significant impact?
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (EPBC CPW)	CE		Known	Loss of 0.55 ha and edge impacts on 2.2 ha within the proposed Edmondson Regional Park and non-certified areas.	No
Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW)		CE	Known	Loss of 1.01 ha and edge impacts on 2.48 ha within non-certified areas. Loss of 0.29 ha outside of SWGC.	No
River-flat Eucalypt Forest on Coastal Floodplains of the		E	Known	Loss of 0.82 ha and edge impacts on 0.84 ha within non-	No

Threatened entity	EPBC Act Status	TSC Act Status	Likelihood of occurrence	Impacts within non-certified lands/Proposed Regional Park	Likely significant impact?
NSW North Coast, Sydney Basin and South East Corner Bioregions (RFEF)				certified areas.	
Marsdenia viridiflora subsp. *viridiflora*		EP	High	Loss of 0.55 ha of potential habitat.	No
Pimelea spicata (Spiked Rice-flower)	E	E	High	Loss of 0.55 ha of potential habitat.	No
Acacia pubescens (Downy Wattle)	V	V	Moderate	Loss of 1.01 ha of potential habitat.	No
Cynanchum elegans (White-flowered Wax Plant)	E	E	Moderate	Loss of 1.37 ha of potential habitat.	No
Pultenaea pedunculata (Matted Bush-pea)		E	Moderate	Loss of 1.01 ha of potential habitat.	No
Meridolum corneovirens (Cumberland Land Snail)		E	Known	Potential mortality of individuals, loss of 1.02 ha of habitat.	No
*Mormopterus norfolkensis (*Eastern Freetail-bat)		V	High	Loss of 1.82 ha of foraging habitat.	No
*Myotis macropus (*Southern Myotis)		V	High	Loss of 1.82 ha of foraging habitat.	No
Pteropus poliocephalus (Grey-headed Flying Fox)	V	V	High	Loss of 1.82 ha of foraging habitat.	No
Ardea ibis (Cattle Egret)	M		Moderate	Loss of 1.82 ha of foraging habitat.	No
Glossopsitta pusilla (Little Lorikeet)		V	Moderate	Loss of 1.82 ha of foraging habitat.	No
Hieraaetus morphnoides (Little Eagle)		V	Moderate	Loss of 1.82 ha of foraging habitat.	No
Lathamus discolour (Swift Parrot)	E	E	Moderate	Loss of 1.82 ha of foraging habitat.	No
Miniopterus schreibersii oceanensis		V	Moderate	Loss of 1.82 ha of foraging habitat.	No

Threatened entity	EPBC Act Status	TSC Act Status	Likelihood of occurrence	Impacts within non-certified lands/Proposed Regional Park	Likely significant impact?
(Eastern Bentwing-bat)					

1. Conservation status under EPBC Act: CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory

2. Conservation status under TSC Act: CE = Critically Endangered, E = Endangered, EP = Endangered Population, V = Vulnerable

Key threatening processes

Table 6-35 lists the key threatening processes (KTPs) that were considered with regard to the proposal.

Table 6-35: Key threatening processes

Act	KTP	Applicability to proposal
FM Act	Degradation of native riparian vegetation along NSW water courses.	The proposal would require the removal of native and degraded riparian vegetation, where it occurs within the proposal area. Given that a small area of this vegetation would be cleared, and the area to be cleared would be revegetated, the proposal would be unlikely to significantly contribute to this KTP.
FM Act	Instream structures and other mechanisms that alter natural flow.	Instream works would be undertaken during the creek realignment, which may alter the natural flow regime of the waterway. Piers would be installed within the creek, however these would be placed outside the newly aligned low flow channel, reducing the potential of increased turbulence and scouring instream.
TSC Act EPBC Act	Clearing of native vegetation.	Native vegetation that occurs within the proposal area would require removal. This includes remnant trees adjoining Campbelltown Road within the road reserve, and remnant woodland of the non-certified areas. The loss of native vegetation would result in the loss of habitat for a variety of species that forage, shelter, nest or roost in such vegetation in the study area.
TSC Act	Loss of hollow-bearing trees.	The four hollow-bearing trees located within the curtilage of Denham Court were the only hollow-bearing trees identified within the study area. All four lie within the proposal area and would require removal. This would result in the loss of sheltering and nesting habitat for hollow-dependent fauna species within the study area. Given that these trees are located within certified areas, no further assessment of this KTP is required.
TSC Act EPBC Act	Competition and grazing by the feral European	Rabbits were recorded throughout the study area, west of the Hume Highway. Grazing by rabbits can reduce the survival and recruitment of several

Act	KTP	Applicability to proposal
	rabbit.	species of threatened plants, and reduce available foraging resources for native fauna. The proposal may exacerbate this KTP through the creation of additional foraging areas. Given that this would be a short-term impact while stabilised areas are restored that would be managed through the riparian management plan, no further assessment of this KTP is required.
TSC Act	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.	Realignment of the headwaters of Maxwells Creek that crosses the study area is proposed, as a result of the upgrade of the existing culvert to twin bridges. This drainage line is currently highly modified. The creek realignment may result in alterations to the natural flows; however, the new channel would be constructed to accommodate natural flow regimes.
TSC Act	Invasion of native plant communities by African Olive (*Olea europaea L.* subsp. *cuspidata*).	*Olea europaea* subsp. *cuspidata* was recorded in the study area. The proposal may exacerbate this KTP by facilitating the spread of seeds or fragments of plant to areas where this weed is not present, via plant or contaminated topsoil.
TSC Act	Invasion of native plant communities by exotic perennial grasses.	One grass of special concern, *Eragrostis curvula* (African Lovegrass) occurs in the study area. The proposal may exacerbate this KTP by facilitating the spread of seeds or fragments of plant to areas where this weed is not present, via plant or contaminated topsoil.

6.1.4 Biodiversity offsets

A biodiversity offset strategy would be developed to compensate for loss of ENV within the non-certified areas, loss of EPBC CPW within the proposed EdmondsonRegional Park and the reduction in the land area of the proposed Edmondson Regional Park. These offsets would satisfy the terms of the agreements (biodiversity certification and conservation agreement) and requirements under the EPBC Act and Major Development SEPP as well as conditions of the existing land zoning.

The offset strategy would be prepared in consultation with OEH, DP&I and SEWPaC and would be in place prior to construction.

6.1.5 Safeguards and management measures

The safeguards and management measures outlined in Table 6-36 would be implemented during construction of the proposal to minimise impacts on flora and fauna.

Table 6-36: Safeguards and management measures for biodiversity

Impact	Environmental safeguards	Responsibility	Timing

Impact	Environmental safeguards	Responsibility	Timing
Impacts on threatened species	• A Flora and Fauna Management Plan would be prepared in accordance with *RMS Biodiversity Guidelines* (RTA 2011) as part of the CEMP. The plan would include but not be limited to the following: - A map which clearly shows vegetation clearing boundaries and no-go zones. - A site walk with the RMS Environmental Officer to confirm clearing boundaries prior to the commencement of work. - A procedure for a suitably qualified ecologist to undertake pre-clearing surveys immediately prior to vegetation removal. Target species would include: *Pimelea spicata*, *Marsdenia viridiflora* subsp*. viridiflora*, Cumberland Plain Land Snail and threatened microbats. - Incorporate management measures identified as a result of the pre-clearing survey report and nominate actions to respond to the recommendations made. - A procedure for clearing potential habitat including hollow-bearing trees in accordance with RMS Specification G40. An experienced, licenced wildlife carer or ecologist would be present to supervise vegetation clearing and capture then relocate fauna if required. Fauna handling and vegetation removal would be in accordance with the RMS Biodiversity Guidelines 2011. An experienced, licensed wildlife carer or ecologist would be notified/on call to supervise	RMS and construction contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	vegetation clearing and capture then relocate fauna if required. Fauna handling would be in accordance with the *RMS Biodiversity Guidelines 2011 – Guide 9*. - Protocols to prevent introduction or spread of pathogens (eg chytrid fungus and *Phytophthora*) should be implemented in accordance with RMS *Biodiversity Guidelines 2011 – Guide 7*. - Provision of education to all personnel taking part in construction activities with regards to the importance of clearing limits, land uses (e.g. non-certified areas, proposed Edmondson Regional Park) and threatened species population and communities and their legislative responsibilities for the same.		
Impacts on threatened species	• If unexpected threatened flora or fauna are discovered, works would stop immediately and the *RTA Unexpected Threatened Species Find Procedure in the RMS Biodiversity Guideline 2011* implemented.	RMS and construction contractor	Construction
Impacts on Cumberland Plain Land Snail	• A relocation plan for the Cumberland Plain Land Snail would be prepared as part of the Flora and Fauna Management Plan. This plan would be developed in consultation with OEH and would consider salvaging snails from habitat within the proposal area and relocation to suitable habitat that would not be affected by the proposal.	RMS	Detailed design and pre-construction
Impacts on Cumberland Plain Land Snail	• A license application to OEH for Cumberland Plain Land Snail relocation under Section 91 would be undertaken prior to works and requirements	RMS	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	incorporated into management plan.		
Loss of native vegetation	• The extent of vegetation removal (including riparian) would be minimised where possible.	RMS and construction contractor	Detailed design and construction
Impacts to riparian areas	• A riparian plan would be prepared as part of the Landscape Plan for areas impacted as a result of the creek realignment and bridge construction. The plan would be prepared in consultation with a qualified ecologist and would include but not be limited to the following measures: - Riparian areas disturbed by the proposal would be rehabilitated as soon as practicable. - Where vegetation would be planted to rehabilitate the newly aligned creek, only native species indigenous to the region would be used. - Vegetation regeneration/weed removal would be undertaken in areas within and adjacent to the proposed construction areas until the areas that are being rehabilitated have become established. - Rehabilitated riparian areas would be maintained for a minimum period of two years after final planting.	RMS and construction contractor	Pre-construction
Impacts on the aquatic environment	• Creek bank stabilisation would be installed prior to and during the creek realignment works in order to minimise bank erosion, topsoil loss and sedimentation of the waterway.	RMS and construction contractor	Detailed design and construction
Impacts on the aquatic environment	• Should fish passage needs to be temporarily blocked for construction purposes, a permit under part 7 of the FM Act would be sought.	RMS and construction contractor	Pre-construction and construction

Impact	Environmental safeguards	Responsibility	Timing
Impacts on the aquatic environment	• Creek diversion would be scheduled during periods of predicted low flow to minimise impacts.	RMS and construction contractor	Construction
Impacts on the aquatic environment	• Notification to DPI (Fisheries) of reclamation/dredging works would be undertaken prior to construction. Consideration would be given to any response within 28 days of notification.	RMS	Pre-construction
Weeds and pathogens	• Actions for weed management would be developed as part of the Vegetation Management Plan in accordance with the requirements of RMS Specifications G36 and G40. The plan would include, but not be limited to, the following: - Type and location of weeds of concern (including noxious weeds) within the proposal area. - Identify sensitive receivers (such as native vegetation and waterways) within or adjacent to the proposal area. - Measures to prevent the spread of weeds and fungi, including hygiene procedures for equipment, footwear and clothing. - Management and disposal weeds (including Declared noxious weeds) which would be in accordance to requirements under the Noxious *Weeds Act 1993* and *RMS Biodiversity Guidelines 2011 - Guide 6* (Weed Management). - A monitoring program to measure the success of weed management until site has been established. - Communication strategies to improve contractor awareness of weeds and weed	RMS and construction contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	management.		
Weeds and pathogens	• Any application of herbicide for weed management would be undertaken in accordance with the requirements of the *Pesticides Act 1999* and an herbicide that is appropriate to the sensitivity of the area would be used. Approval by the RMS Regional Environmental Officer would be obtained prior to use	Construction contractor	Pre-construction and construction
Offsets	• A biodiversity offset strategy would be developed to compensate for loss of ENV within the non-certified areas, loss of EPBC CPW within the proposed Edmondson Regional Park and the reduction in the land area of the proposed Edmondson Regional Park. These offsets would satisfy the terms of the agreements (biodiversity certification and conservation agreement) and requirements under the EPBC Act and Growth Centres and Major Development SEPPs as well as conditions of the existing land zoning. • The offset strategy would be prepared in consultation with OEH, DP&I and SEWPaC and would be in place prior to construction.	RMS	Pre-construction

6.2 Aboriginal heritage

6.2.1 Methodology

An Aboriginal archaeological survey and cultural heritage assessment were carried out for the proposal. The aims of the survey and assessment were to accurately locate previously registered Aboriginal sites, any potential archaeological deposits and to assess their archaeological significance. The complete Aboriginal Archaeological Survey Report is attached to the CHAR in Appendix G of this REF. The outcomes of these investigations are summarised in this section.

This Aboriginal archaeological survey and CHAR were completed in accordance with the RMS PACHCI (RMS 2011), and also applicable OEH regulations, including the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales 2010* (Code of Practice), and the *Aboriginal Cultural Heritage Consultation*

Requirements for Proponents 2010.

The Aboriginal heritage study area is defined as the road reserve of Campbelltown Road (between Camden Valley Way and Brooks Road), as well as a buffer of up to 100 metres on either side of the road. The study area includes the proposal area, access roads and compound sites.

The methodology of the field investigation and assessment consisted of:

- Desktop investigation, including Native Title and Aboriginal Heritage Information System (AHIMS) database searches, as well as consideration of previous archaeological survey reports within and adjacent to the study area.
- Detailed site archaeological survey.
- Consultation with the Aboriginal community.

A Native Title search was conducted on the 23 January 2012 by Artefact Heritage. A search of the AHIMS database was undertaken on the 23 January 2012 (and again on 22 January 2013) for sites within a six kilometre by four kilometre area of the study area with a buffer of 50 metres. Previous Aboriginal Archaeological survey reports within and adjacent to the study area were considered when undertaking the desktop investigations.

A survey of the study area was conducted by Artefact Heritage, accompanied by representatives of TLALC. This survey was undertaken over two days (2 and 3 April 2012). The study area was covered on foot, apart from areas that were clearly highly disturbed, or were heavily vegetated. A handheld Global Positioning System (GPS) was used to track the path of the surveyors, and to record the coordinates of the site, as well as features and location of landform units along the route. As the study area was a long linear strip of land transected by a number of landform units, survey units were not designated.

All ground exposures were examined for stone artefacts, shell or other traces of Aboriginal occupation. Old growth trees were examined for signs of cultural scarring or marking. Photographs were taken to represent the landform units, vegetation communities, objects of interest and levels of disturbance.

A methodology for salvage excavations was prepared in consultation with the Aboriginal stakeholder groups at an Aboriginal Focus Group (AFG) meeting on the 22 February 2013. In accordance with Stage 3 PACHCI a CHAR has been prepared to accompany the future AHIP application informed by further consultation (Appendix G).

6.2.2 History

Aboriginal people traditionally lived in small family or clan groups that were associated with particular territories or places. Groups that were known to use the south-western Sydney areas include the Dharawal, Darug and Gundungurra language groups.

The Dharawal language group was largely coastal and is thought to have extended from the Shoalhaven River, north to Botany Bay and then inland to Camden (Attenbrow 2002, p. 34). Historical records show that the Gundungurra were located to the west and south-west of the Dharawal and into the southern Blue Mountains. The Darug language group occupied much of the Cumberland Plain between the Blue Mountains and the coast, with the language being divided into coastal and

hinterland dialects (Attenbrow 2002, p. 34).

British colonisation had a profound effect on the Aboriginal population of the Sydney region. In the early days of the colony, Aboriginal people were disenfranchised from their land as the British claimed areas for settlement and agriculture. The colonists, often at the expense of the local Aboriginal groups, also claimed resources such as pasture, timber, fishing grounds and water sources.

Relationships between Aboriginal people and colonists were amicable in the early 1800s. A sustained drought during 1814 and 1815 as well as continued disenfranchisement lead to tensions between farmers and Aboriginal people who remained in the south-west of Sydney. These tensions culminated in the Appin massacre, when Aboriginal people were pursued by a detachment lead by Captain James Wallis. Fourteen Aboriginal people of the Dharawal language group were shot or driven over a cliff to their deaths by soldiers. The bodies of two of the Aboriginal men were strung up at the site (Turbet 2011).

Although the numbers of Aboriginal people in the area decreased as settlers and farmers moved into the locality, communities remained living at Camden Park and along the Georges River near Liverpool (Liston 1988).

6.2.3 Existing environment

The study area is an undulating landscape of hills or low ridges with occasional more prominent rises. The landform units within the study area range from swampy creek flats and creek terraces, to gentle hill slopes and gullies. The study area is primarily underlain by Bringelly Shale which forms part of the Wianamatta Group, consisting of shale, carbonaceous claystone, claystone, laminate, fine to medium grained lithic sandstone, rare coal, and tuff (Clark and Jones 1991). The study area would once have been primarily covered by open Cumberland Plain Woodland, which is typical of the Wianamatta Group shale geology (Benson and Howell 1990). Tree species would have included Forest Red Gum (*Eucalyptus tereticornis*), and Grey Box (*E. moluccana*). In the north-east of the study area, Sydney Coastal River-Flat Forest (which occurs along minor watercourses such as Maxwells Creek) would also have been present. Tree species in this area would also have included Forest Red Gum, as well as Cabbage Gum (*E. amplifolia*).

The study area has been heavily impacted by agricultural use and semi-rural development. The Denham Court, Edmondson Park and Bardia areas have been part of a wider agricultural district since the early 19th century. Further ground disturbance resulted from the establishment of the Ingleburn Army Camp in 1939. Widespread erosion in the area can be associated with the camp, both in terms of construction and also as a result of munitions testing. Urban development in the area is still minimal; however, it is expected to increase given that the study area is within the SWGC.

The language groups occupying the current study area are thought to have been the Dharawal, the Darug and the Gundungurra (Attenbrow 2010, pp. 221-222). It has been suggested that the Campbelltown area may have represented the intersection between the boundaries for these language groups, and that the Narellan Valley may have been part of a travel corridor facilitating movement between the northern Cumberland Plain and the Illawarra (JMcDCHM 2007, p.21 after Haglund 1989).

Archaeological data gathered in the locality suggests that artefacts would be found across the landscape in low densities. Higher densities would be found in certain

locations, greatest on terraces and lower slopes within 100 metres of water and higher order streams.

Sites and places

A search of the AHIMS database identified a total of 53 Aboriginal sites within the vicinity of the study area, with four registered within the study area:

- 45-5-0780 (MC-3).
- 45-5-0781 (MC-4).
- 45-5-2455 (DDI).
- 45-5-2455 (SWRL Site 5).

Two additional sites were found to have been recorded within the study area but have not been registered with AHIMS. These are two isolated finds recorded by Mary Dallas in 1999 (IF1 and IF2).

The site survey investigation included visits to each of the four existing AHIMS registered sites in order to relocate the object/s and to check on-site condition.

Eight new Aboriginal sites were located during the site survey: seven open scatters and one isolated find. One site complex was also identified within the study area (CRSCI) (Figure 6-54). The site complex covers approximately 800 metres from the eastern portion of the Urban Growth land to about 200 metres west of the SWRL corridor where the high disturbance associated with the former Ingleburn Defence Site begins (an area of about eight hectares in total). The sites within the study area are described in Table 6-37. Figure 6-52 shows the location of identified Aboriginal sites within the study area.

Table 6-37: Aboriginal sites identified within the study area

AHIMS number	Site name	Site type	Within the proposal area?	Disturbance levels	Landform
45-5-0780	MC-3	Open artefact scatter	No	Low	Slight rise along swamp
45-5-0781	MC-4	Open artefact scatter	No	High	Modified creek bank
45-5-2455	DD1	Open artefact scatter	No	Moderate	Hill slope
45-5-3535	SWRL Site 5 (impacted)	Open artefact scatter	No	High	Hill slope
Not registered	IF1	Isolated find	No	Moderate	Hill slope
Not registered	IF2	Isolated find	No	Moderate	Hill slope
45-5-4245	CR01	Open artefact scatter	Yes	Low	Terrace
45-5-4246	CR02	Open artefact	Yes	Low	Terrace

		scatter			
45-5-4247	CR03	Open artefact scatter	No	Low	Terrace
45-5-4248	CR04	Open artefact scatter	No	Low	Terrace
45-5-4249	CR05	Open artefact scatter	No	Low	Hill slope
45-5-4250	CR06	Open artefact scatter	No	Moderate	Hill slope
45-5-4251	CR07	Open artefact scatter	No	Moderate	Hill slope
45-5-4252	CR08	Isolated find	No	High	Hill slope
TBC	CRSC1	Site complex (artefact scatter)	Partially	Low	Terrace/Hill slope

Source: Artefact Heritage (2013)

Figure deleted from public document

Figure 6-52: Aerial showing identified Aboriginal sites within the study area (Artefact Heritage 2013)

There were no Native Title claims granted or registered for consideration within the Aboriginal heritage study area.

Assessment of archaeological potential

Archaeologist potential is closely related to the levels of ground disturbance in the area. Other factors as also taken into account when assessing archaeological potential include whether artefacts were located on the surface, and whether the area is within a sensitive land form unit according to the predictive statements for the area.

A large section of the study area within the eastern portion of the former Ingleburn Defence Site has been assessed as having a high archaeological potential. The area extends from about 150 metres to the west of the SWRL corridor to the eastern boundary of the Urban Growth land on the northern side of Campbelltown Road. Ground disturbance is generally low/moderate within this study area. A number of surface finds have been located previously as well as by the current study.

Maxwells Creek runs through the area, within a floodplain. The area was also assessed as having a high archaeological potential by the Edmondson Park Aboriginal Heritage Management Plan (AMBS 2003). It is considered likely that the areas to the east and west of the SWRL corridor which have been assessed as having a high archaeological potential and are within CRSC1 would also retain artefact-bearing deposits.

The remainder of the study area has a low archaeological potential as a result of landscape modification associated with development of commercial and residential structures, the development and use of the western section of the former Ingleburn Defence Site and construction of infrastructure.

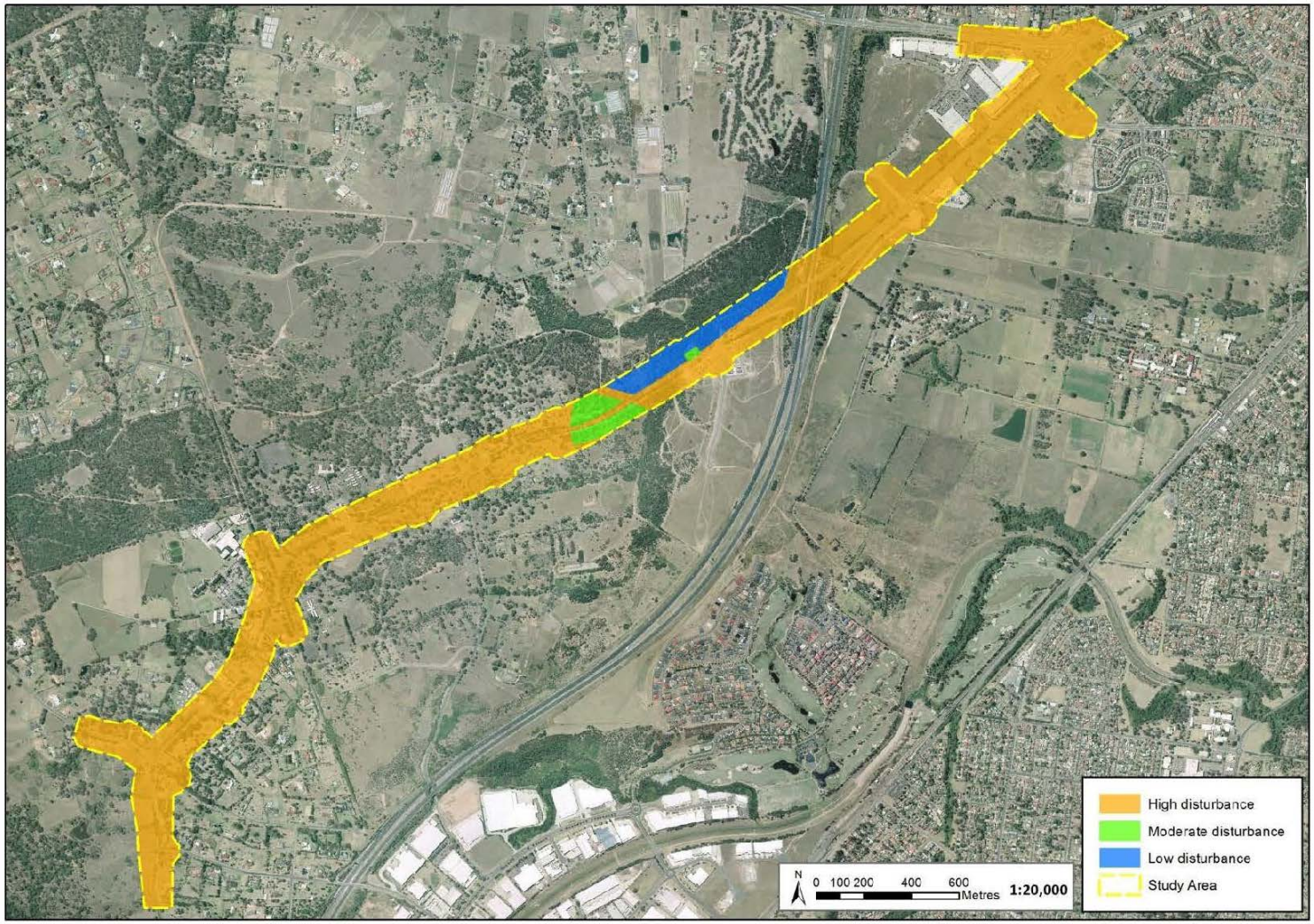


Figure 6-53 shows areas of archaeological disturbance along the study area (Artefact Heritage 2013)

Assessment of archaeological significance

Archaeological significance refers to the archaeological or scientific importance of a landscape or area. This is characterised using archaeological criteria such as archaeological research potential, representativeness and rarity of the archaeological resource and potential for educational values.

The assessment of significance concluded the following:

- Five Aboriginal sites identified along the proposed upgrade corridor for Campbelltown Road have been assessed as having a low archaeological significance. This assessment was made based on the disturbance levels of the site and the number of artefacts present at the site in relation to ground surface visibility. The representative and rarity values of these sites were low.
- Seven Aboriginal sites identified along the proposed upgrade corridor for Campbelltown Road have been assessed as having a moderate archaeological significance. In the case of these sites their representativeness and rarity values were moderate with some potential for research value.
- Two Aboriginal sites identified along the proposed upgrade corridor for Campbelltown Road have been assessed as having a high archaeological significance. These sites are both artefact scatters within areas of low ground disturbance on hill slopes and terraces associated with the tributary of Maxwells Creek.
- Site complex CRSC1 is assessed as having a moderate archaeological significance, based on the assessment criteria outlined above. The site complex includes twelve recorded surface artefact sites across an area that demonstrates low levels of surface disturbance bordering Maxwells Creek. The area has been identified in previous archaeological investigations as both an area of low disturbance (KNC 2010) and an area of high archaeological sensitivity (AMBS 2003, AMBS 2010b).

Table 6-38 provides a summary of the assessment of overall archaeological significance for each of the sites identified during the survey.

Table 6-38: Summary of overall archaeological significance for sites identified during Aboriginal cultural heritage survey

Site name	Research potential	Representative value	Rarity value	Educational value	Overall significance
MC-3	High	Moderate	Moderate	Low	High
MC-4	Low	Low	Moderate	Low	Low
DD1	High	Moderate	Moderate	Low	Moderate
SWRL Site 5 (impacted)	Low	Low	Low	Low	Low
IF1	Low	Low	Low	Low	Low
IF2	Low	Low	Low	Low	Low
CR01	High	Moderate	Moderate	Low	Moderate
CR02	Moderate	Moderate	Low	Low	Moderate
CR03	High	Moderate	Moderate	Moderate	Moderate
CR04	Moderate	Moderate	Low	Low	Moderate
CR05	High	High	Moderate	Moderate	High
CR06	Moderate	Low	Low	Low	Moderate
CR07	High	Moderate	Moderate	Moderate	Moderate
CR08	Low	Low	Low	Low	Low
CRSC1	High	Moderate	Moderate	Moderate	Moderate

Source: Artefact Heritage 2013

Assessment of cultural significance

Cultural significance is characterised using both primary and secondary sources, including consultation with Aboriginal cultural knowledge holders who have specific knowledge about objects, places or cultural features. Consultation with registered Aboriginal parties was undertaken during the preparation of the CHAR and AFG to ascertain the cultural significance of the items identified as part of this investigation.

The assessment of cultural significance concluded the following:

- No specific areas of cultural importance were identified by representatives of the TLALC during the field survey, but it was made clear that the country and landscape as a whole was culturally significant to Aboriginal people.
- Comprehensive consultation with Aboriginal stakeholders through Stage 3 of the RMS PACHI supported the statements of TLALC that all Aboriginal sites and the landscape as a whole are culturally significant to Aboriginal people.
- Aboriginal stakeholders indicated that the management of identified Aboriginal cultural heritage values was important, including details of ongoing management during construction works and protection of areas that are in the vicinity of proposed works but will not be directly impacted.
- It was noted that the complex of sites, not just within the study area but also across the Edmondson Park area as a whole, was important to Aboriginal people, and that the complex of sites across the area should be viewed and managed cohesively. Stakeholders were concerned that the complex of sites within the current study area had already been partially impacted by residential

development in adjoining areas, and that the conservation of identified Aboriginal cultural heritage values is paramount.

- Through written responses to the draft CHAR and at the AFG, Aboriginal stakeholders have indicated their strong support for reburial of artefacts retrieved during archaeological excavation.

6.2.4 Potential impacts

Three identified Aboriginal sites would be directly impacted by the proposal: CRSC1 and associated sites CR01 and CR02.

A 25 metre wide portion of the proposal encroaches into the CRSC1 (along its southern boundary). The impacted area extends about 500 metres to the east and 100 metres to the west of the SWRL corridor to the north of Campbelltown Road. The realignment work at Maxwells Creek extends the proposal a further 50 metres into the CRSC1 (for about 20 metres along the proposal length). In total, the proposal would impact on approximately 1.6 hectares of CRSC1 (which is approximately eight hectares in total). Included within the impacted area of CRSC1 are sites CR01 and CR02, which would be directly impacted by the proposal (Figure 6-54).

The CHAR (Artefact Heritage 2013) concluded that changes in hydrology associated with the realignment would be of net benefit to the CRSC1 site complex and associated sites. The majority of CRSC1 is deemed flood-prone land. The areas subject to inundation during flooding within the site complex would be reduced by the realignment works proposed, with a small section of the site complex to the north-west of the bridge subject to greater inundation. Overall, the proposal would not significantly affect impacts to Aboriginal heritage related to hydrology at this site.

It was considered that mitigation in the form of salvage excavation would be sufficient to manage impacts on Aboriginal sites of moderate archaeological significance. Aboriginal stakeholders have identified that site complex CRSC1 represented high cultural significance, especially in association with other sites in the area. The majority of CRSC1 within the boundaries of the study area would not be impacted by the proposed works.

As significance of the site has been assessed (and no potential archaeological deposits were identified), further sub surface testing under the OEH Code of Practice was not required. An area-based Aboriginal Heritage Impact Permit would be applied for prior to construction and any salvage would be undertaken in accordance with the proposed salvage methodology and any conditions of approval (if granted).

Figure deleted from public document

Figure 6-54: Aerial showing CRSC1, CR01 and CR02 locations in relation to proposal area (Artefact Heritage 2013)

The remaining twelve identified Aboriginal sites are located outside the proposal area and would not be directly impacted by the proposal. There would be potential impact to inadvertently impact Aboriginal sites, however with appropriate safeguards, this potential is considered low. A summary of the potential impacts of the proposal is presented in Table 6-39. There were no potential indirect impacts to sites or artefacts identified.

Table 6-39: Potential impacts of proposal on identified Aboriginal sites and artefacts

Site or artefact ID	Impacts
45-5-0780 (MC-3)	No impacts
45-5-0781 (MC-4)	No impacts
45-5-2455 (DD1)	No impacts
45-5-3535 (SWRL Site 5)	No impacts
IF1	No impacts
IF2	No impacts
CR01	Would be impacted. Within proposal footprint.
CR02	Would be impacted. Within proposal footprint.
CR03	No impacts
CR04	No impacts
CR05	No impacts
CR06	No impacts
CR07	No impacts
CR08	No impacts
CRSC1	Partial. The area of impact is approximately 1.6 hectares

Source: Artefact Heritage (2013)

It was noted during the survey that one Aboriginal site (SWRL 5) has been previously impacted by the SWRL project. SWRL5 is no longer an Aboriginal site and records held by Australian Museum Business Services (AMBS) have been updated accordingly.

6.2.5 Safeguards and management measures

The overall guiding principle for Aboriginal heritage management is that where possible Aboriginal sites would be conserved. If conservation is not possible, measures would be taken to mitigate against impacts to Aboriginal sites.

Table 6-40 summarises the proposed safeguards and management measures for known sites that would be impacted by the proposal, as well as proposed safeguards and management measures for any potential Aboriginal objects which may be identified during construction.

Table 6-40: Proposed safeguards and management measures for Aboriginal heritage

Impact	Environmental safeguards	Responsibility	Timing
Impacts to known	• An Aboriginal Heritage Management Plan would be	RMS and construction	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Aboriginal heritage sites	prepared prior to commencement of works and included in the CEMP. This plan would include but not be limited to the following: - The location of all Aboriginal sites within and adjacent to proposal area. These would be marked on relevant site plans. - An environmental risk assessment to determine potential risks for discrete work elements or activities likely to affect Aboriginal heritage items. - Specific mitigation measures to avoid risk of harm or protect Aboriginal heritage. - Clearly defined boundaries for site CRSC1, including a map representing areas that would need to be protected as no go zones. - If sites are within 25 m of the proposal area, these would be identified on construction plans and exclusion fencing and signage would be placed at the boundary of the proposal area at this location in order to prevent indirect or inadvertent impacts to the site. - A stop works procedure in the event of actual or suspected potential harm to a heritage feature/place. - Workers would be made aware of the location of sites and their responsibilities under the *National Parks and Wildlife Act* and any relevant permits during an Aboriginal heritage induction prior to works commencing.	contractor	and construction
Impacts to known Aboriginal heritage sites	• An area based AHIP would be obtained prior to construction and any salvage would be undertaken in accordance with the proposed salvage methodology and any conditions of approval (if granted).	RMS	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Possible disturbance to unknown Aboriginal heritage due to construction activities	• In the event of an unexpected find of an Aboriginal heritage item (or suspected item), work would cease in the affected area and RMS Regional Environmental Officer and the RMS Senior Environmental Specialist (Aboriginal heritage), would be contacted for advice on how to proceed. The *RMS Unexpected Archaeological Finds Procedure* (2011) would be implemented.	Construction contractor	Construction

6.3 Non-Aboriginal heritage

6.3.1 Methodology

A Non-Aboriginal Heritage Assessment and Statement of Heritage Impact was prepared for the proposal (Artefact Heritage 2013). This report was completed in accordance with the principles and guidelines of the Burra Charter, the *Heritage Manual* (NSW Heritage Office 1996) and *Assessing Heritage Significance* (NSW Heritage Office 2001) to identify any known and/or likely heritage items within the study area and ascertain the significance of any potential impacts. A complete copy of the report is provided in Appendix M, and a summary is provided in this section.

The study area comprised the road reserve of Campbelltown Road, as well as a buffer of 50 to 100 metres on either side of the road. This buffer was designed to be a minimum of 50 metres to capture any known heritage items within the vicinity, based on background documentary research and heritage database searches.

Database searches

Previously identified heritage items in the study area were located through a search of heritage registers. This search was initially undertaken in April 2012 and was repeated in February 2013 to ensure that no changes to heritage listings had taken place. Databases searched include:

- World Heritage List (statutory) – maintained by the World Heritage Committee to protect cultural and natural heritage which the Committee deems to have outstanding universal value.
- National Heritage List (statutory) – established to list places of outstanding heritage significance to Australia. It includes natural, historic and Indigenous places that are of outstanding national heritage value to the Australian nation.
- Register of the National Trust (non-statutory) – lists landscapes, townscapes, buildings, industrial sites, cemeteries and other items or places that the Trust determines have cultural significance and are worthy of conservation.
- Register of the National Estate (RNE) (non-statutory) – lists natural, Indigenous and historic heritage places throughout Australia. It was originally established under the *Australian Heritage Commission Act 1975* (Commonwealth).
- State Heritage Register (SHR) (statutory) – lists places and objects of particular importance to the people of NSW and is administered by the Heritage Branch of the OEH.

- Section 170 register (non-statutory) – established in accordance with Section 170 of the NSW *Heritage Act 1997* to meet RMS statutory requirements. It is administered by RMS.
- Campbelltown LEP 2002 (statutory) – lists items/sites of heritage significance within the Campbelltown LGA.
- Liverpool LEP 2008 (statutory) – lists items/sites of heritage significance within the Liverpool LGA.

An additional desktop investigation was undertaken to research the general history of the locality, the history of the study area itself and of heritage listed items within it. The following libraries were consulted:

- National library of Australia, including both map resources and newspaper archives.
- State library of NSW.
- Land and Property Information Division, including both aerial photographs and the Parish Map Preservation Project resources.

Site survey

Subsequent to this desktop research, a site survey was conducted by Artefact Heritage on 20 April 2012 to identify and inspect any visible heritage items. The site survey included physical inspections of all heritage listed items within the study area, as well as any identified potential archaeological sites (Figure 6-55i-iv). A photographic record was kept, with photographs taken of all heritage items and potential archaeological sites.

Assessment of significance

Assessments of significance for listed items were consulted. An assessment of significance was completed for potential heritage items identified that were not already listed. This assessment was prepared in accordance with the NSW Heritage Assessment Guidelines, which are included in the NSW Heritage Manual (NSW Heritage Office 1996). This approach is founded on the NSW heritage assessment criteria, which are consistent with the principles of the Burra Charter. The criteria used in the assessment of significance are summarised in Table 6-41 below. The assessment also identified the relative level of significance of heritage items as being either state or local.

Table 6-41: Criteria used in assessment of significance (NSW Heritage Office 1996)

Criteria	Description
A – Historical significance	An item is important in the course or pattern of the local area's cultural or natural history.
B – Associative significance	An item has strong or special associations with the life or works of a person, or group of persons, of importance in the local area's cultural or natural history.
C – Aesthetic significance	An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in the local area.
D – Social significance	An item has strong or special association with a particular community or cultural group in the local area for social, cultural or spiritual reasons.
E – Research	An item has potential to yield information that will

Criteria	Description
potential	contribute to an understanding of the local area's cultural or natural history.
F – Rarity	An item possesses uncommon, rare or endangered aspects of the local area's cultural or natural history.
G - Representative	An item is important in demonstrating the principle characteristics of a class of NSW (or local area).

6.3.2 Existing environment

History

The incentive for European exploration in the Camden and Campbelltown districts was the presence of a herd of wild cattle descended from two bulls and four cows that had escaped the first settlement in Sydney in 1788. The settlement of Campbelltown began in 1809, when Lieutenant-Governor Paterson encouraged cultivation in the Cabramatta, Bringelly, and Minto areas following the failure of the colony's main agricultural frontier, the Upper Hawkesbury, which was suffering from flooding and exhausted soils. Paterson was generous with land grants in the Campbelltown region, and further grants were made by Governor Macquarie in 1811 (Liston 1988:7-8). By 1813, a sizable farming community was established in the Minto area. Most of the small grants were concentrated along Bow Bowing and Bunburry Curran Creeks and their owners were engaged in mixed farming; producing barley, wheat, potatoes, sheep, and cattle (Liston 1988:10-11).

Within the study area, large grants were made to Richard Atkins ('Denham Court'), James Meehan ('Macquarie Fields'), Charles Parker ('Parker's Farm'), Henry Kitchen ('Clermont'), and Charles Throsby ('Glenfield'). The first settlers in the area began as pastoralists, grazing sheep, cattle and pigs, before establishing crops of wheat, maize, barley, and oats. In the 1860s, an outbreak of rust destroyed the wheat industry and led to the rise of dairying as a major local industry (AMBS 2010:17).

Current context

By the late 19th century, many of the large estates, including 'Denham Court' and 'Macquarie Fields', had begun to be subdivided and smaller market gardens, poultry farms, dairies, and vineyards were established. The area around the present-day suburbs of Denham Court and Edmondson Park remained an agricultural community until recently, but is becoming increasingly urbanised.

The agricultural influence of the area is still evident in areas in the vicinity of the proposal, particularly in the south-eastern portion of the study area, where cattle grazing can be witnessed from the roadside.

Heritage listed items

There were a number of heritage listed items identified within the study area. The results of database searches are presented in Table 6-42.

Table 6-42: Listed Non-Aboriginal heritage items within the study area

Suburb	Item	Within the study area?	Lot/DP	Listings
Denham Court	Denham Court historic homestead	Yes	Lot 392, DP 564854	SHR. Campbelltown LEP 2002 RNE. Register of the National Trust.
Denham Court	St Mary the Virgin's Anglican Church	Yes	Lot 19, DP 725739	Liverpool LEP 2008. RNE. Register of the National Trust.
Various (unspecified)	Milestones, Campbelltown Road	Yes (3 of the 6 listed milestones)		Campbelltown LEP 2002. Register of the National Trust.
Edmondson Park/ Ingleburn	Mont St Quentin Oval, including entry gates	Yes	Part of Lot 2 DP 831150	Campbelltown LEP 2002. RNE. SHR (draft).
Edmondson Park/ Ingleburn	Mess Hall, Ingleburn Army Camp	No	Part of Lot 2, DP 831150	Campbelltown LEP 2002. RNE.
Edmondson Park/ Ingleburn	Ingleburn Military Heritage Precinct	Yes	Part Lot 2, DP 831152	Liverpool LEP 2008. RNE. SHR (draft).
Edmondson Park/ Ingleburn	Ingleburn Village site and lecture hall building (Nissen hut)	Yes	Part Lots 1 & 2, DP 831152	Liverpool LEP 2008. RNE.
Denham Court	Springmead Farm	Yes	Lot 23, DP 585290	None.
Various	Campbelltown Road corridor	Yes		None.

For the purposes of this assessment, the above listed heritage items are summarised as follows:

- Denham Court (Listed on SHR, Campbelltown LEP 2002, Register of the National Trust, RNE).
- St Mary the Virgin's Anglican Church (Liverpool LEP 2008, RNE, Register of the National Trust).
- Milestones, Campbelltown Road (inclusive of the three within the study area) (Campbelltown LEP 2002, Register of the National Trust).
- Former Ingleburn Defence Site (inclusive of the general area of the former army camp and village, all remnant Ingleburn military sites and features) (various components of this site are listed on Campbelltown LEP 2002, Liverpool LEP 2008, RNE and SHR (draft)).

Figure 6-55i-iv shows the heritage listed items identified within the study area in relation to the proposal area.

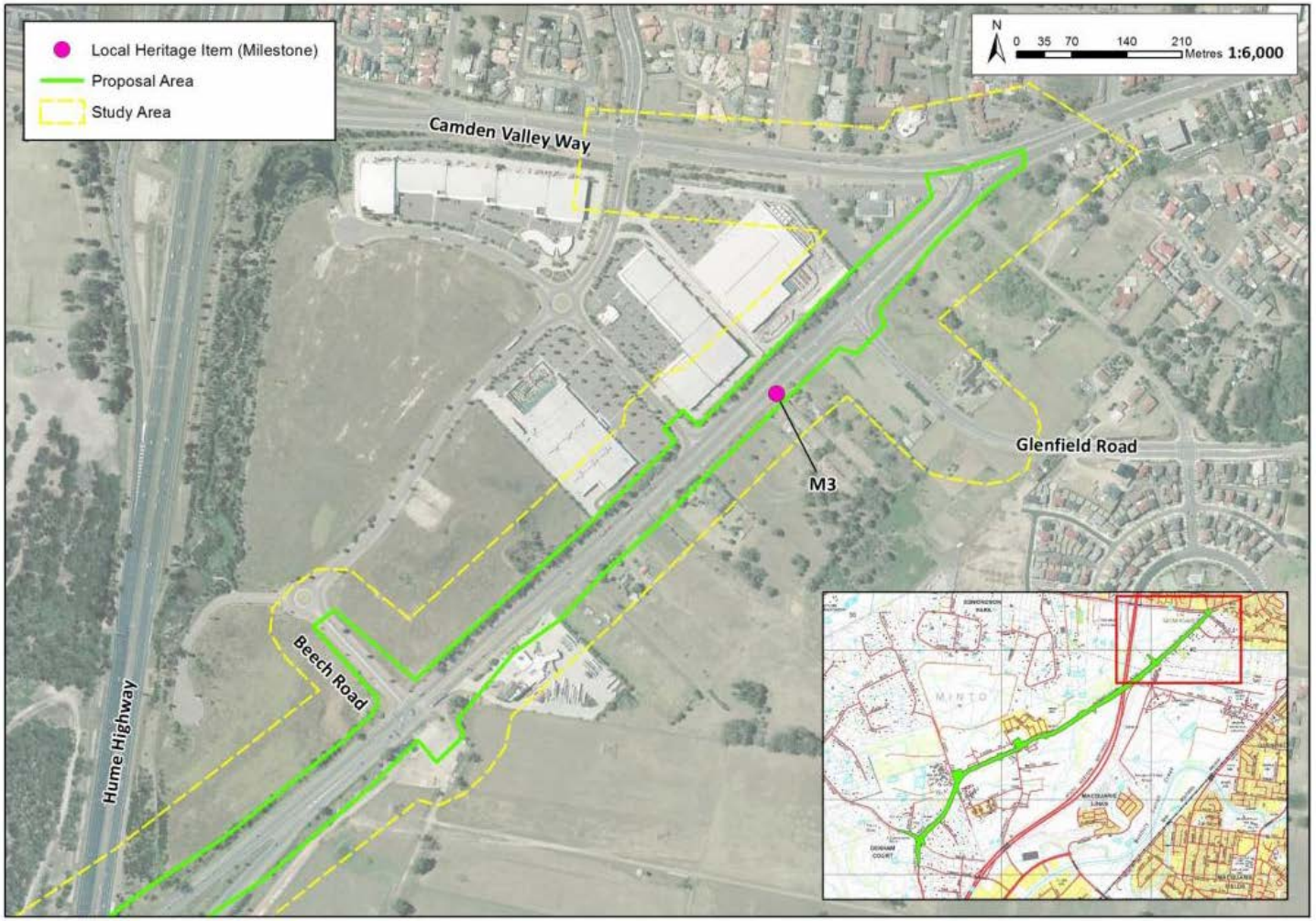


Figure 6-55i: Non-Aboriginal heritage listed items within the study area in relation to the proposal area, Camden Valley Way to Beech Road (Artefact Heritage 2013)

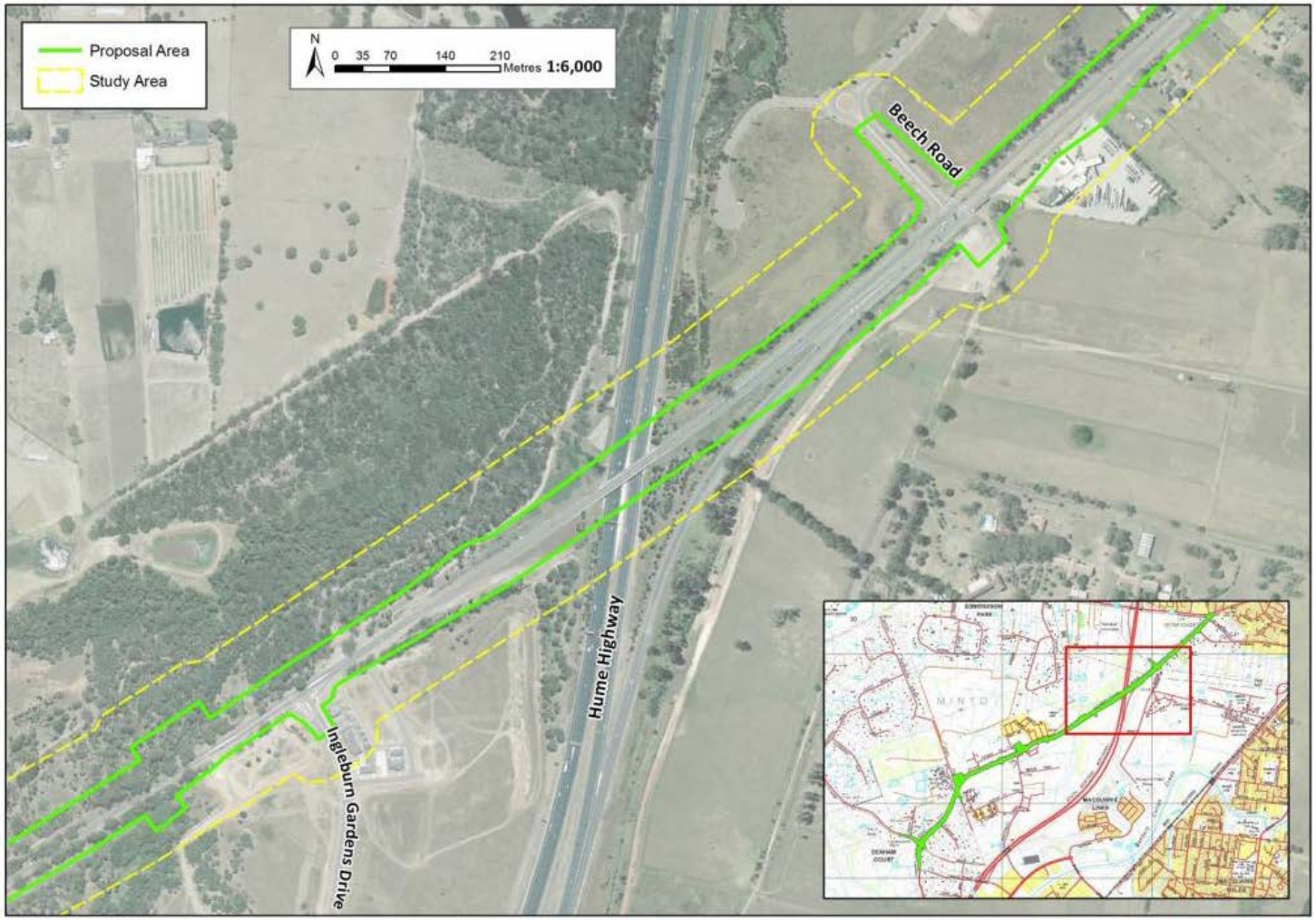


Figure 6-55ii: Non-Aboriginal heritage listed items within the study area in relation to the proposal area, Beech Road to Ingleburn Gardens Drive (Artefact Heritage 2013)

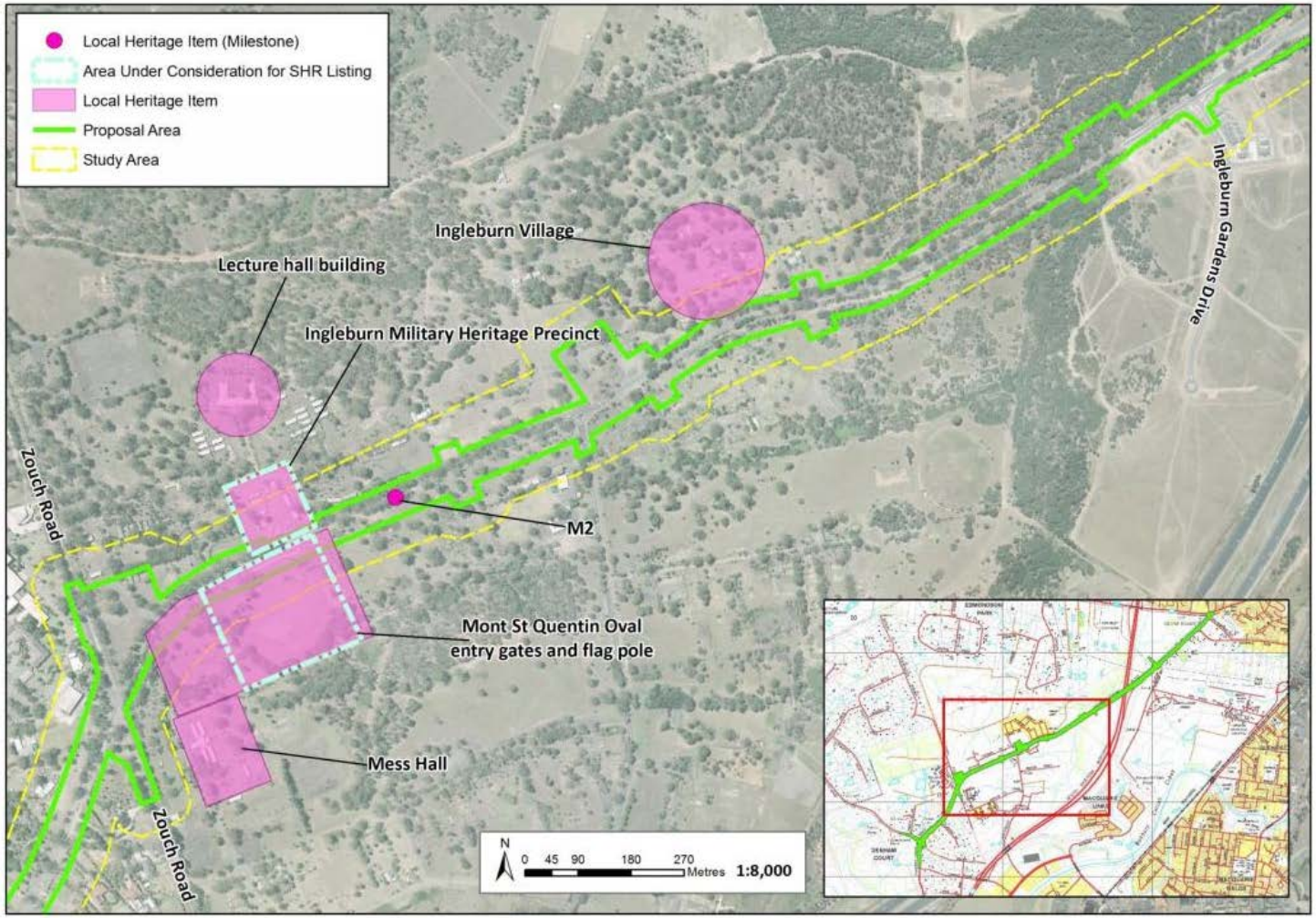


Figure 6-55iii: Non-Aboriginal heritage listed items within the study area in relation to the proposal area, Ingleburn Gardens Drive to Zouch Road (Artefact Heritage 2013)

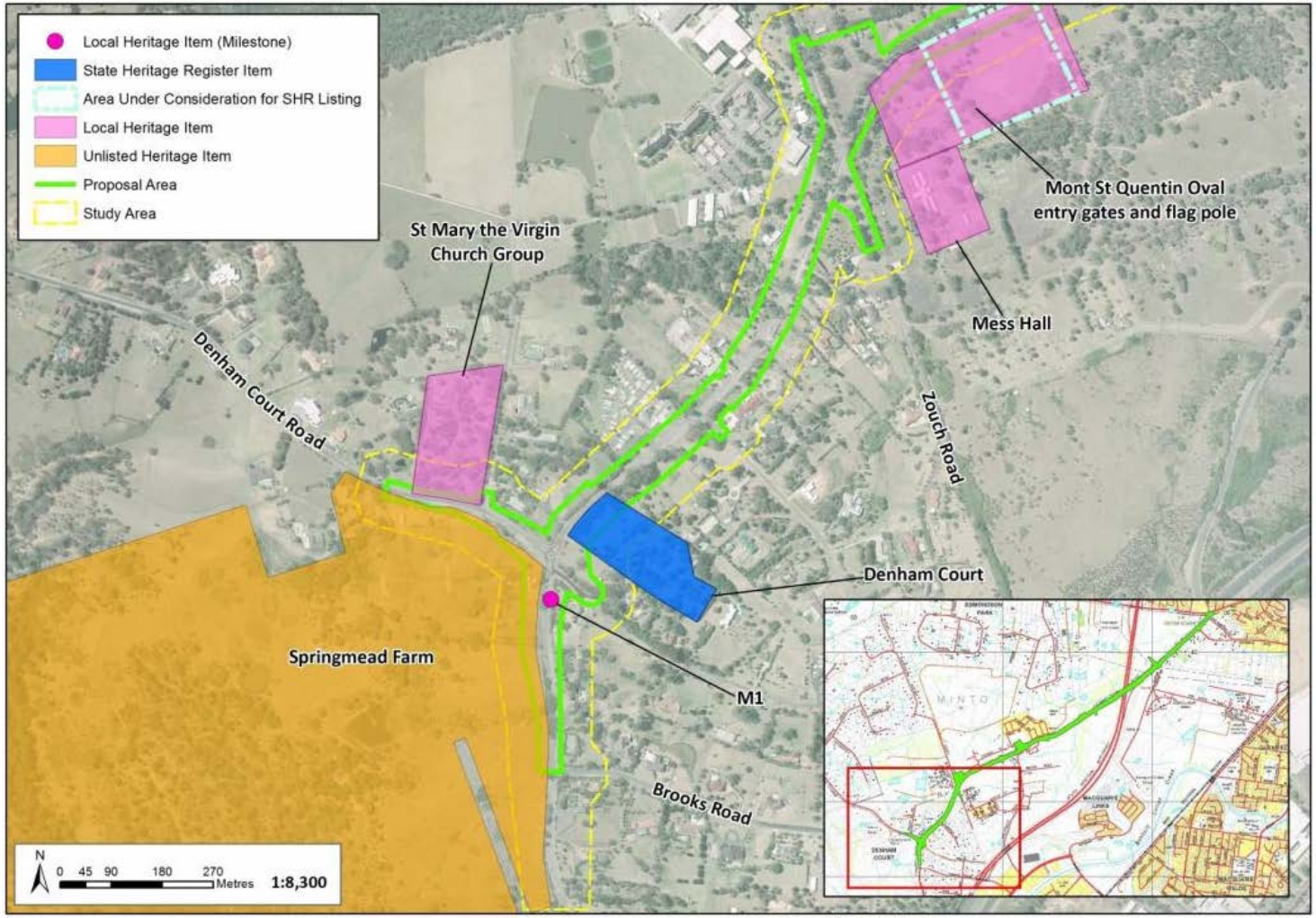


Figure 6-55iv: Non-Aboriginal heritage listed items within the study area in relation to the proposal area, Zouch Road to Brooks Road (Artefact Heritage 2013)

Denham Court

The house at Denham Court was designed by the well-known architect John Verge as a replica of Denham Court in Middlesex, England. Initial design and construction was completed between 1820 and 1829, with an extension added during 1832 and 1833. The house consists of a two-storey central wing in the Grecian style, flanked by single storey bow fronted pavilions with curved sash windows. The central front façade of the central wing features a portico with Doric columns over the doorway.

The house is located on a hill and faces south-east, away from Campbelltown Road. An informal avenue planting of trees runs in a curved line to the east of the house. A large area of lawn slopes gradually from the rear of the house toward Campbelltown Road. Along the street frontage is a row of mature eucalyptus trees, a timber post-and-rail fence and an entrance gate that appears to be modern but which is in keeping with the heritage values of the property.

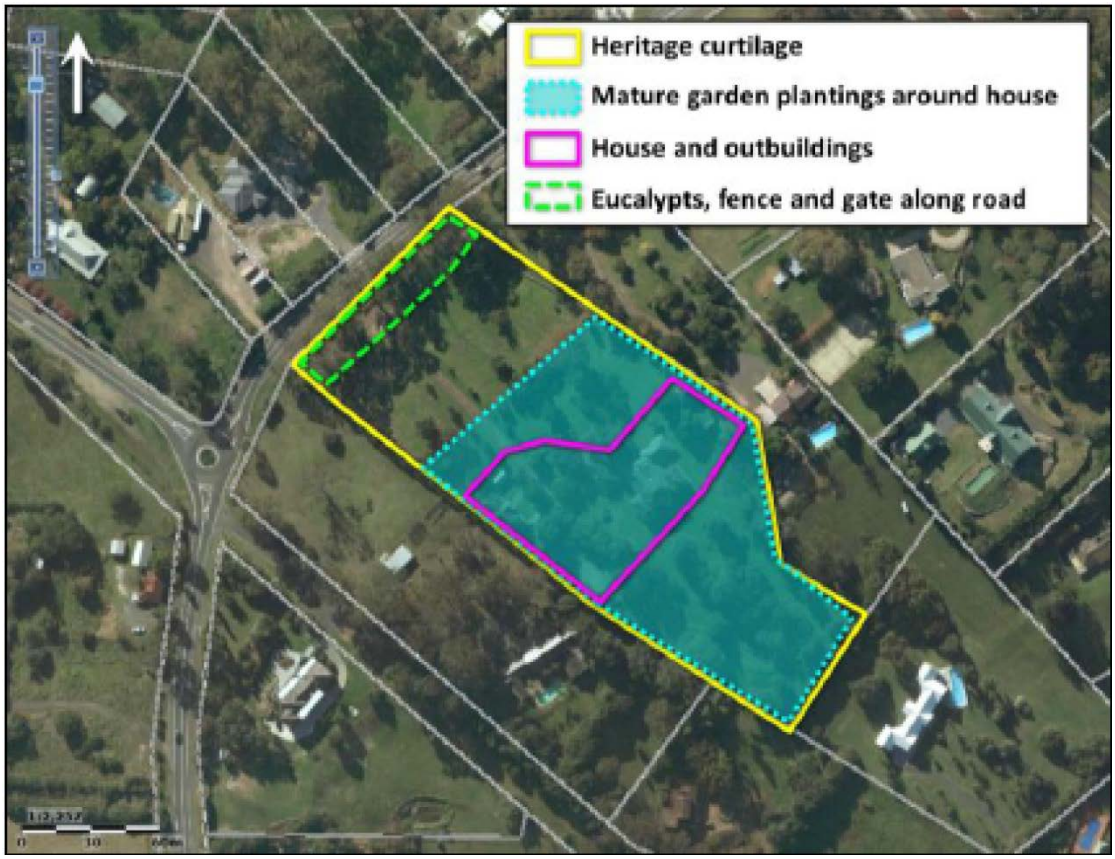


Figure 6-56: Constituent elements of Denham Court (Artefact Heritage 2013)

St Mary the Virgin Church and Cemetery Group

St Mary the Virgin Church at Denham Court is one of the oldest churches in Australia, and is owned by the Anglican Church of Australia. John Verge designed the church between 1833 and 1835. The church and cemetery are separated from Denham Court Road by about 150 metres of bushland, with a fenced area of about 0.4 hectares. It is a small country church, originally built as a private chapel. The cemetery contains approximately 130 monuments, arranged in south-east facing rows with the earliest dated 1837. The church group is of local heritage significance. Although the church is included in the name of the 'Denham Court and Chapel' SHR item, this name is misleading as the listing does not actually include the church.

Figure 6-57: St Mary the Virgin Church (Artefact Heritage 2013)

Milestones

Three milestones are located within the study area. They consist of sandstone blocks between 76.2 centimetres - 91.4 centimetres high, inscribed with Roman numerals. All three milestones are in good condition, though the eastern-most milestone cannot be seen clearly from the road as the shrubs on either side obscure it from view. Each is located within a few metres of the road and is surrounded by metal bollards and garden plantings, with a modern plaque close to one side showing the date and distance of the milestone.

Figure 6-58: Milestone 2, Campbelltown Road (Artefact Heritage 2013)

Former Ingleburn Defence Site

The defence site at Ingleburn was established in 1939 to house the battalions being trained to serve in World War two (WWII). It included a number of different

components, including Mont St Quentin Oval, Bardia Barracks, Ingleburn Village, Lecture Hall building, Mess and Dining Hall complex. The oval served as the original parade ground for WWII troops at Ingleburn Army Camp, and was the location from which troops were formally farewelled and welcomed on return from service overseas. A footpath leads from the Ingleburn Military Heritage Precinct (formerly known as Bardia Barracks) to the northern edge of the oval, passing through two sets of entry gates. These gates include the original set of entry gates to the oval, as well as the Military Hospital gates which were relocated from the former Military Hospital site located elsewhere on the former Ingleburn Defence Site (refer to Figure 6-59 for location of all heritage gates and existing footpath).

The memorial area of the Ingleburn Military Heritage Precinct established in 2001-2 as a National Memorial and conservation zone. The area includes the former Bardia Barracks entrance gates, sentry boxes, Guard House and Cell Block, memorials, the former Post Office and Chaplain's Office, three Sydney Williams type buildings, a section of entry road way, and car parking areas.

The cottages within the village have been gradually demolished over the recent years. There are no longer any extant cottages, but driveways, garden plantings, and other features associated with the former cottages are still visible throughout the former Ingleburn Village site. In 2010, AMBS wrote that archaeological relics that may be present in the vicinity of Ingleburn Village "are unlikely to provide new insights into the lives of those who lived and trained at the camp" (AMBS, 2010:50). It is also unlikely that the remains present elsewhere in the study area would provide any information about the creation or functioning of the camp that is not already known from documentary and oral history sources.

Figure 6-59: Mont St Quentin Oval, flag pole and entry gates (Artefact Heritage 2013)

Figure 6-60: Entry to Bardia Barracks (Google maps)

Non-listed heritage items within the study area

The site survey undertaken by Artefact Heritage (2013) revealed two additional heritage sites that were not listed: Springmead Farm and the alignment of Campbelltown Road itself. These are described below.

Springmead Farm

The western end of the study area encompasses part of a property known as Springmead Farm, located on the south-west corner of the Denham Court Road intersection (Lot 23, DP 585290). Located near the corner are a small brick house (c. 1950s), two modern outbuildings, and several older outbuildings. An 1884 subdivision plan (Appendix M) shows that a cluster of small buildings was present on the corner of Campbelltown and Denham Court roads by this date, along with three fenced paddocks. One of these buildings is labelled as a house, and it is assumed that the others were outbuildings. During the 1930s, the property was owned by Mr and Mrs Hirst, who ran it as a horse stud and lived in a large house off Denham Court Road, to the north of the study area. There is a possibility that archaeological remains associated with the 19th century structures could be present within the study area; however, it is unlikely that these remains would be substantial or intact, due to subsequent building works on the site throughout the 20th century. Any surviving archaeological material within the property is unlikely to be of heritage significance. An assessment of significance is presented in Table 6-43 and statement of significance presented in Table 6-44.

Figure 6-62: Modern buildings at Springmead Farm at the corner of Denham Court Road (Artefact Heritage 2013)

Campbelltown Road

Originally known as the Southern Road from Liverpool to Campbelltown, the road has functioned as a major transport artery from the early 19th century to the present. The alignment of the road has changed little since its original creation as evidenced by an early parish map (Figure 6-62). An assessment of significance is presented in Table 6-43 and a statement of significance is presented in Table 6-44.

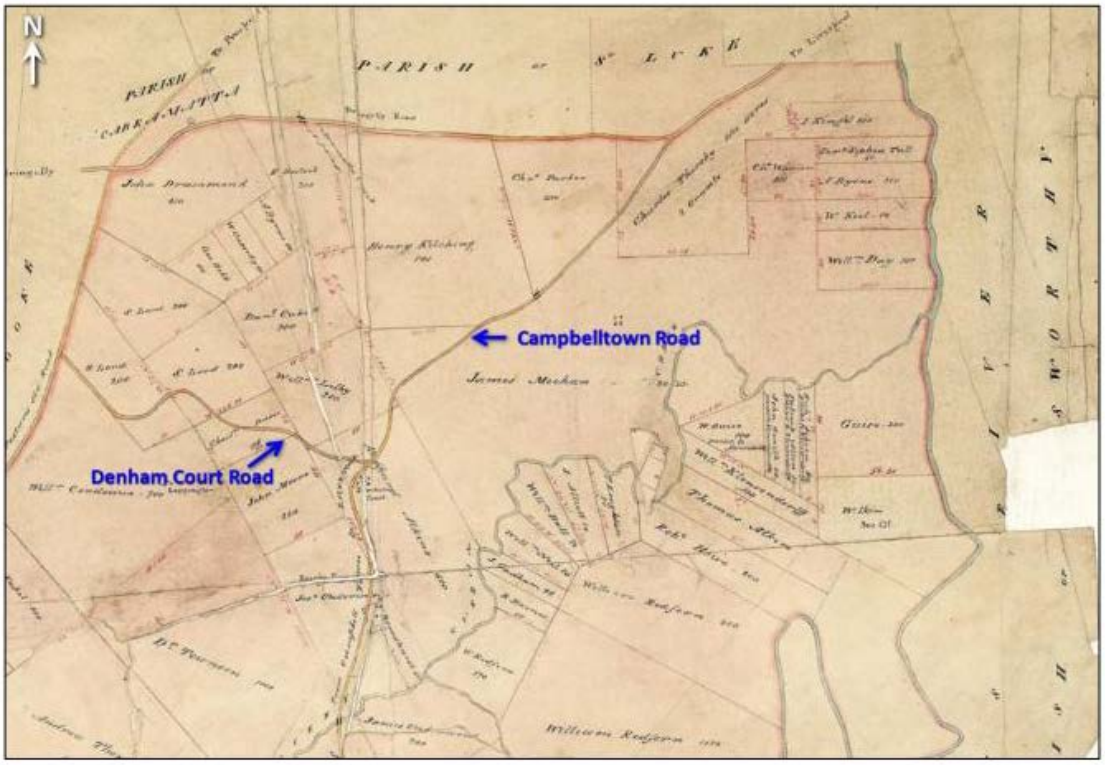


Figure 6-62: Early Parish map showing Campbelltown Road alignment (Artefact Heritage 2013)

Assessment of significance

As part of the Non-Aboriginal Heritage Assessment and Statement of Heritage Impact (Artefact Heritage 2013), assessments of significance were prepared for non-listed items, including Springmead Farm and Campbelltown Road. These are included below in Table 6-43.

Table 6-43: Assessment of significance of non-listed heritage items

Statement	Criterion	Local	State
Campbelltown Road corridor			
The alignment of Campbelltown Road has changed little since its creation in the early 19th century, and is of historical significance as one of the earliest main roads in NSW. Along with other early main roads in the region, Campbelltown Road has the ability to demonstrate patterns of early land use and transportation networks.	Criterion A (Historic significance – Evolution)	Yes	No
Campbelltown Road is not of associative significance.	Criterion B (Historic significance – Association)	No	No
The road passes through a landscape that is still largely rural in nature, and the mature native vegetation along	Criterion C (Aesthetic significance)	Yes	No

Statement	Criterion	Local	State
both sides of the road helps to maintain a visual connection with its rural past.			
The Campbelltown Road alignment is not considered to be of social significance.	Criterion D (Social significance)	No	No
It is possible that remains of former road surfaces survive beneath the existing road. However any such would be unlikely to provide answers to significant research questions, and therefore the research potential of the road is considered to be low.	Criterion E (Research potential)	No	No
The road is not significant as a rare item.	Criterion F (Rarity)	No	No
Campbelltown Road is representative of early main roads in the local area.	Criterion G (Representativeness)	Yes	No
Springmead Farm			
Springmead Farm may be of local historic significance if it is found to include extant features or archaeological evidence related to late 19th century or early 20th century occupation.	Criterion A (Historic significance – Evolution)	Yes	No
The site is unlikely to be associated with any notable individuals or organisations.	Criterion B (Historic significance – Association)	No	No
The site does not appear to contain any structures or features of aesthetic significance, however the rural farm landscape preserved within the property is of aesthetic value.	Criterion C (Aesthetic significance)	Yes	No
The site is not known to be of social significance.	Criterion D (Social significance)	No	No
There is a possibility that archaeological remains associated with the 19th century structures could be present within the study area. Such remains could provide additional information about the occupation of the site; however, it is unlikely that these remains would be substantial or intact, due to subsequent buildings works on the site throughout the 20th century.	Criterion E (Research potential)	Yes	No
Based on the existing knowledge of the site, it is not rare in either a local or State context.	Criterion F (Rarity)	No	No
The site is not known to have any notable representative values	Criterion G (Representativeness)	No	No

The statement of heritage significance for each heritage item (listed and non-listed) is presented in Table 6-44.

Table 6-44: Assessment of significance of listed heritage items

Heritage item	Statement of significance
Denham Court	*"Denham Court is one of the most interesting and historically significant early country houses in NSW. The site was granted to Judge-Advocate Richard Atkins and was later acquired by Captain Richard Brooks, a trader operating in the Indian and Pacific Oceans. He applied to become a free settler and arrived in NSW with his family in 1814. The family came to Denham Court in 1820. The rear buildings at Denham Court are thought to have been built before 1820. The main part of the house, the two-storey front section was designed by John Verge in 1832. The garden contains some remnant colonial and Victorian era plantings, including an informal avenue planting east of the house and a palo alto (Picconia excelsa) tree, which is a rare species nationally."* (SHR entry, in Artefact Heritage 2013). Denham Court is of State significance.
St Mary the Virgin Church and Cemetery Group	*"St Mary's the Virgin Anglican Church & Cemetery Group is one the oldest churches in the State to be erected as a private Chapel, which is still used for public worship. The site is linked with many early families of the area, particularly Richard and Christine Brooks. A number of the Brook's family members are buried in the cemetery. The Church is associated with Colonial Architect John Verge and Bishop William Grant Broughton. The site is aesthetically pleasing containing a rare and well preserved example of a Colonial "Picturesque Gothic" country church, enhanced by the building's retention of its original courtyard and semi-rural setting. There is the potential to gain more information on the site from further architectural, archaeological and documentary research."* (OEH n.d. in Artefact Heritage 2013). The church group is of local heritage significance.
Milestones	*"The milestones are of local historical significance for their association with the construction of a major road that opened up the region south-west of Sydney for development. The installation of milestones along major roads during the 19th century was a form of recognition of their importance to the development of the nation. The milestones are of local significance as one of a group of mid-19th century milestones that demonstrate a degree of creative and technical achievement. The milestones are representative examples of the standardised milestones erected along Campbelltown Road in 1854.*" (Artefact

Heritage item	Statement of significance
	Heritage 2013).
Former Ingleburn Defence Site	An overall statement of significance is included below: "*The Ingleburn Army Camp which was from 1939 to the 1970s, one of Australia's major army camps is a place of considerable historic significance. The site played a central role in the mobilisation of Australia's citizens and their military training throughout World War II and was the first purpose-built infantry training camp for World War II. It was the assembly point for the first military contingent assembled for overseas service in World War II and is associated with training for the Korean and Vietnam Wars and the anti-conscription movement.* *Ingleburn Army Camp is of social significance as it is a symbol of the service given by the generations of soldiers who trained there and as a place where the respect for and remembrance of that service has become a continuity and highly valued tradition. For several generations of NSW men and a smaller number of women, Ingleburn Army Camp is of social significance as a place that was formative in their lives, shaping their values and outlook. It is a place with long associations with a State wide 'Army community', and is a place where a sense of 'Army community' is expressed, celebrated and passed on.* *Ingleburn Army Camp is of social significance for the local community as a landmark that symbolises the important historical and contemporary role played by the Army within the area and as a community meeting place, where links were forged between civilians and Army.* *The remaining buildings on the Ingleburn Army Camp are representative examples of standardised barracks and support structures, which were erected in rapid response to the training demands of World War II. Remnant bushland within the Ingleburn Army Camp includes rare surviving Cumberland Grey box woodland a plant community of high scientific significance."* (Godden Mackay Logan 2001, in Artefact Heritage 2013). More specific statements of significance for surviving elements of the former Ingleburn Defence Site are located near Campbelltown Road.
Springmead Farm	*"Springmead Farm may be of local historic significance if it is found to include extant features or archaeological evidence related to late 19th century or early 20th century occupation. There is a possibility that archaeological remains associated with the 19th century structures could be present within the study area. Such remains could provide additional information about the occupation of the site; however, it is unlikely that these remains would be substantial or intact, due to subsequent buildings works on the site throughout the 20th century. The rural farm landscape preserved within the property is of local aesthetic value."* (Artefact Heritage 2013).

Heritage item	Statement of significance
Campbelltown Road	*"The alignment of Campbelltown Road has changed little since its creation in the early 19th century, and is of historical significance as one of the earliest main roads in NSW. Along with other early main roads in the region, Campbelltown Road has the ability to demonstrate patterns of early land use and transportation networks (AMBS, 2010:14). The road passes through a landscape that is still largely rural in nature (although planned developments will soon change this), and the mature native vegetation along both sides of the road helps to maintain a visual connection with its rural past."* (Artefact Heritage 2013).

6.3.3 Potential impacts

The proposal would involve direct impacts to a number of heritage listed items: Denham Court, elements of the former Ingleburn Defence Site, and three milestones, in addition to features and sites of potential heritage significance. Table 6-45 outlines the potential impacts to each identified heritage item during operation and construction of the proposal and an assessment of the significance of the potential impacts.

Other potential impacts to heritage items that could occur during construction include:

- Previously unidentified artefacts could be uncovered in disturbed areas.
- The use of plant and machinery could contribute to vibration impacts in heritage buildings or accidental damage to the fabric of nearby heritage items.

The proposed road alignment would essentially follow the existing road alignment, which has changed little since the construction of the road in 1818. Therefore, other potential impacts to heritage items that could occur during construction or operation of the Campbelltown Road upgrade are considered unlikely.

Table 6-45: Assessment of significance of potential impacts to heritage items

Item	Listing(s)	State or local significance	Impact of proposal	Impact significance
Denham Court	SHR (S71313) Campbelltown LEP 2002 Register of the National Trust (S71313) RNE (Place ID 3275)	State	• The proposal area would encroach into the curtilage of the property by a distance of up to about 37 m. Up to 27 m of this total would be included in the road corridor, while about 10 m including the road batters would be returned to the curtilage of Denham Court following the completion of works (see Figure 2-11). • The fence and gate along the boundary of the property would be relocated within the curtilage. Trees of a similar species would be planted within the curtilage. • Views toward Campbelltown Road from Denham Court would not be affected due to the screening vegetation present to the north-west of the house. • The proposed work is unlikely to involve vibratory impacts to the heritage structures at Denham Court, which are all located at least 50 m from the proposal area.	• As the current curtilage of the item is much reduced from the original size of the estate, it is not considered that the size of the current lot makes a significant contribution to the heritage significance of the item, beyond its role in ensuring that an adequate area of lawn and garden is retained around the house in order to maintain a sense of its original setting. A substantial amount of lawn (at least 50 m between the proposal area and the closest building) would be retained and the existing plantings between the homestead complex and the property boundary (excluding the Eucalypts along the Campbelltown Road frontage) would be retained. • While there would be a loss in curtilage along the proposal boundary, the historical relationship between the property and Campbelltown Road would remain essentially unchanged as the property would retain a frontage to Campbelltown Road.

Item	Listing(s)	State or local significance	Impact of proposal	Impact significance
			• It is unlikely that significant archaeological deposits associated with Denham Court would be impacted by the proposal.	• The loss of the eucalypts along the property boundary would have a negative impact on views toward Denham Court, as well as views along Campbelltown Road in the short-term, while new trees grow to re-establish the existing view. • An Arboricultural Assessment (Footprint Green 2013) has assessed that the SULE of each of the eucalypt trees in a row along the property boundary is five years or less due to poor health. Consequently, these trees would eventually require removal regardless of the impact of the proposal. • Therefore, although it would be preferable for impacts to the curtilage of the item to be avoided or minimised, this impact is considered to be acceptable if alternatives have been considered and discounted.
St Mary the Virgin Church and Cemetery Group, including church and churchyard.	Liverpool LEP 2008 Register of the National	State	• The proposal area includes a small strip of land (about 5 m) along the western side of the item's heritage curtilage and a minor section at the corner of	• The proposal would not involve significant impacts to the views or setting of the church.

Item	Listing(s)	State or local significance	Impact of proposal	Impact significance
	Trust (S9893) RNE (Place ID 3275)		Denham Court Road and Church Road. • The item would not be affected by vibration impacts because all structures on the site are located over 100 m from the construction footprint. • Views to and from the church would not be impacted by the proposal.	
Milestones, Campbelltown Road	Campbelltown LEP 2002 Register of the National Trust (S9001) Register of the National Trust (S8975) Register of the National Trust (S8976)	Local	• The proposal would require the relocation of three heritage listed milestones (Campbelltown LEP 2002) on the southern side of Campbelltown Road: M1 (near Denham Court Road), M2 (near Bardia Barracks) and M3 (near Glenfield Road).	• Relocation of these milestones beside the road following completion of works would retain their heritage significance, provided that the milestones were relocated at the same distance along the road.
Former Ingleburn Defence Site – Ingleburn Military Heritage Precinct	SHR (draft) Liverpool LEP 2008 RNE (RNE Place ID 101050)	State	• Although the proposal area includes the southern boundary of the Precinct, the construction footprint would avoid direct impacts to the gates and entrance and would not impact	• There would be no impact to heritage significance provided appropriate safeguards are implemeterd during construction to avoid vibration impacts.

Item	Listing(s)	State or local significance	Impact of proposal	Impact significance
			on the curtilage of the item. • The original walls and sentry boxes of the entrance to Bardia Barracks would be located very close to the construction footprint, and could be subject to potential vibratory impacts. • There is potential for incidental impacts during construction due to proximity of proposed works.	
Former Ingleburn Defence Site – Mont St Quentin Oval	SHR (draft) Campbelltown LEP 2002 RNE (RNE Place ID 101050)	State	• The proposal would require relocation of the northernmost set of entry gates to Mont St Quentin Oval. • The proposal would retain the original set of entry gates to Mont St Quentin Oval within a verge between the road and the existing path. • The existing footpath to the north of the oval would be replaced by the verge which would be the area of a possible shared path that runs along the southern extent of the proposed upgrade. • The trees alongside Campbelltown Road where it passes the entrance to Mont St	• The northernmost set of entry gates were relocated from the site of the former military hospital in 1997. Relocation to elsewhere within the Ingleburn Military Heritage Precinct or Mont St Quentin Oval heritage curtilage would not have an impact on their heritage value. • While the original Mont St Quentin Oval entry gates would not be directly impacted, their setting would be substantially altered, as they would be bypassed by the footpath and would no longer function as the entry to the oval. • The replacement of the existing footpath to the north of the oval with the shared path would obscure the

Item	Listing(s)	State or local significance	Impact of proposal	Impact significance
			Quentin Oval and Ingleburn Military Heritage Precinct would be removed.	connection between the oval and Bardia Barracks. The proposed impact would be acceptable, provided that some form of heritage interpretation was employed to indicate the historic connection between the oval and the barracks. Ideally, this would be achieved by reinstating the existing northernmost set of entry gates to the oval on the footpath, adjacent to the entrance to Bardia Barracks. • The trees alongside Campbelltown Road at the entrance to Mont St Quentin oval and the Ingleburn Military Heritage Precinct are considered by the local community to mark the extent of the former Ingleburn Defence Site and are thus seen to hold significance. However, if their removal is necessary it would be an acceptable impact, provided that mitigation measures were employed.
Former Ingleburn Defence Site – Mess Hall (otherwise known as the kitchen/ dining hall complex)	Campbelltown LEP 2002 RNE (RNE Place ID 101050)	Local	• The Mess Hall is not located within the proposal area and would not be impacted by the proposal.	• There would be no impacts to heritage significance.

Item	Listing(s)	State or local significance	Impact of proposal	Impact significance
Former Ingleburn Defence Site – Ingleburn Village site and lecture hall building (Nissen Hut)	Liverpool LEP 2008 RNE (RNE Place ID 101050)		• Most of the remaining features associated with Ingleburn Village are located some distance from the proposal area and would not be affected by the proposal. • Those remaining features associated with Ingleburn Village that are located within the proposal area would be removed.	• Those features of Ingleburn Village that would be directly affected by the proposal area are former roads and car parking areas of low heritage significance.
Springmead Farm	Unlisted	Local	• Only a narrow section of the property falls within the proposal area (around 5-35 metres along its eastern boundary). • The proposal would require removal of the three modern buildings near the corner. • There would be potential subsurface impacts in the vicinity of the demolished buildings and to the west of Denham Court Road.	• It is unlikely that substantial or intact archaeological deposits associated with earlier structures are present within the study area. • The significance of the site derives from the large intact area of rural pastureland that is preserved in the property. The proposal would only involve a small reduction of 5 to 35 metres in the curtilage of the property along the roadside, constituting a tiny proportion of the entire property, and this would not have a significant impact on the rural landscape or the significance of the item. The proposed impacts are acceptable.
Campbelltown Road	Unlisted	Local	• The proposed alignment of the	• Any remains of former road

Item	Listing(s)	State or local significance	Impact of proposal	Impact significance
corridor			road would essentially follow the existing road alignment, maintaining the ability of the road to demonstrate historic patterns of land use, transport and regional development. • The widening of the road, the removal of the roadside trees, and the addition of possible features such as traffic lights, would impact on the rural nature of the road. This would also be compounded by associated changes to the surrounding landscape through planned urban development.	surfaces would be unlikely to provide answers to significant research questions, and therefore the heritage impact is unlikely to be significant.

6.3.4 Safeguards and management measures

The impacts on items of heritage significance can be mitigated through the implementation of a series of safeguards specific to identified items. Table 6-46 summarises the proposed safeguards and management measures for each of the locations that would be impacted by the proposal, as well as proposed safeguards and management measures for potential unexpected archaeological finds which may be located during construction. It should be noted that the proposal design has avoided known heritage items and archaeological deposits where possible.

Table 6-46: Proposed safeguards and management measures for Non-Aboriginal heritage

Impact (site or artefact ID)	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage impacts	• A Non-Aboriginal Heritage Management prepared prior to commencement of works and included in the CEMP. This plan would include but not be limited to the following: - Sensitive areas mapped which clearly identifies all known non-Aboriginal heritage items (including curtilages) and exclusions zones. - Mitigation measures to avoid risk of harm including dilapidation surveys (including measures outlined in Noise and Vibration Management Plan). - Fencing to control access to exclusion zones during construction - A non-Aboriginal heritage induction to all site personnel prior to commencing works. Aspects such as location of heritage items, their significance, responsibilities under the *Heritage Act 1977* and any relevant permits would be discussed.	RMS and construction contractor	Pre-construction and construction
Impacts to Denham Court	• Impacts to curtilage of Denham Court would be minimised where possible.	RMS and construction contractor	Detailed design and construction
Impacts to Denham Court	• Archival recording of existing curtilage, trees, fence and gate would be undertaken prior to commencing works.	RMS	Pre-construction

Impact (site or artefact ID)	Environmental safeguards	Responsibility	Timing
Impacts to Denham Court	• A relocation plan for the fence and gate to Denham Court would be prepared as part of the Non-Aboriginal Heritage Management Plan by a qualified heritage consultant and in consultation with OEH (Heritage Branch). • The fence and gate would be relocated outside of the area of impact and replacement trees of the same or similar species would be replanted along the fence in the same number and configuration.	RMS and construction contractor	Pre-construction and construction
Impacts to Denham Court	• Works would be undertaken in accordance with a Section 60 permit which would be obtained from NSW Heritage Council prior to works commencing at this location.	RMS and construction contractor	Pre-construction and construction
Impacts to St Mary the Virgin Church and Cemetery Group	• If any trees are removed as part of the proposal, replacement trees of a similar species would be planted along the southern boundary of the item's curtilage following completion of works in consultation with the landowner.	RMS and construction contractor	Pre-construction and construction
Impacts to three milestones	• A relocation plan for the affected milestones would be prepared as part of the Non-Aboriginal Heritage Management Plan by a qualified heritage consultant. This relocation plan would include the following measures: - The milestones would be repositioned beside the upgraded road, each at its original distance along the road, as indicated in the Non-Aboriginal Heritage Assessment and Statement of Heritage Impacts (Artefact Heritage 2013). - Methods to prevent damage during movement, options for storage before reinstatement (including measures to prevent the milestones or their provenance details being lost).	RMS and construction contractor	Pre-construction and construction

Impact (site or artefact ID)	Environmental safeguards	Responsibility	Timing
	- Options for landscaping and heritage interpretation near the milestones once they are reinstated would be considered.		
Impacts to former Ingleburn Defence Site	• Archival recording of the former Ingleburn Defence Site elements which would be impacted by the proposal in their existing context would be undertaken prior to works commencing.	RMS	Pre-construction
Impacts to former Ingleburn Defence Site	• Prior to commencement of works, an exception under Section 139 of the *NSW Heritage Act 1977* would be obtained for impacts to identified relics within the proposal area.	RMS	Pre-construction
Impacts to former Ingleburn Defence Site	• A condition survey would be undertaken before the start of work by a qualified contractor to minimise vibration impacts in the vicinity of Bardia Barracks (refer to noise and vibration safeguards Section 6.7.5).	Construction contractor	Pre-construction
Impacts to former Ingleburn Defence Site	• A fenced exclusion zone would be established around the original fabric of the entrance to Bardia Barracks and the entrance gates to the oval, in order to prevent incidental impacts during construction. If necessary, insulating material would be used to further protect the fabric from accidental damage.	Construction contractor	Pre-construction
Impacts to former Ingleburn Defence Site	• Further consideration of the configuration of the path and both sets of entry gates to Mont St Quentin oval would be undertaken in detailed design (as per the Statement of Heritage Impacts (Artefact Heritage 2013)).	RMS	Detailed design
Impacts to former Ingleburn Defence Site	• Impacts to the trees on either side of Campbelltown Road in the vicinity of the former Ingleburn Defence Site road would be minimised or avoided where possible. Where trees are removed, similar species would be replanted along roadsides	RMS and construction contractor	Detailed design and construction

Impact (site or artefact ID)	Environmental safeguards	Responsibility	Timing
	following the completion of works.		
Impacts to former Ingleburn Defence Site	• If the draft SHR listing for the Ingleburn Military Heritage Precinct and Mont Saint Quentin Oval is finalised prior to the commencement of works, a Section 60 permit would be obtained from the NSW Heritage Council prior to commencement of works at this location.	RMS	Pre-construction
Impacts to unanticipated heritage items	• If unexpected archaeological remains or potential relics are uncovered during the works, all works would cease in the vicinity of the material/find and the RMS Unexpected Archaeological Finds Procedure 2012 would be followed.	RMS and construction contractor	Construction

6.4 Hydrology and water quality

6.4.1 Methodology

A Flooding and Drainage Investigation was undertaken by Lyall and Associates (Lyall and Associates (2013) (Appendix J of this REF). The investigation identifies the local catchments and defines the flood flows experienced at Campbelltown Road.

The study area, for the purpose of discussions on hydrology and drainage impacts, divides the length of the proposal into three sections, with each section representing a different creek system in which the existing road drainage systems are located. The Flooding and Drainage Investigation defines the catchments and cross drainage requirements. Each system is described separately to outline the source of flows in existing drainage lines which cross the road corridor.

Catchment modelling was undertaken to define peak flood flows arriving at the road corridor at the various cross drainage sites. Modelling was also used to investigate the impact that widening the road and upgrading existing cross drainage would have on peak flows in existing drainage lines downstream of Campbelltown Road, and to assist in the development of a strategy for discharging runoff from the upgraded roadway to these receiving drainage lines.

Existing cross drainage systems along the length of the road upgrade were hydraulically assessed to firstly define the hydrologic standard of the existing carriageway. Further hydraulic analysis was then undertaken to assess requirements for the future upgrade of cross drainage along the route.

The study included a detailed hydraulic investigation to determine the nature of flooding under both pre-road and post-road upgrade conditions where Campbelltown Road crosses Maxwells Creek, a tributary of the Georges River, due to the complex

nature of flooding patterns in this area. Requirements for the upgrade of existing cross drainage at this location aimed at minimising the impact of the road upgrade on flood behaviour were also assessed. Flow depths and velocities both upstream (south) and downstream (north) of the road corridor for storms with ARIs of 1 and 2 years was undertaken to assess the potential impacts of realigning a section of Maxwells Creek.

A complete copy of the report is available in Appendix J of this REF and a summary is provided below.

6.4.2 Existing environment

The proposal is located within the upper reaches of the Georges River catchment. The creek systems identified within the study area are:

- Maxwells Creek System, extending from the intersection with Camden Valley Way to 200 metres to the south of Zouch Road.
- Cabramatta Creek System, extending from 200 metres south of Zouch Road to the intersection with Denham Court Road.
- Cottage Creek System, extending from south of Denham Court Road to Brooks Road.

The area adjacent to Maxwells Creek is also a floodplain. The systems drain to ten cross drainage structures along Campbelltown Road and one existing cross drainage structure under the southbound ramp to the Hume Highway. The existing drainage structures are outlined in Section 2.2, Table 2-4.

Maxwells Creek

Campbelltown Road crosses the main arm of Maxwells Creek immediately to the south of Ingleburn Garden Estate. The creek system has a number of small tributaries on either side of Campbelltown Road, with the main confluence being adjacent to Ingleburn Gardens Drive. The creek runs generally to the north and is conveyed under the existing two lane carriageway via a three cell box culvert system. Maxwells Creek is thought to be ephemeral based on observations. It was seen to be flowing after heavy rains in January and February 2012; however, was dry for both inspections in August 2012 and January 2013. Both in-bank and overbank areas of the creek are heavily vegetated on either side of the road corridor; however, the creek channel south of Campbelltown Road has been completely cleared and planted out as part of adjacent private development.

The Maxwells Creek catchment is approximately 1.8 square kilometres in area at Campbelltown Road. The catchment includes Edmondson Park South, part of the broader Edmondson Park precinct that forms part of the SWGC.

Between its intersections with Camden Valley Way and Beech Road, runoff from the dual carriageways of Campbelltown Road is controlled by the existing pavement drainage system. The system discharges to an existing drainage line that runs to the north of Campbelltown Road, along Parkers Farm Place. The trunk drainage line comprises a single 1800 millimetre diameter RCP running westward and increasing in size to 2100 millimetre diameter west of Beech Road before discharging into Maxwells Creek at the western end of Parkers Farm Place.

Runoff from upslope areas along the southern side of Campbelltown Road is also conveyed to the existing trunk drainage line in Parkers Farm Place via three existing

cross drainage systems that cross the road corridor.

Surface water runoff from the catchment to the north of Glenfield Road is conveyed under Glenfield Road and then under Campbelltown Road via a cross drainage structure (1050 millimetres diameter RCP). This drainage structure also receives runoff from the road corridor via a series of kerb inlet pits, before transferring the water to the trunk drainage line in Parkers Farm Place.

Panorama Estate, to the south of Glenfield Road, is drained internally by a series of piped drainage systems. These systems drain under Campbelltown Road at two locations: one directly through a 1350 millimetre diameter RCP and the other from a stormwater detention basin, through two 750 millimetre diameter RCPs. These cross drainage systems then connect to the trunk drainage line that runs down Parkers Farm Place.

Between Beech Road and the Hume Highway, runoff from the northbound carriageway of Campbelltown Road is controlled by a series of kerb inlet pits and pipes located along the northern kerb-line. Stormwater discharges through a trunk drainage line that drains northwards, crossing Creekside Place before discharging to Maxwells Creek. This trunk drain also captures water from the southern side of Campbelltown Road and a cross drainage structure under the Hume Highway south-bound off ramp. Surface water from these areas drains under the road through a series of 4 x 600 millimetre diameter RCPs.

Immediately west of the existing Hume Highway overbridge, an existing cross drainage system conveys runoff to the north beneath Campbelltown Road. The catchment contributing runoff to this cross drainage structure is around 17.5 hectares in area and includes a section of the Hume Highway corridor extending about one kilometre to the south. This cross drainage also conveys water from the eastern portion of the Ingleburn Garden Estate. Flows are discharged to a small drainage channel which flows into Maxwells Creek about 150 metres north of Campbelltown Road.

The majority of Ingleburn Garden Estate drains to an existing water quality control basin that is located on the south-western corner of Campbelltown Road and Ingleburn Gardens Drive. Water from the basin is directed under Campbelltown Road via a culvert and to a drainage channel that runs northwards, through bushland, and to Maxwells Creek.

West of Maxwells Creek, Campbelltown Road climbs along a ridge line to Mont Saint Quentin Oval over a distance of approximately 1.5 kilometres. A single 375 millimetre diameter RCP drains to the south under Campbelltown Road, discharging to an informal drainage line immediately north of the oval.

Cabramatta Creek

Two cross drainage structures run under Campbelltown Road within the Cabramatta Creek catchment, to convey water from the south-east of the road to the north-west. The northern crossing drainage structure is a 600 millimetre diameter RCP, and the southern crossing structure is a 1525 millimetre diameter RCP. These cross drainage structures discharge into a tributary of Cabramatta Creek, which joins with Cabramatta Creek about 70 metres north of Campbelltown Road.

There are two catchments for Cabramatta Creek. One is immediately north of Blomfield Road, a single 600 millimetre RCP conveys runoff from east to west across

the road corridor, controlling a 2.3 hectare catchment along the eastern side of Campbelltown Road. Further south 200 metres, a single 525 millimetre RCP also conveys runoff from east to west across Campbelltown Road, controlling a 5.6 hectare catchment along the eastern side of the road corridor.

Cottage Creek

South of Denham Court Road, Campbelltown Road continues along a ridge line that falls to the south towards Cottage Creek. The headwaters of Cottage Creek are located 50 to 150 metres south-west from the proposal area. There is no cross drainage under the existing two lane carriageway for the short distance over which the proposed road upgrade works would transition back to match the existing road geometry at Brooks Road.

Existing cross drainage structures and performance

The assessed design capacities for many of the cross drainage structures beneath Campbelltown Road are insufficient to convey flows during events above the 50 year ARI event and, for the structure adjacent to Mont Saint Quentin Oval, above the two year ARI event. The assessment assumed that the cross drainage structures operate at 100 per cent capacity. Blockages to the cross drainage structures by debris or accumulated sediment would further reduce the capacity of the structure and the ARI event that the structure could convey.

The existing cross drainage structures in the proposal area, as well as their performance, are detailed in Table 6-47.

Table 6-47: Existing cross drainage structures and performance

Structure No.	Catchment	Location	Existing drainage structure	Description of receiving environment	Sub-catchment area (ha)	Peak flows (m3/S) (I)			Assessed design capacity (ARI)
						5 year ARI	20 year ARI	100 year ARI	
1	Maxwells Creek	70 m south of Glenfield Road.	1 x 1050 mm diameter RCP	Discharge to piped drainage system along Parkers Farm Place, ultimately drains to Maxwells Creek.	11.1	1.6	2.5	4.0	Unable to be determined.
2	Maxwells Creek	Immediately south of Parkers Farm Place.	1 x 1350 mm diameter RCP		7.7	1.5	2.1	2.8	100 year.
3	Maxwells Creek	80 m south of Parkers Farm Place.	2 x 750 diameter RCPs		13.3	2.7	3.7	4.9	100 year.
4	Maxwells Creek	150 m south of Beech Road.	4 x 600 mm diameter RCPs	Discharge to piped drainage system and ultimately drains to Maxwells Creek.	22.1	2.4	3.9	6.5	20-50 year.
5	Maxwells Creek	Hume Highway Ramp.	1 x 375 mm diameter RCP	Discharge to upstream (southern) side of road, then to inlet of Structure	0.5	0.09	0.13	0.2	20-50 year.

Structure No.	Catchment	Location	Existing drainage structure	Description of receiving environment	Sub-catchment area (ha)	Peak flows (m3/S) (I)			Assessed design capacity (ARI)
						5 year ARI	20 year ARI	100 year ARI	
				No. 4.					
6	Maxwells Creek	Immediately west of Hume Highway.	1 x 1050 mm diameter RCP	Discharge to drainage line that feeds in to Maxwells Creek.	17.5	1.8	2.6	3.9	20-50 year.
7	Maxwells Creek	Immediately west of Ingleburn Gardens Drive.	1 x 2400 mm by 600 mm reinforced concrete box culvert (RCBC)		10.2	1.4	2.1	3.2	20-50 year.
8	Maxwells Creek	Maxwells Creek.	3 x 2700 mm by 1200 mm RCBC	Maxwells Creek.	178	13.8	21.2	34.3	20-50 year.
9	Maxwells Creek	270 m east of Zouch Road.	1 x 375 mm RCP	Discharge to informal drainage line adjacent to Mont Saint Quentin Oval.	3.8	0.43	0.7	1.2	< 2 year.
10	Cabramatta Creek	Immediately east of Blomfield Road.	1 x 600 mm RCP	Discharge to piped drainage system, ultimately	2.3	0.31	0.50	0.83	50-100 year.

Structure No.	Catchment	Location	Existing drainage structure	Description of receiving environment	Sub-catchment area (ha)	Peak flows (m3/S) (I)			Assessed design capacity (ARI)
						5 year ARI	20 year ARI	100 year ARI	
				drains to Cabramatta Creek.					
11	Cabramatta Creek	150 m east of Denham Court Road.	1 x 525 RCP	Discharge to informal drainage line across grassed area adjacent to existing residence.	5.6	0.78	1.3	2.1	2-5 year.

Source: Lyall & Associates (2013)

(1) Peak flows represent local catchment flows only and do not include bypass flows from nearby cross drainage systems. Peak flows have been quoted to more than one decimal place for ease of comparison where flows are relatively small.

(2) Adopted peak 100 year ARI flow rate at Maxwells Creek crossing based on PRM (Probabilistic Rational Method) estimate of 34.3 m^3 /s for the purpose of this investigation. For comparison, the peak 100 year ARI flow rate estimated by DRAINS is 29.8 m^3 /s.

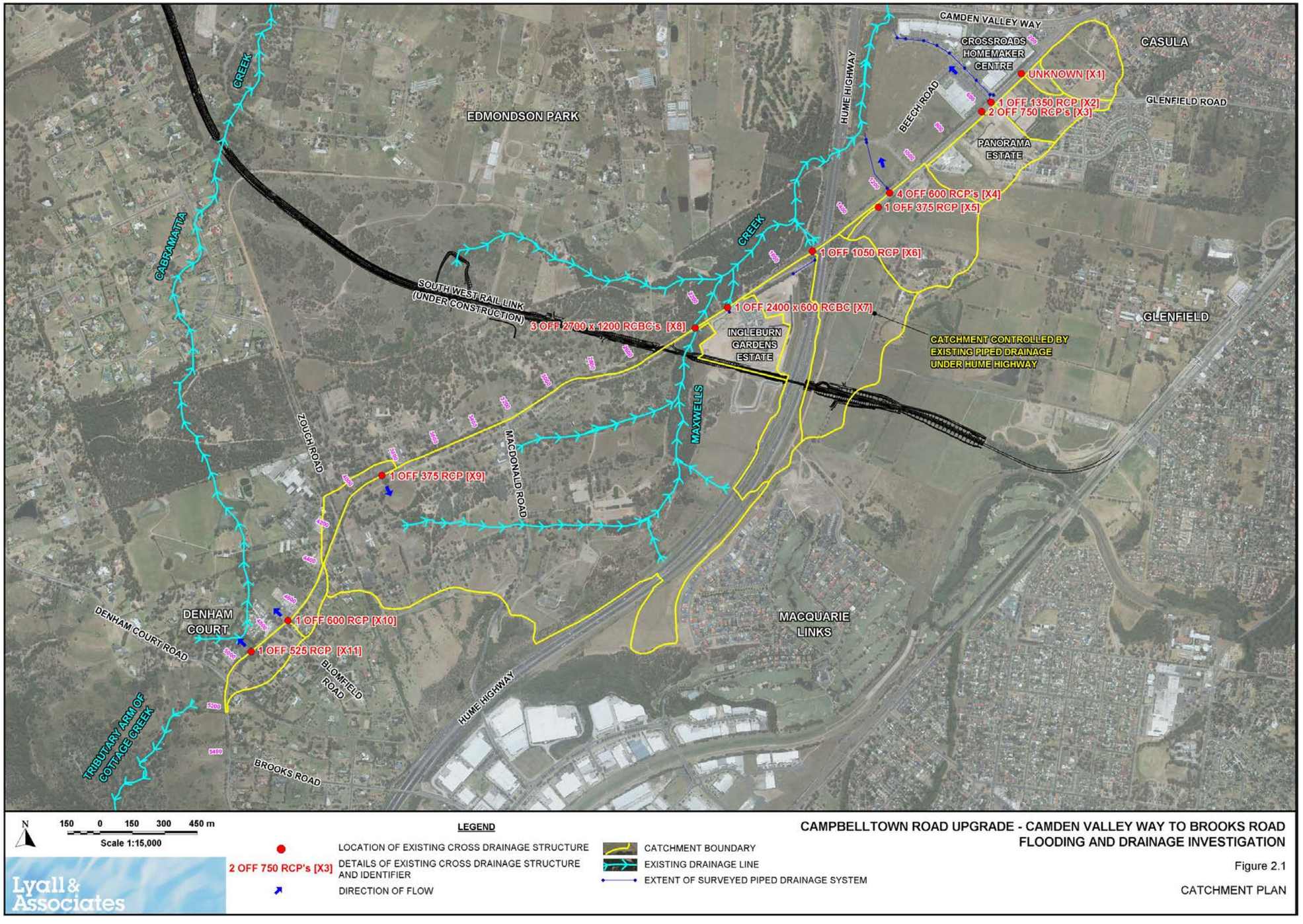


Figure 6-63: Catchments in and around the proposal area and existing drainage structures (Lyall and Associates 2013)

Flood assessment

A flood assessment was undertaken to determine the flooding impacts in relation to the proposal. Investigations of flood prone land in Liverpool and Campbelltown LGAs from the Major Development SEPP Edmondson Park South Flood Planning, shows that the flood prone land in the vicinity of the proposal is specific to the surrounds of Maxwells Creek only. For this reason, the flood assessment undertaken focuses on Maxwells Creek.

Flood modelling was undertaken to determine the baseline flood conditions in the vicinity of Maxwells Creek, based on 100 year ARI flooding patterns in 2011 (with the presence of a levee bank which was located along the right hand bank of Maxwells Creek, immediately upstream of the road corridor), and again following the completion of the SWRL and the channel works which are presently being constructed by the developer of the Ingleburn Gardens Estate.

Results of the latter case are shown in Figure 6-64, as a representation of current flood patterns. The potential for flooding along Campbelltown Road is greatest around Ingleburn Gardens Estate with expected inundation levels between 0.05 and 0.3 metres for a 100 year ARI event.

The modelling shows that the construction of the emergency overflow channel which runs from the western end of the existing water quality pond in the Ingleburn Gardens Estate development to Maxwells Creek has resulted in an increase in the rate at which floodwater will surcharge the existing road culverts on Maxwells Creek. The relief route created by the construction of the channel works leads to an approximately 700 millimetre reduction in the peak 100 year ARI flood level at the inlet to the road culverts. Culverts would convey a peak flow of 25 cubic metres per second during a 100 year ARI event due to the increase in rate of flow discharging toward the east on the southern (upstream) side of the road. This is less than the 33 cubic metres per second under 2011 100 year ARI flood conditions.

Structure No. 7 (which crosses Campbelltown Road immediately west of the Ingleburn Gardens Drive) has insufficient capacity to convey the flow which surcharges Maxwells Creek and the water quality ponds in the Ingleburn Gardens Estate development. This means that, during the 100 year ARI event, floodwater will inundate Ingleburn Gardens Drive near its intersection with Campbelltown Road to a maximum depth of about 800 millimetres. This water would either flow over Campbelltown Road or southwards to Structure No. 6 which crosses Campbelltown Road immediately west of the Hume Highway.

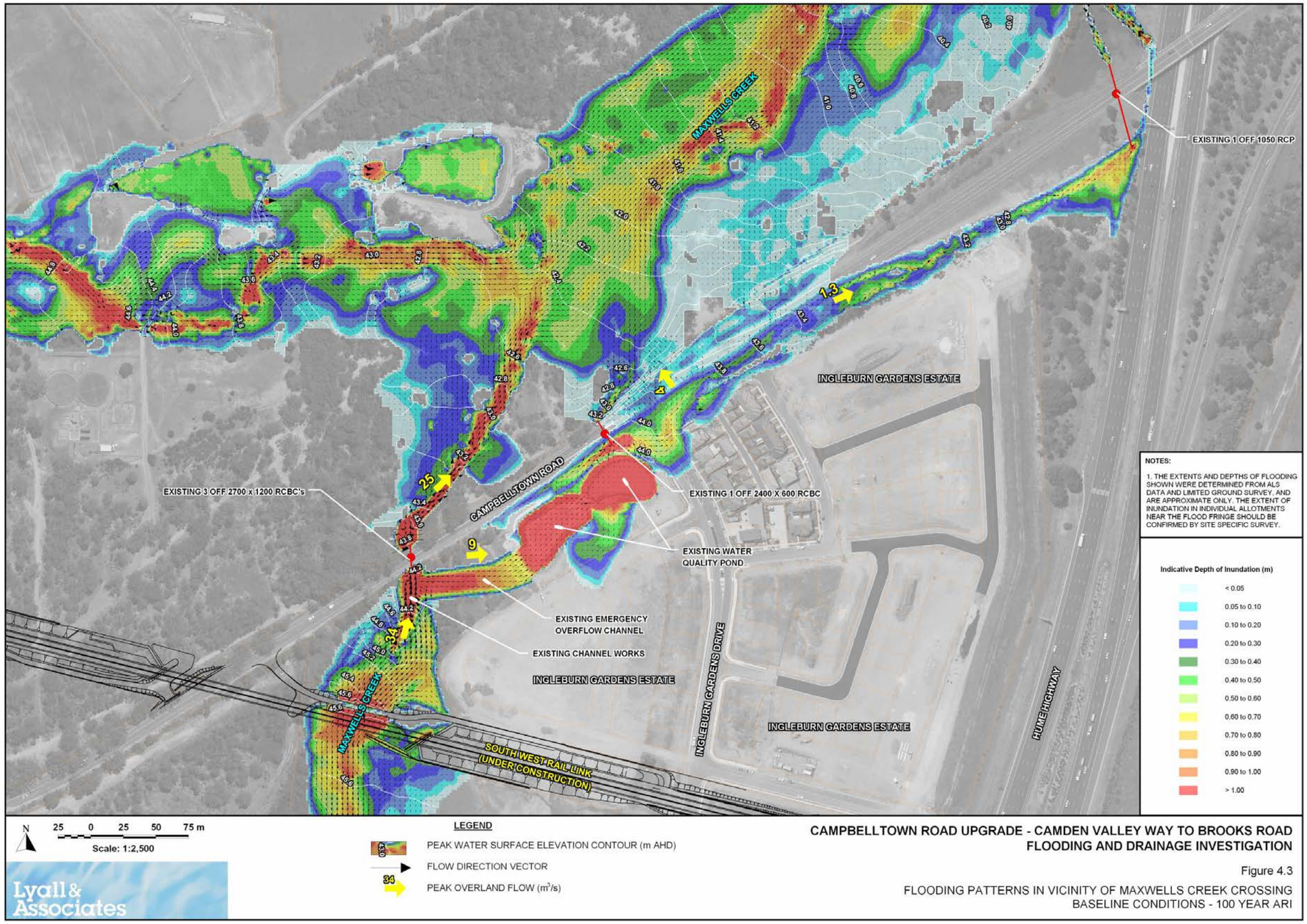


Figure 6-64: 100 year ARI flood modelling results in the vicinity of Maxwells Creek (Lyall and Associates 2013)

Groundwater

An online search of the Groundwater Bores NSW Map (http://waterinfo.nsw.gov.au/gw/) was undertaken as part of the Stage 1 Preliminary Contamination Assessment (Hyder Consulting 2013) to assess likely impacts of the proposal to groundwater. The closest groundwater monitoring bores are located on the western end of Campbelltown Road near Denham Court Road. Bore data was obtained for the four closest groundwater bores to the proposal. Based on the information available on depth to groundwater, the water table ranged from between 113 and 276 metres from the surface. As the elevation based on Australian Height Datum (AHD) was not provided for any of the bores, the actual depth of the water table and likelihood of there being a common groundwater system below the bores, could not be determined.

A geotechnical investigation was completed by RMS between 10 October and 18 November 2011 consisting of nine test pits and two boreholes. The geotechnical investigation indicated that groundwater was not reached in any of the 11 tests completed. The depths of the tests ranged between 0.6 metres and 8.57 metres.

Water quality

Hydrological and sediment regimes have been dramatically altered due to vegetation clearance and increasing urbanisation, affecting the water quality in the Georges River catchment. The quality of surface runoff from Campbelltown Road is impacted by the build-up of contaminants on the road surface including hydrocarbons, fuel additives and lubricants. Stormwater from urban and agricultural areas also constributes to the poor water quality of the creeks.

Water quality sampling was undertaken at two of the four aquatic assessment locations along Maxwells Creek, approximately 150 metres apart. The water quality sampling locations are shown in Figure 6-65. The depth of water within Maxwells Creek despite recent heavy rains, was low (range 10-60 centimetres) limiting the availability of oxygen within the water. Sampling was undertaken to provide a snapshot of the creeks condition. Variables measured in situ included pH, dissolved oxygen (DO), temperature turbidity and electrical conductivity (EC) (see results in Table 6-52).

There was no water present in Maxwells Creek to be sampled immediately upstream of the Campbelltown Road crossing and the waterway was inaccessible downstream of the Hume Highway, hence an assessment of the impact of the existing road on water quality was not possible.

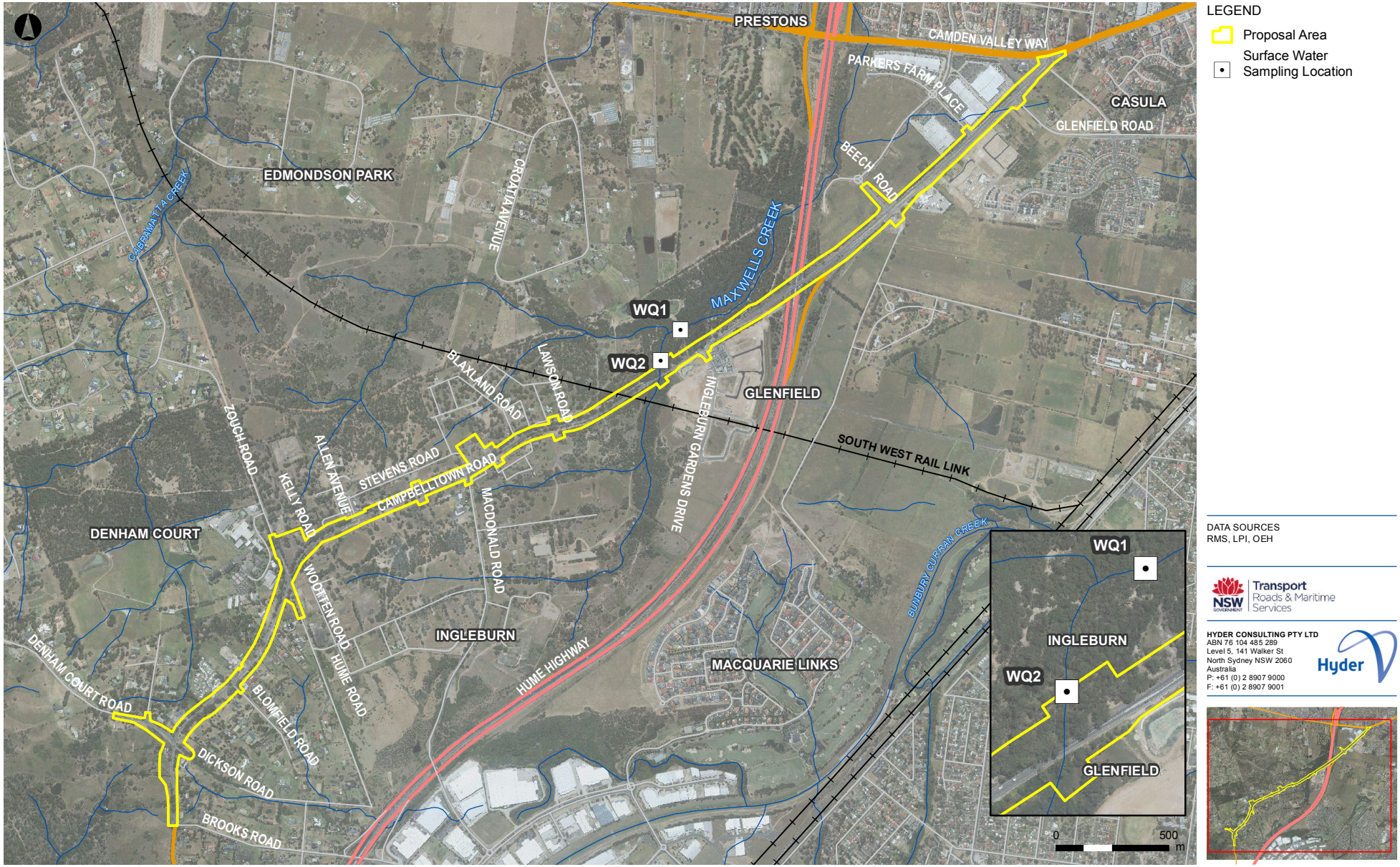
Both the Cabramatta Creek and Cottage Creek systems appear to be within modified landscapes that have had rural/residential land use for some time and both have been dammed in the upper reaches.

High levels of turbidity were observed within the creek system and are attributable to the clay substrate of the catchment and the high levels of rainfall experienced in the catchment at the time of inspection. The sampling results were compared to the Australian and New Zealand guidelines for fresh and marine water quality - 2000 (ANZECC) for physical and chemical stressors in lowland river systems in south-eastern Australia, (Table 6-52).

Table 6-52: Water quality results (Maxwells Creek)

Analyte	ANZECC guideline limit for lowland rivers in SE Australia	Sample location 1	Sample location 2
Temperature (°C)	-	18.98	18.18
pH	6.5-8.0	6.84	6.7
Conductivity (µS/cm)	125-2200	243	257
DO (ppm)	>6.0	4.08	4.03
Saturation (%)	85 – 110	45.5	41.6
Turbidity (NTU)	6 – 50	263	405
Alkalinity (as $CaCO_3$)	-	100	120

Results for DO and saturated oxygen were below the ANZECC guideline limits, at the time of sampling. The low results are attributable to the shallow depth of water in the creek system at the time of sampling and the warm water temperatures. Sampling results and the ANZECC guideline limits for lowland rivers in south-eastern Australia are shown in Table 6-52. High turbidity levels coupled with low oxygen levels reduces the suitability of aquatic habitat (refer to Section 6.1 Biodiversity). Generally, the water quality measured is representative of drainage lines in highly disturbed areas, although a series of sampling events over a period of time would be required in order to provide certainty on this assumption.



LEGEND

- Proposal Area
- Surface Water Sampling Location

DATA SOURCES
RMS, LPI, OEH

Transport Roads & Maritime Services

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

Figure 6-65: Location of surface water sampling sites, Maxwells Creek

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QA by : LD

6.4.3 Potential impacts

Construction

Water quality

The proposal has the potential to impact on water quality due to erosion and sedimentation, particulary during rainfall events and high winds on dry days. During construction, several activities have the potential to expose soils. These include vegetation removal and grubbing processes primarily undertaken during the initial stages of works. Large areas of exposed soil have the potential to be eroded through wind and water leading to loss of topsoils and potential sedimentation of surrounding land and drainage lines, particularly areas adjacent to the existing carriageway where stands of vegetation are present. The soils and topography of the proposal area have been assessed as having moderate to very high erosion potential.

Vegetation removal around Maxwells Creek has the potential to cause sedimentation of waterways through the destabilisation of the existing creek banks. This is more likely at the location of the proposed bridge construction and during the removal of the existing culvert. This is in addition to cross drainage and culvert works along the length of the proposal (see Figure 6-66 for location of works).

Excavation is also required along the length of the proposal, particularly in areas of carriageway construction and cut areas. Large quantities of material are required to be excavated and transported within the proposal area for the purposes of reuse or stockpiling. The proposal would result in an estimated 147,000 cubic metres of cut material (of which 100,000 cubic metres is estimated to be re-used as fill) and about 29,000 cubic metres of fill material to be imported. The highest amount of excavation required is likely to occur around Maxwells Creek and around areas where reinforced retaining walls would be constructed. The most likely risk would be the retaining wall along Campbelltown Road at the proposed Edmondson Regional Park. This retaining wall would be 190 metres long with a maximum height of about nine metres. However, no substantial cut or fill embankments would be required and the topography is unlikely to substantially change as a result of the works.

During construction, pollutants such as sediment, soil nutrients and construction waste have the potential to enter Maxwells, Cabramatta and Cottage Creek catchments, particularly during high rain events. Spillage of fuel during refuelling and leakage of hydraulic and lubricating oil from plant and equipment or rinse water from plant washing and concrete washouts would also have the potential to enter drainage lines.

Other activities which would expose soils and potentially cause erosion and sedimentation of surrounding land, urban areas and waterways include:

- Temporary creek diversions (dredging and reclamation within Maxwells Creek) where bridge and culvert works are being undertaken. Diversions, if not constructed and designed for the identified flow rates of the creeks, particularly during high run-off events, would have the potential to cause large amounts of sediment laden water. This would be as a result of diversions overtopping and construction waters entering the creek systems.
- Other high risk activities at culverts would be the installation of scour protection mechanisms such as rock armouring and concreting works. Both of these activities have the potential to release sediment laden water and/or concrete into the waterway if not managed effectively.
- The construction of the twin two-span bridges over Maxwells Creek and the

realignment of the creek for a distance of approximately 85 metres downstream (requiring about 1700 square metres of excavation works, dredging works and associated loss of riparian vegetation). The entire area would be excavated to bed level causing a high erosion risk during excavation works. Scour protection works would also potentially require excavation of the bed and embankments for a distance of 70 metres along the realignment (see Figure 3-42 for extent of estimated scour protection).

- Demolition of the exisitng culvert at Maxwells Creek. This would require channel widening, however this would occur at the same time and within the same footprint of the twin bridges.
- Piling activities including construction of piling pads and concreting works during construction of twin brides at Maxwells Creek. Piling works within the creek line has the potential to cause sedimentation downstream of the waterway in addition to release of piling lubricants, leading to pollution.
- Vehicle movements driving off-road and transporting dirt and mud onto nearby sealed roads.
- Stockpiling and rehabilitation of temporary stockpiles.
- Landscaping.

Erosion and subsequent sedimentation from the proposal, if uncontrolled, could potentially have the following effects:

- Reduction in oxygen availability and impact on riparian flora and fauna. Sedimentation impacts (particulary sedimentation of fine or clayey materials) to water courses can result in increased turbidity, which in turn can result in an increase of the temperature of the water body and a consequential decrease of dissolved oxygen.
- Fluctuations in the stream flow characteristics.
- Increased sediment load and organic matter resulting in adverse impacts to benthic fauna.
- Reduction in photosynthetic productivity of water bodies from increasing turbidity.
- Reduction in channel habitat from sediment deposition.
- Scour of stream banks due to high discharge velocities and increased flows.
- Introduction of gross pollutants entering receiving creeks.
- Declining water quality from the influx of man-made substances affecting the aquatic ecology.

As Maxwells Creek has been assessed as having minimal habitat potential and reduced water quality with ponding water, the potential for impacts to water quality due to the proposal is thought to be minor. The distance of Cabramatta Creek and Cottage Creek systems from the proposed upgrade further reduces the likelihood of impacts to water quality.

Operation

In assessing the size requirements for new cross drainage structures, allowance was generally made for a 50 per cent reduction in the available waterway area which may result from a partial blockage of the structure by debris or sediment. This is in addition to a 10 per cent increase in capacity of drainage structures to account for predicted climate change impacts.

For the purposes of assessing potential impacts to hydrology and drainage due to the proposal, the proposed hydraulic works associated with hydraulic performance are summarised in Table 3-6 in Section 3.2.5.

Hydrology

The Flooding and Drainage Investigation (Lyall and Associates 2013) modelled the impact that the proposal would have on peak flows in the receiving drainage lines downstream of Campbelltown Road using the DRAINS software. The changes in peak flow which would result from the road upgrade are summarised in Table 6-48.

The proposal would increase the peak flows of surface water discharging from Campbelltown Road. Increased flow velocities and volumes have the potential to cause scour to waterways and the transportation of silt and sediment downstream, which has the potential to impact on aquatic habitat (see discussion in Section 6.1.3). Final design of cross drainage and kerb-side drainage structures would accommodate the increased flows and mitigate potential downstream impacts.

Table 6-48: Predicted impact on peak flows

Location	Existing peak flows (m3/s)(1)			Predicted peak flows (m3/s)			Change in flow (m3/s)		
	5 year ARI	20 year ARI	100 year ARI	5 year ARI	20 year ARI	100 year ARI	5 year ARI	20 year ARI	100 year ARI
Downstream of structures No. 2 & 3	6.3	9.02	12.91	6.6	9.4	13.3	+0.3	+0.3	+0.4
Downstream of Structures No. 4 & 5	2.5	3.2	6.9	2.7	3.3	7.0	+0.2	+0.2	+0.1
Downstream of Structure No. 7	0.8	1.2	1.5	1.2	1.6	2.0	+0.4	+0.4	+0.6
Downstream of Structure No. 8 (Maxwells Creek)	13.8	21.2	29.8	13.9	21.3	29.9	+0.2	+0.1	+0.2
Downstream of Structure No. 9	0.43	0.7	1.15	1.4	1.4	2.0	+0.5	+0.7	+0.9

Source: Lyall & Associates (2013)

The proposed new bridge and creek realignment works at Maxwells Creek would have only a minor impact on flow depths and velocities both upstream (south) and downstream (north) of the road corridor for storms with ARI's of 1 and 2 years. On this basis, the risk to stream stability both upstream and downstream of the creek realignment as a result of the road upgrade is considered to be negligible.

Impacts on flow depths outside the footprint of the proposed works are confined to the area immediately upstream of the new bridge structure for both the 1 and 2 year ARI events. This occurs as a result of removing the backwater imposed by the existing box culvert structure, and the introduction of a more efficient waterway under the new bridge.

The reduction in flow depths immediately upstream of the new bridge are

accompanied by a corresponding acceleration of flow through the section of channel that has recently been modified by the developer of the Ingleburn Gardens Estate (refer to Appendix J for further details of these recent works).

At the time of writing, the final surface treatment in the section of engineered channel immediately upstream of Campbelltown Road (i.e. the channel works recently undertaken by the developer of Ingleburn Gardens Estate) is not known. Further hydraulic analyses would be undertaken during detailed design to assess the impact that removal of the backwater imposed by the existing box culvert system will have on the scour potential of the creek bed upstream (south) of the new bridge, to determine the need for additional scour protection measures in this area.

Flow velocities in the section of Maxwells Creek immediately downstream of the realignment works would be slightly reduced for the 1 year ARI event. This suggests the width of the new creek channel as modelled for the purpose of this present investigation has introduced additional storage into the creek that is sufficient to slightly attenuate flows for the smaller, more frequent flood events. However, this degree of flow attenuation and corresponding reduction in flow velocities is not evident for the 2 year ARI event.

The hydrology assessment also considered a strategy aimed at mitigating the adverse impacts of the road upgrade works on existing development as a result of an increase to the impervious area and additional stormwater. The pavement drainage (longitudinal drainage) strategy developed considers the potential impact of the proposal on both nuisance and major flooding events. Further details of the proposed pavement drainage strategy are identified in Appendix J.

Given the expected depth of groundwater in the vicinity of the proposal, it is considered unlikely that groundwater would be intercepted based on works detailed in the proposal.

Flooding

The proposal would also seek to minimise changes in afflux. Afflux is the localised increase in water surface level that occurs in the vicinity of a drainage structure (i.e. bridge or structure).

The replacement of the existing road culverts with a bridge would reduce the peak 100 year ARI flood level on the southern (upstream) side of the road corridor by about 700 millimetres. The resulting reduction in the peak 100 year ARI flood level on the southern (upstream) side of the road corridor would establish a 300 millimetre freeboard to the crest level of the earth embankment which runs along the northern and eastern sides of the existing water quality pond, therefore preventing the breakout of flow which presently occurs toward the east.

Figure 6-66 indicates that the twin two-span bridges option would also result in an increase in peak 100 year ARI flood levels immediately downstream (north) of Campbelltown Road, by a maximum of around 200 millimetres. However, the area over which peak flood levels would be increased is contained within the proposed Edmondson Regional Park and would not impact on the existing development.

The proposed cross drainage and pavement drainage strategies outlined previously would minimise the adverse flood-related impacts of the proposal on existing development and the existing drainage lines into which the new cross and pavement drainage systems will discharge. Residual impacts relate primarily to creation of drainage easements within a number of properties adjoining the widened road

corridor, with peak flow rates in receiving drainage lines located adjacent to existing development generally subject to only minor increases as a result of the proposed upgrade works. A summary of residual drainage-related property impacts is provided in Appendix J.

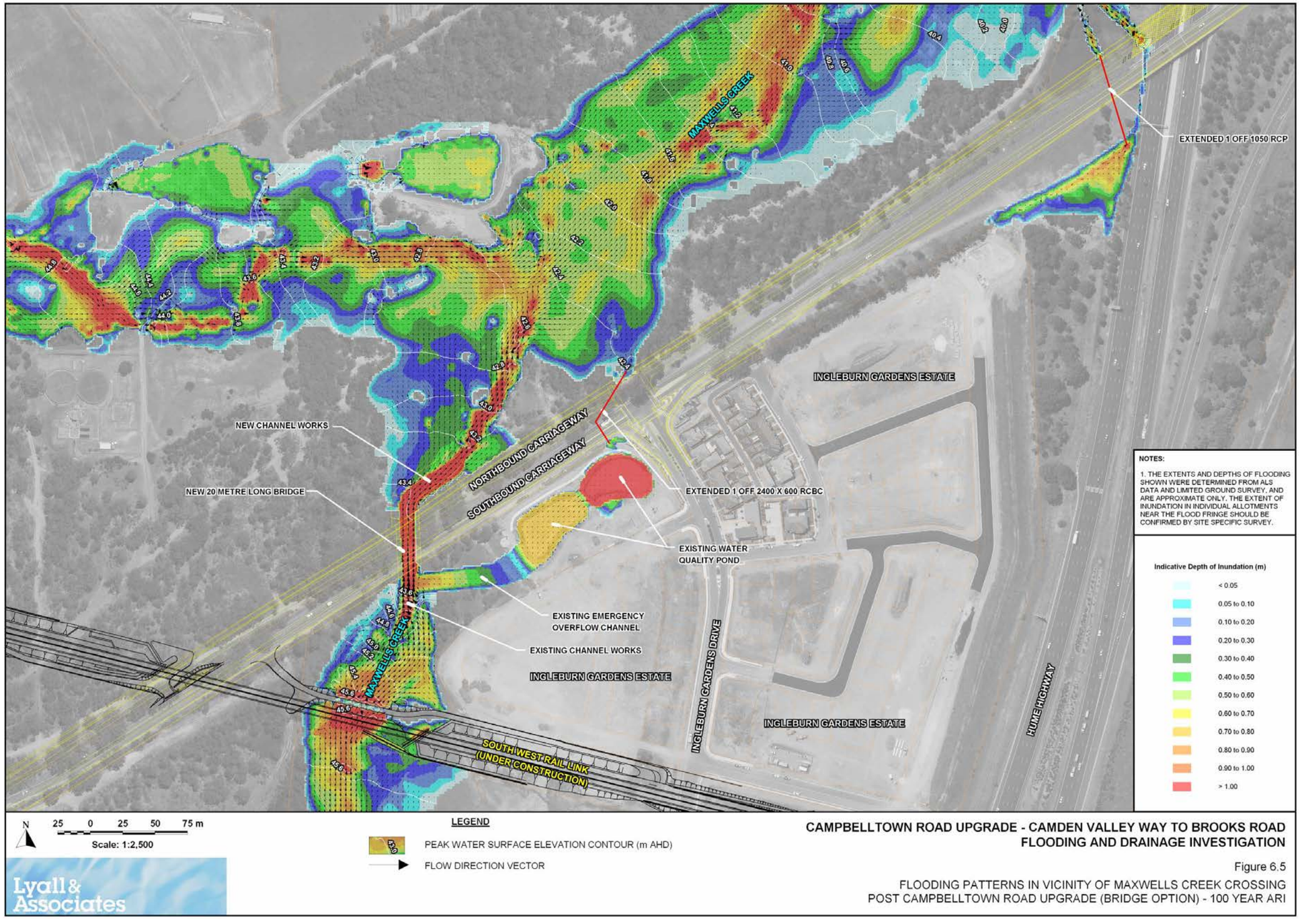


Figure 6-66: Flooding patterns, Maxwells Creek (Twin two-span bridges option) (Lyall and Associates 2013)

Water quality

An 85 metre long section of Maxwells Creek would need to be realigned around 15 metres to the north of the existing road. As a result, a new section of creek line at around 105 metres long would be created and the existing section of creek line reclaimed to allow the upgrade of Campbelltown Road. The realigned section of creek line would need to be adequately stabilised to avoid potential scouring and sedimentation during operation, especially during the early stages where creek banks would be more prone to scouring. Key features of the proposed creek alignment works would comprise:

- A rock-lined low flow channel extending along the realignment, including beneath the new bridge structure, to direct frequent low flows in the creek invert.
- Appropriately sized and graded rock riprap scour protection for the new bridge abutments. The outside bend of the realigned section of creek downstream (north) of the new bridge would also need to be adequately protected with rock riprap.

All of the above measures would assist in reducing erosion and sedimentation of creek banks, and downstream impacts to water quality of the creek system.

Following the revegetation of riparian areas and land within the construction impact area disturbed by construction works, the potential for erosion to occur during operation of the proposal would be minimal. The culverts would be designed and would incorporate features to minimise potential scouring of the banks of waterways as described in Chapter 3. Scour protection measures have been incorporated in the concept design and would be further investigated during detailed design.

Once constructed, the road would be asphalted and with the surrounding corridor landscaped and vegetation cover restored, the proposal would no longer present an erosion risk and would not contribute to sediment loading within the adjacent waterways.

The main risk to water quality during operation is surface runoff from impervious surfaces such as road pavement and concentration of contaminants in runoff by drains and kerbs. This can result in the build up of contaminants on road surfaces, median areas, and roadside corridors in dry weather which, during rainfall events, can be transported to surrounding watercourses or in filtrate into the groundwater system.

The contaminants of most concern relating to road runoff are:

- Suspended sediment from the paved surface and landscaped batters during the establishment period.
- Heavy metals attached to particles washed off the paved surface
- Oil, grease and other hydrocarbon products.
- Litter from the road corridor.
- Nutrients from biological matter.

In addition, nutrients such as nitrogen and phosphorus are also found in road runoff due to natural atmospheric deposition of fine soil particles.

The water quality of nearby creeks and streams during the operation of the road has the potential to be affected and could result in:

- Increased sediment loads reducing light penetration through the water column, impacting aquatic flora and fauna.

- Decay of organic matter and some hydrocarbons which can decrease dissolved oxygen levels affecting fish and aquatic life.
- Increased nutrients (nitrogen and phosphorus) stimulating the excessive growth of algae and aquatic plants leading to toxic conditions.
- Increased levels of heavy metals (including aluminium and iron) which are toxic to aquatic biota and fish.
- Silting of waterways and associated smothering of aquatic flora and fauna.
- Increased levels of litter, oils and grease.

The current water quality (pavement drainage) strategy outlines the proposed drainage system and discharge points with a number of stormwater control measures. Operational measures, such as swales, would be provided at discharge points that drain directly to a waterway along the proposed alignment. Swales would range in length between 60 metres and 455 metres, details to be further defined in detailed design.

Runoff from the upgraded pavement drainage system between Camden Valley Way and the Hume Highway would be discharged to Maxwells Creek via two existing gross pollutant traps (GPT) located at the western end of Parkers Farm Place and at the northern side of Creekside Place.

6.4.4 Safeguards and management measures

In addition to the cross drainage structures identified in Table 3-6, the Flooding and Drainage Investigation (Lyall and Associates 2013) identified the need for a pavement drainage design strategy. The proposed flooding and drainage strategy contained in the report, would improve the level of flood immunity afforded to the new section of road west of Beech Road to a minimum 100 year average recurrence interval standard. They will also mitigate the adverse impacts of the road upgrade works on existing development and the existing drainage lines into which the new pavement drainage system will discharge.

The principles to be adopted at the detailed design of the proposal to minimise peak flow velocities associated with the proposal during operation are included in Table 6-49. Environmental safeguards to minimise impacts associated with hydrology and flooding during construction of the proposal are also incorporated in Table 6-49.

Table 6-49: Proposed safeguards and management measures for hydrology and water quality

Impact (Location)	Environmental safeguards	Responsibility	Timing
Impacts to water quality	• During detailed design an Erosion and Sedimentation Management Report is to be prepared. The report is to include: - Proposed staging plans for the project to ensure appropriate erosion and sediment control measures are possible. - The likely run-off from each road sub-catchment and direction of off and on site water flow.	RMS	Detailed design

Impact (Location)	Environmental safeguards	Responsibility	Timing
	- Diversion of off site water around or through the site. - The direction of runoff and drainage points during each stage of construction. - The locations and sizing of sediment basins / sumps. - Appropriate scour protection for all drainage outlets, bridge abutments and the creek diversion and realignment. - Requirements for erosion and sediment controls during construction according to the Department of Housing's publication *Managing Urban Stormwater – Soils and Construction*.		
Impacts to water quality	• A soil conservationist from the RMS Erosion, Sedimentation and Soil Conservation Consultancy Services Register is to be engaged to review the Erosion and Sedimentation Management Report.	RMS	Detailed design
Impacts to water quality	• A Soil and Water Management Plan (SWMP) would be prepared as part of the CEMP in accordance with the requirements of RMS contract specification G38 prior to the commencement of construction. The SWMP would also address the following: - The *RMS Code of Practice for Water Management.* - The *RMS Erosion and Sedimentation Procedure* (RTA, 2008). - The *Blue Book- Managing Urban Stormwater: Soils and Construction, Volume 1and 2* (Landcom, 2004). - RMS Technical Guidelines – Temporary Stormwater Drainage for Road Construction (RMS, 2011).	Construction contractor	Pre-construction

Impact (Location)	Environmental safeguards	Responsibility	Timing
Impacts to water quality	• The SWMP would also address the following: - Identification of catchment areas and the direction of on-site and off-site water flow - The likely run-off from each road sub-catchment - Separation of on-site and off-site water - The direction of run-off and drainage points during each stage of construction - The locations and sizing of sediment traps such as sump or basin. - The locations of other erosion and sediment control measures (eg rock check dams, swales, scour protection and sediment fences) - The staging plans, location, sizing and details of creek alignment and relaingment controls for scour protection and bank and bed stabilisation including those used during construction and long term. - Location and staging of scour protection - Include progressive site specific Erosion and Sedimentation Control Plans (ESCPs). The ESCP is to be updated at least fortnightly. - Process for monitoring and preparing for wet weather. - The SWMP is to be reviewed by a soil conservationist and would be updated to address the recommendations - Provision of an inspection and maintenance schedule for ongoing maintenance of temporary and permanent erosion and sedimentation controls.	Construction contractor	Pre-construction

Impact (Location)	Environmental safeguards	Responsibility	Timing
Impacts to water quality	• A rain event plan is to be included and shown on the ESCP which outlines the controls to be implemented in preparation for a rain event.	Construction contractor	Pre-construction and construction
Impacts to water quality	• Measures would be put in place to make sure any debris from the construction of the bridges over Maxwells Creek is captured prior to reaching the waterway.	Construction contractor	Construction
Impacts to water quality	• Progressive re-vegetation and mulching of the proposal area would be undertaken as each section of work is completed.	Construction contractor	Construction
Construction impacts to drainage lines and flow paths causing scouring	• Restoration of the natural creek geomorphology would be undertaken to reduce velocity and scour during high flow events and ensure natural bed forms, such as an alternating sequence of pools, riffles and runs.	Construction contractor	Construction
Construction impacts to drainage lines and flow paths causing scouring	• Channel bank and bed stabilisation measures would be maintained until riparian vegetation is completely re-established.	Construction contractor	Construction
Spills	• Emergency wet and dry spill kits would be kept on site at all times. All staff would be made aware of the location of the spill kit and trained in its use.	Construction contractor	Construction
Spills	• All refuelling of vehicles and equipment on site would be undertaken on an impermeable surface, within a bunded area located at least 40 m away from water bodies and surface water drains.	Construction contractor	Construction
Spills	• Any fuel, oils or other liquids stored on site would be stored in an appropriately sized impervious bunded area away from water bodies.	Construction contractor	Construction
Flooding due to increases in	• Further flood modelling, including a detailed afflux assessment, would be undertaken during	RMS	Detailed design

Impact (Location)	Environmental safeguards	Responsibility	Timing
peak flow velocities	detailed design to confirm impacts to surrounding land uses.		

6.5 Topography, geology and soils

6.5.1 Existing environment

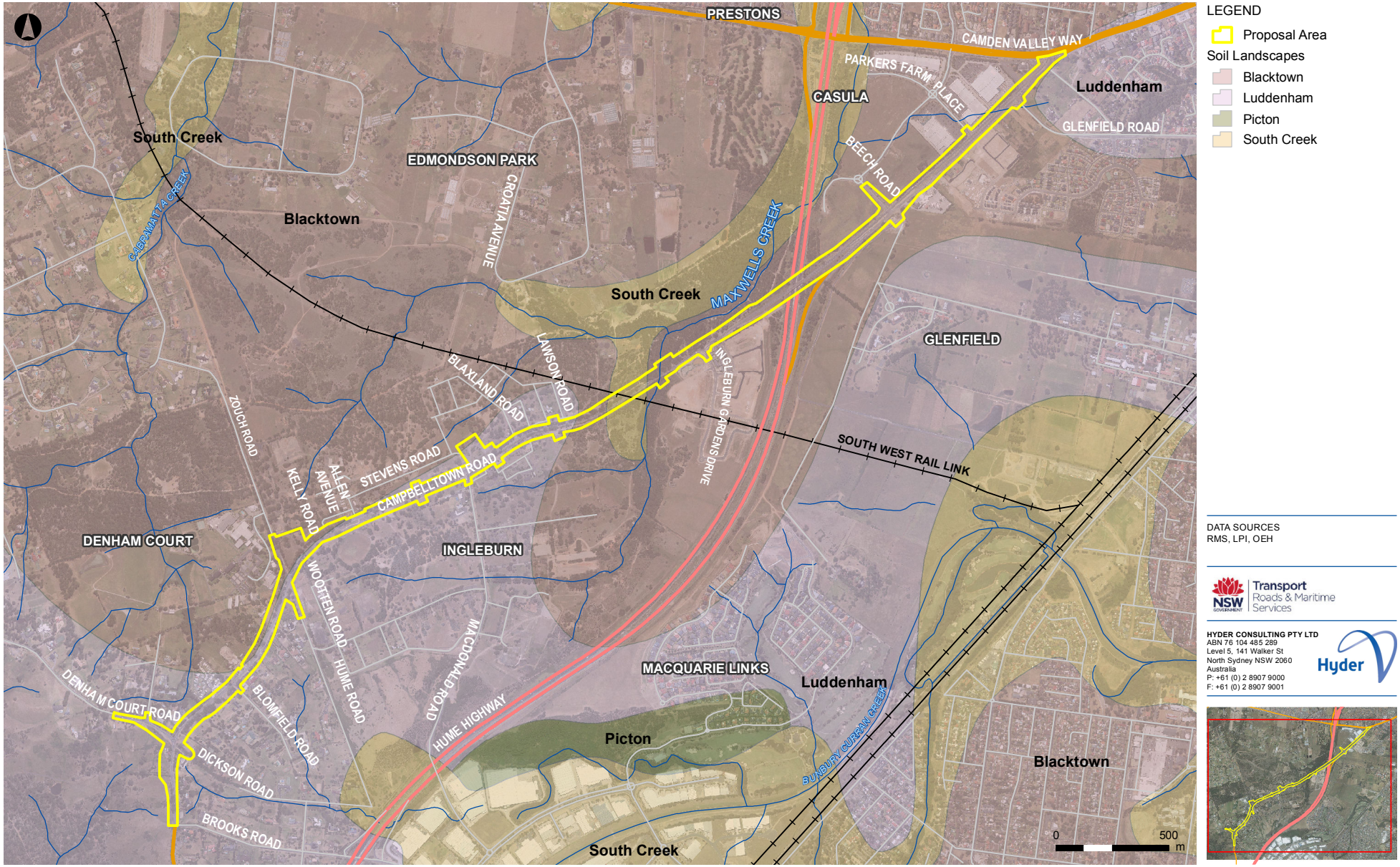
Topography

The topography across the proposal area and surrounding areas is relatively flat with few undulating rises and falls. The proposal area itself is relatively low lying with ground elevations varying from 61 metres above sea level (MASL) at the north-eastern end of the proposal near the Hume Highway to 91 MASL near Denham Court Road.

Geology and soils

The geology of the Penrith 1:100 000 sheet was mapped by Clark and Jones (1991). The study area was mapped as mainly Bringelly Shale (map unit Rwb), described as “shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff”. A narrow tongue of Quaternary deposits of medium-grained sand, clay and silt (map unit Qpn) was mapped in association with the tributary of Maxwells Creek that intersects the study area.

The soil landscapes of the Penrith 1:100 000 sheet were mapped by Bannerman and Hazelton (1990). There are three different soil landscapes mapped within the study area: the residual Blacktown soil landscape, the erosional Luddenham soil landscape and the fluvial soil landscape South Creek (refer to Figure 6-67).



LEGEND

- Proposal Area

Soil Landscapes

- Blacktown
- Luddenham
- Picton
- South Creek

DATA SOURCES
RMS, LPI, OEH

Transport Roads & Maritime Services

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

Figure 6-67: Soil landscapes within the vicinity of the proposal area

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The soils landscapes within and adjacent to proposal area have a moderate to very high erodibility factor (K factor). The Revised Universal Soil Loss Equation (RUSLE) was applied to the soils of the proposal area to provide an indication of the erosion hazard posed by works along the alignment. The equation was applied with the following assumptions, which represent the worst case scenario:

- Soils are totally exposed with no ground cover.
- The average gradient of the site is eight per cent, over 300 metres.
- Soils are compacted and smooth.

The erosion hazard and soil class for each of the soil landscapes was determined in accordance with Managing Urban Stormwater: Soils and Construction (Landcom 2004). The features and location in the study area of the mapped soil landscapes are detailed in Table 6-50.

Table 6-50: Soil landscapes applied in the proposal area by Bannerman and Hazelton et al. (1990)

Soil landscape	Features (Bannerman and Hazelton 1990)	Erodibility	Location in study area	Soil loss class
Blacktown (residual).	Shallow to moderately deep hardsetting mottled texture contrast soils, red and brown podzolic soils on crests, draining to yellow podzolic soils on lower slopes and drainage lines. On gently undulating rises on Wianamatta Group Shales.	Blacktown soil materials have moderate erodibility with the potential for high erodibility in subsoils. The erosion hazard for non-concentrated flows is slight to moderate. Under concentrated flows the erosion hazard is moderate to high (K factor = 0.02 – 0.04).	Most of the north-eastern half of the study area and small strip along the north-western edge of south-western section of the study area.	4 – Moderate erosion hazard.
Luddenham (erosional).	Shallow dark podzolic soils or massive earthy clays on crests, moderately deep red podzolic soils on upper slopes, moderately deep yellow podzolic soils and prairie soils on lower slopes and drainage lines. Landscape is undulating to rolling low hills on Wianamatta Group shales often	Luddenham soils are generally considered of moderate erodibility. Clays of the soil landscape should be considered highly erodible. Under concentrated flows the erosion hazard is high to very high. K factor = >0.04.	Small portion at north-eastern end of study area, along the majority of the south-western half of the study area.	5 – High erosion hazard.

Soil landscape	Features (Bannerman and Hazelton 1990)	Erodibility	Location in study area	Soil loss class
	associated with Minchinbury Sandstone.			
South Creek (fluvial).	Often deep layered sediments over bedrock or relict soils. Present active floodplain of many drainage networks of the Cumberland Plain, landscape is flat to gently sloping alluvial plain with occasional terraces or levees providing low relief.	The erodibility of South Creek soils is high. Erosion hazard under non-concentrated flows is high to very high, K factor = >0.06.	Associated with the tributary of Maxwells Creek intersecting the study area.	6 – Very high erosion hazard.

Salinity

In 2002 the then Department of Infrastructure, Planning and Natural Resources (DIPNR) mapped the salinity hazards in Western Sydney. The proposal crosses land that is classified as moderate and high salinity potential (Figure 6-68).

Areas of high salinity potential are characteristically low points that can accumulate water easily, contain soils of high clay content and are typically of the Blacktown Soil Landscape. Areas of high salinity potential are located in the northern end of the proposal area near Maxwells Creek crossing.

All other areas of the proposal are located within an area of moderate salinity potential. This is characteristic of Wianamatta Group Shales and soils of the Luddenham Soil Landscape. It should be noted that salinity has been known to affect buildings in these areas and some special construction methods are required.

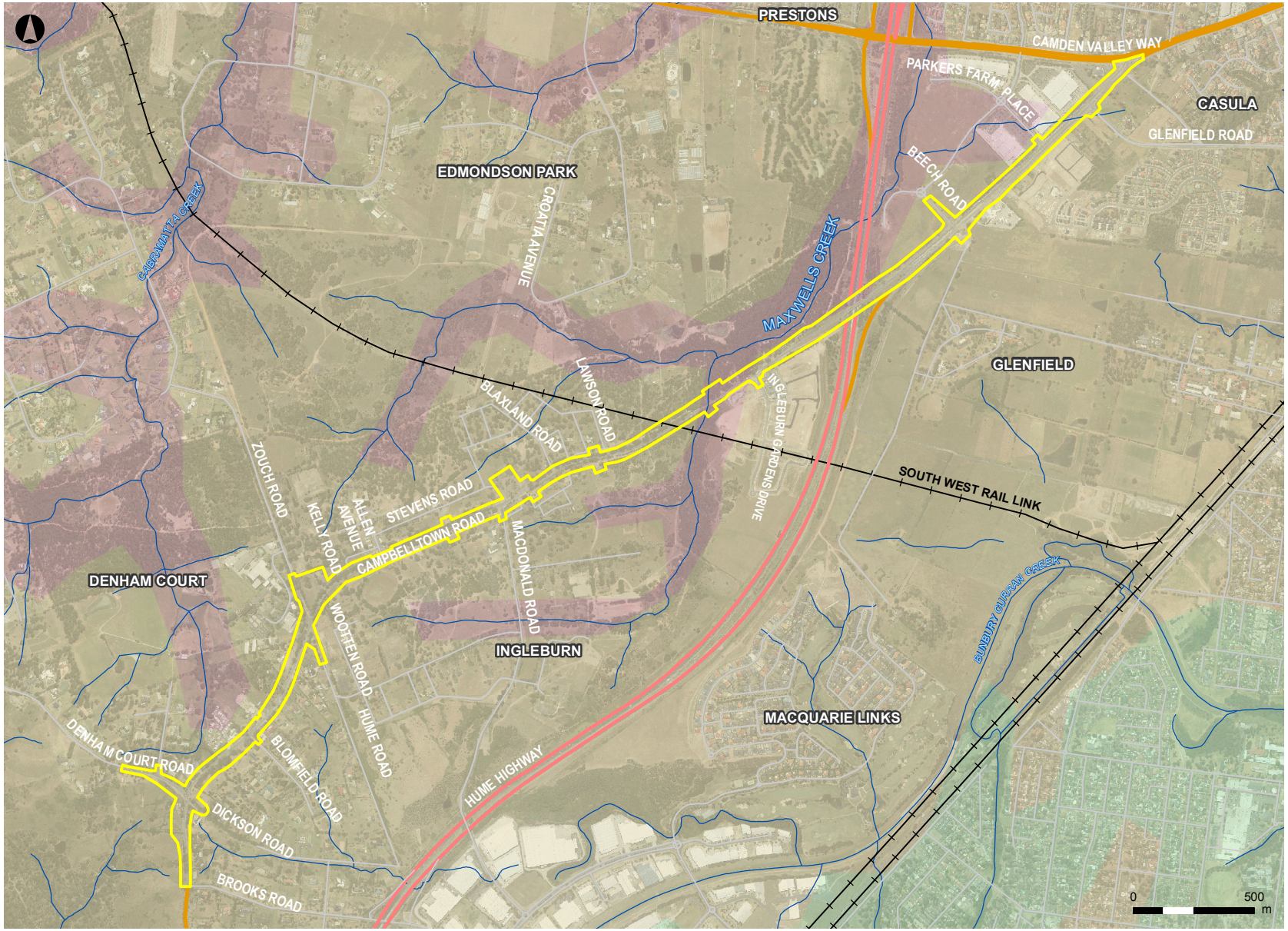


Figure 6-68: Salinity potential of soil within the vicinity of the proposal area

Acid sulphate soils

A search of the Australian Soil Resource Information System database undertaken in May 2012 shows that there is a low to extremely low probability of acid sulphate soils in the proposal area (Australian Soil Resource Information System 2011).

Contaminated land

A Stage 1 Preliminary Contamination Assessment (2013) was undertaken by Hyder Consulting (2013) and is included in Appendix N. The purpose of the investigation was to identify potential risks associated with contamination based on past and present uses in and adjacent to the proposal area and to identify areas that may require remediation or management through construction phases. The investigation was undertaken in accordance with the relevant OEH guidelines and standard industry practice. The study area for the assessment includes the proposal area, defined as the area that would be directly disturbed as a result of construction, with a consideration of adjacent current and previous land uses.

The investigation included:

- Desktop review of site history information of the proposal area and adjoining sites in November 2012 to identify potential areas of environmental concern. This included a desktop review of available aerial photographs, land title certificates, contaminated sites databases, groundwater, soil and geology databases and relevant available historical reports and documentation as required.
- A site inspection that included an initial drive by of the proposal area and then a walkover at areas of interest by a Hyder representative and contaminated land specialist. Site inspection was to identify current and past activities, site features, signs of ground contamination and potential sources of contamination.

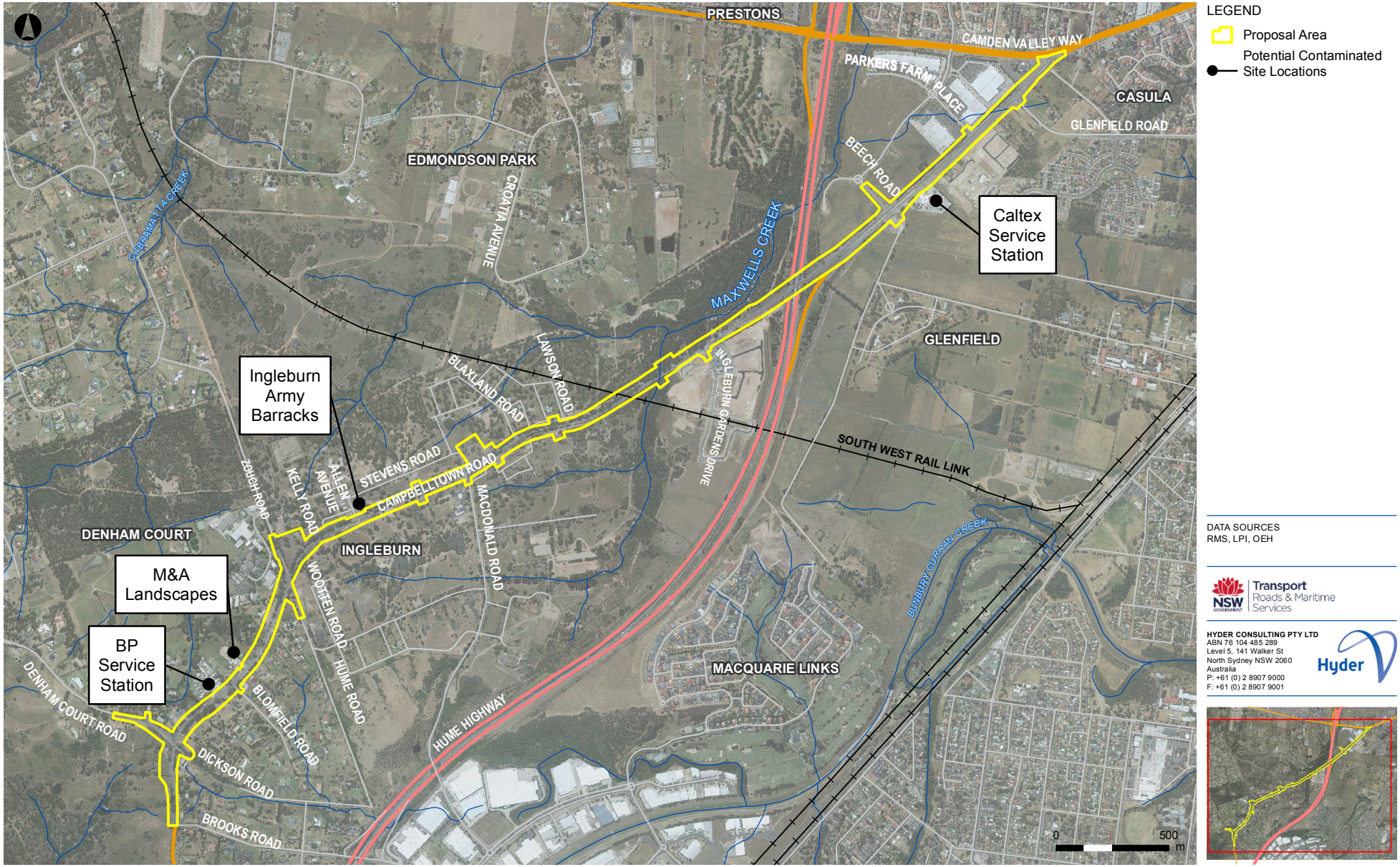
The assessment revealed that four sites were identified as having potential contamination issues based on past and present activities. These potential contaminated sites are shown in Figure 6-69:

- The Caltex service station located near the intersection of Beech Road and Campbelltown Road. The site is a large commercial truck refuelling facility with several underground storage tanks (UST) on-site (petroleum hydrocarbon storage).
- The Ingleburn Military Heritage Precinct (formerly known as Bardia Barracks) which operated from 1939 to 2005 and is located near the intersection of Zouch Road and Campbelltown Road.
- The M&A Landscapes is located north of the intersection of Blomfield Road and Campbelltown Road. The site is a landscape supply business and has a landscape feature at the entrance which comprises of a small amount of retained fill.
- The BP service station is located south the intersection of Blomfield Road and Campbelltown Road. The site operates a small refuelling facility with three USTs in close proximity to road boundary.

The contaminants of potential concern and potential receptor at each of the identified sites are summarised in Table 6-51.

Table 6-51: Contaminants of potential concern

Site description	Potential contaminants	Potential receptor
Caltex service station.	Aliphatic hydrocarbons, BTEX, PAHs, Phenols, and lead.	Groundwater. Downstream water body habitats such as Maxwells Creek. Surrounding Soil. Construction workers during earthworks activities.
Ingleburn Military Heritage Precinct (cut material at Chainage 3760 to 4060 in front of Bardia Barracks).	Aliphatic hydrocarbons, BTEX, PAHs, Phenols, and heavy metal including lead.	Construction workers during earthworks activities.
M&A Landscapes.	Aliphatic hydrocarbons, heavy metals.	Construction workers during earthworks activities.
BP service station.	Aliphatic hydrocarbons, BTEX, PAHs, Phenols, and lead.	Groundwater. Downstream water body habitats such as Maxwells Creek. Surrounding Soil. Construction workers during earthworks activities.



LEGEND

- Proposal Area
- Potential Contaminated Site Locations

DATA SOURCES
RMS, LPI, OEH

Transport Roads & Maritime Services

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

Figure 6-69: Areas showing potentially contaminated land within the vicinity of the proposal area

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6.5.2 Potential impacts

Construction

Potential impacts on the soils, topography and geology of the proposed construction works would primarily be associated with the erosion of exposed soils and stockpiles, and associated potential sedimentation of surrounding land and drainage lines.

During construction, several work elements have the potential to expose soils. Construction activities which have the potential to result in the exposure of soils which could potentially lead to erosion and sedimentation, as well as the exposure of saline or contaminated soils include:

- Earthworks within the construction impact area, particularly within Maxwells Creek, drainage lines and new utility lines.
- Vehicle movements.
- Removal and installation of general fill material.
- Stockpiling.
- Vegetation removal.
- Grubbing processes.
- Landscaping.

Managing Urban Stormwater: Soils and Construction (Landcom 2004) prescribes that a SWMP be developed for the site with provision for minimising erosion and capture of sediment laden stormwater with capacity to allow sediments to settle before any water discharge from site. As a part of the Flooding and Drainage Investigation undertaken by Lyall and Associates (2013), an assessment was undertaken to develop an erosion and sediment control strategy.

Soils and Construction – Managing Urban Stormwater" Volume 1 (Landcom, 2004) and *Volume 2D* (DECC, 2008) allows for localised erosion and sediment control measures to be used in the absence of large scale sediment retention basins where the average annual soil loss from a disturbed area, as derived by application of the "Revised Universal Soil Loss Equation" (RUSLE), is less than 150 cubic metres per annum. This assessment determined the average annual volume of sediment which could be "washed off" the road corridor if appropriate measures were not implemented during the construction phase of the project. The estimated average annual soil loss from each local erosion and sediment control area does not exceed the threshold value of 150 cubic metres per annum. The outcomes of this assessment concluded that large scale sediment retention basins do not necessarily need to form part of the soil and water management plan (SWMP) as part of the proposal. This would be further addressed during detailed design in order to mitigate erosion and sedimentation impacts during construction.

For the construction phase, the implementation of effective localised erosion and sediment control measures aimed at minimising erosion and the volume of sediment which is transported from disturbed areas would be key in the absence of any large scale sediment retention basins. Measures would include use of the following smaller scale elements:

- Temporary revegetation/rehabilitation works to reduce the extent of disturbed surfaces.
- Application of temporary surface treatments or blanketing on exposed earth

surfaces.
- Sediment barriers and sumps, in series where necessary.
- Vegetative buffer strips.

Salinity

Excavation associated with the proposal would occur in moderate to high potential salinity areas, in particular around Maxwells Creek. Changing of the soil profile on-site may expose more reactive and saline soils, which have the potential to damage foundations of infrastructure including roads and bridges. Saline soils would be considered in the detailed design of the road.

Contaminated soils

Based on available historical information, identified areas of concern, and the results of the site inspection, land located within the proposal area is generally considered to have a low to moderate risk of harm to human health and the environment and can be made suitable for the proposed upgrade to Cambelltown Road. Furthermore, examination of the impact site surface revealed no obvious ash materials, asbestos sheets/pieces, odour or discolouration of the soils and vegetation that would indicate the potential for contamination. A Stage 2 Detailed Site Investigation is required in order to confirm whether the proposal area is impacted by the areas of concern. In the event of contamination, further assessment, remediation/mitigation and validation would be required.

Disruption of contaminated soils could impose health risks to construction workers and enable spreading of contaminants across a larger area, to a range of other sensitive receivers, including Maxwells Creek. Potential risks are, however, considered to be low. Based on the concept design for the proposal, the four identified sites are generally in fill areas and do not require extensive earthworks, therefore potential volumes of soil to be excavated in areas where there is potential for contamination are considered minimal.

Soil sampling and analysis of the proposed cut material (during detailed design) would verify the status of the soil so appropriate management strategies of the earthworks spoil can be considered if necessary. Any contaminated material discovered would be removed and disposed of at an appropriate licensed facility in line with a developed management plan.

Operation

Following the revegetation of areas of land within the construction impact area disturbed by construction works, the potential for erosion to occur during operation of the proposal would be minimal. The planting of deep-rooted trees would assist in reducing the potential for urban salinity.

6.5.3 Safeguards and management measures

Table 6-53 outlines the proposed safeguards and management measures in terms of maintaining soil and water quality for both construction and operational phases of the proposal.

Table 6-53: Safeguards and management measures for topography, geology and

soils

Impact	Environmental safeguards	Responsibility	Timing
Soils and water quality	• Environmental Work Method Statements (EWMS) would be prepared for high risk activities such as: - Clearing and grubbing. - Earthworks - Creek realignment works. - Works around the bridge and culverts. - Drainage works. - Utilities works. - Bridge and culvert construction works.	Construction contractor	Pre-construction and construction
Soils and water quality	• EWMS must include the following: - Description of the works/activities including machinery. - Outline of the sequence of the work/activities, including interfaces with other construction activities. - Identification of potential environmental risks/impacts due to the works/activities and associated with wet weather events. - Evaluation of methods to eliminate/reduce the environmental risk. - Mitigation measures to reduce environmental risk. - Any safeguards resulting from consultation with public authorities and other stakeholders, where appropriate. - A map indicating the locations of sensitive locations (such as threatened species), likely potential environmental impacts, and work areas. - Identification of work area and exclusion areas. - Operational and monitoring measures to eliminate/reduce environmental impact.	Construction contractor	Pre-construction and construction

Impact	Environmental safeguards	Responsibility	Timing
	- A process for assessing and reporting the performance of the implemented environmental control measures. - A process for resolving environmental issues or conflicts and reporting outcomes		
Soils and water quality	• Control measures at egress points to minimise dirt and mud tracking.	Construction contractor	Construction
Soils and water quality	• All stockpiles would be designed, established, operated and decommissioned in accordance with *RMS Stockpile Management Procedures* (RTA 2011a). Stockpile sites would be located: - At least 50 metres from the nearest waterway. - In an area of low ecological and heritage conservation significance. - At least 100 metres distance from residential dwellings and other land uses that may be sensitive to noise. - On relatively level ground. - Outside the 1 in 10 year ARI floodplain.	Construction contractor	Construction
Soils and water quality	• Topsoil would be stockpiled separately for possible reuse for the landscaping and rehabilitation works.	Construction contractor	Construction
Soils and water quality	• An accredited soil conservationist would be engaged to regularly inspect works throughout the construction phase.	Construction contractor	Construction
Soils and water quality	• Any material transported onto pavement surfaces would be swept and removed at the end of each working day and prior to rainfall.	Construction contractor	Construction
Contamination	• A Stage 2 – Detailed site investigation in accordance with NSW EPA guidelines would be prepared and would include	RMS	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	preparation of a sampling, analysis and quality plan in accordance with the RTA Contaminated Land Management Guidelines 2005. This plan would include site specific sampling and analysis of soil at the following locations along Campbelltown Road: - The Caltex Service Station. - Ingleburn Army Barracks. - M & A Landscapes. - BP Service Station.		
Contamination	• Following the Stage 2 – Detailed site investigation, a Contaminated Land Management Plan would be prepared in accordance with the *Contaminated Land Act 1997 and* relevant OEH Guidelines as part of the CEMP and would include: - Outline of occupational health and safety measures - Contamination management measures. - Incident reporting in according with the RMS Environmental Incident Management Procedure. - Identification of rehabilitation requirements, classification, transport and disposal requirements of any contaminated land within the construction footprint. - In the event that indications of contamination are encountered (known and unexpected, such as odorous or visually contaminated materials), work in the area would cease until an contamination assessement can be prepared to advise on the need for remediation or other action, as deemed appropriate.	RMS and construction contractor	Pre-construction and construction

6.6 Traffic, transport and access

A Traffic and Transport Assessment was carried out by AECOM (2013). A complete copy of the report is available as Appendix B of this REF, and a summary is provided below.

The Traffic and Transport Assessment outlines that Campbelltown Road would play a major role in accommodating traffic generated by Edmondson Park precinct and traffic associated with the SWGC. It also outlines increased pressure on Campbelltown Road due to expected additional traffic due to the SWRL.

The purpose of this traffic assessment is to assess the following elements:

- Operational performance of the key intersections to determine the ultimate intersection footprint (intersection configuration for the proposal) required to cater for the expected traffic growth as a result of full development of the SWGC, as well as the intersection staging requirements and timing to cater for all interim traffic growth scenarios in the south-west region.
- Operational impacts to property access, freight transport, public transport, pedestrians and cyclists.
- Preliminary construction traffic assessment.

6.6.1 Existing environment

General features

Campbelltown Road is one of the main north-south corridors in the SWGC, linking the Camden and Liverpool LGAs. The road acts as a strategic road link connecting major urban and rural areas in the south-west region of Sydney.

Campbelltown Road is designated a B-Double route for trucks up to 26 metres in length with connections to other B-Double routes including the Hume Highway and Camden Valley Way. Further detail on the existing road network is presented in Section 2.2.

Current traffic volumes

Annual Average Daily Traffic (AADT) counts for Campbelltown Road in 1996, 1999, 2002 and 2005 are provided in Table 2-1. Traffic volumes at Campbelltown Road, south of the Hume Highway underpass and Campbelltown Road, South of Glenfield Road have steadily increased at an annual growth rate of 1.52 per cent and 1.8 per cent respectively from 1996 to 2005. The average annual historical traffic volume increase for the corridor based on the two count locations is therefore 1.19 per cent per annum.

RMS commissioned traffic surveys in October 2011 to measure current traffic volumes at key locations along Campbelltown Road. The automatic traffic count (ATC) tubes were located on Campbelltown Road at the following locations:

- Immediately east of Ingleburn Gardens Drive.
- Immediately west of Beech Road.

Table 6-54 indicates that the highest daily volume of traffic occurs on Campbelltown Road, west of Beech Road, with 28,214 vehicles during an average weekday. The average weekday traffic flow on Campbelltown Road, east of Ingleburn Gardens Drive is 13,260 vehicles.

Table 6-543: ATC results, October 2011

Location on Campbelltown Road	Two-way traffic volumes			
	Average weekday traffic (veh/day)	Average daily traffic (veh/day)	Average weekday peak hour traffic (veh/day) (hour beginning)	Average weekday peak hour traffic (veh/day) (hour beginning)
Immediately east of Ingleburn Gardens Drive	13,260	11,820	1231 (07:00)	1095 (17:00)
Immediately west of Beech Road	28,214	25,868	1929 (07:00)	2462 (17:00)

Source: RMS 2005

There is a difference of approximately 15,000 vehicles/day recorded on the eastern and western ends of Campbelltown Road, with higher traffic flows on the north-eastern end near Beech Road. This is due to the traffic using the southbound on-ramp to access the Hume Highway.

The peak hour for traffic volumes recorded on Campbelltown Road occurs 7–9am in the morning and 3–6pm in the afternoon.

Mode of transport use

Private vehicles are the predominant mode of transport utilised in the area. This is attributed to public transport services being limited along the Campbelltown Road corridor and surrounds. There is no rail link to the suburbs immediately south of Campbelltown Road. Casula to the north has a train station, serviced by the Cumberland and South Lines. The nearest major train station is at Glenfield, which is serviced by the South Line, Airport and East Hills Line, Cumberland Line and Southern Highlands Line. The SWRL is anticipated to be constructed by 2016, with a station planned for Edmondson Park.

Five bus routes service the northern end of Campbelltown Road between the Camden Valley Way/Hume Highway and Glenfield Road intersections, with an average frequency of around half an hour. The remainder of Campbelltown Road is not serviced by any bus route. However, there are school bus routes that currently use Campbelltown Road between Macdonald Road and Denham Court Road. There are two bus stops currently located on Campbelltown Road (one on either side of the road between Blaxland Road and Lawson Road).

There are currently limited dedicated walking and cycling facilities along Campbelltown Road. Shoulders and verges provide a means for pedestrians to travel along Campbelltown Road; however, the speed of traffic on the road combined with the rural nature of the area result in very little pedestrian and cyclist activity. There is an on-road cycle lane within the road shoulder on sections of Campbelltown Road. Between Denham Court Road and Ingleburn Gardens Drive the cycle lane is marked (bicycle symbols only); however, from Ingleburn Gardens Drive towards the Cross Road the cycle lane is unmarked.

Campbelltown Road is an important B-double freight route and heavy vehicles use it

to transport from Casula to Campbelltown. Heavy vehicles make up approximately 10 per cent of traffic volumes along Campbelltown Road. Heavy vehicle volumes and proportions on Campbelltown Road are higher on weekdays than on weekends, and volumes are higher west of Beech Road compared to east of Ingleburn Gardens Drive.

Intersections

The existing intersections along the Campbelltown Road corridor include (from north to south):

- Glenfield Road.
- Parkers Farm Place.
- Beech Road.
- Ingleburn Gardens Drive.
- Lawson Road.
- Blaxland Road.
- Stevens Road.
- Macdonald Road.
- Allen Avenue.
- Kelly Road.
- Wooten Road.
- Zouch Road.
- Blomfield Road.
- Denham Court Road.
- Dickson Road.

Refer to Section 2.2, Table 2.3 for a description of each of the existing intersections. The location of these intersections along Campbelltown Road is showing in Figure 6-70.

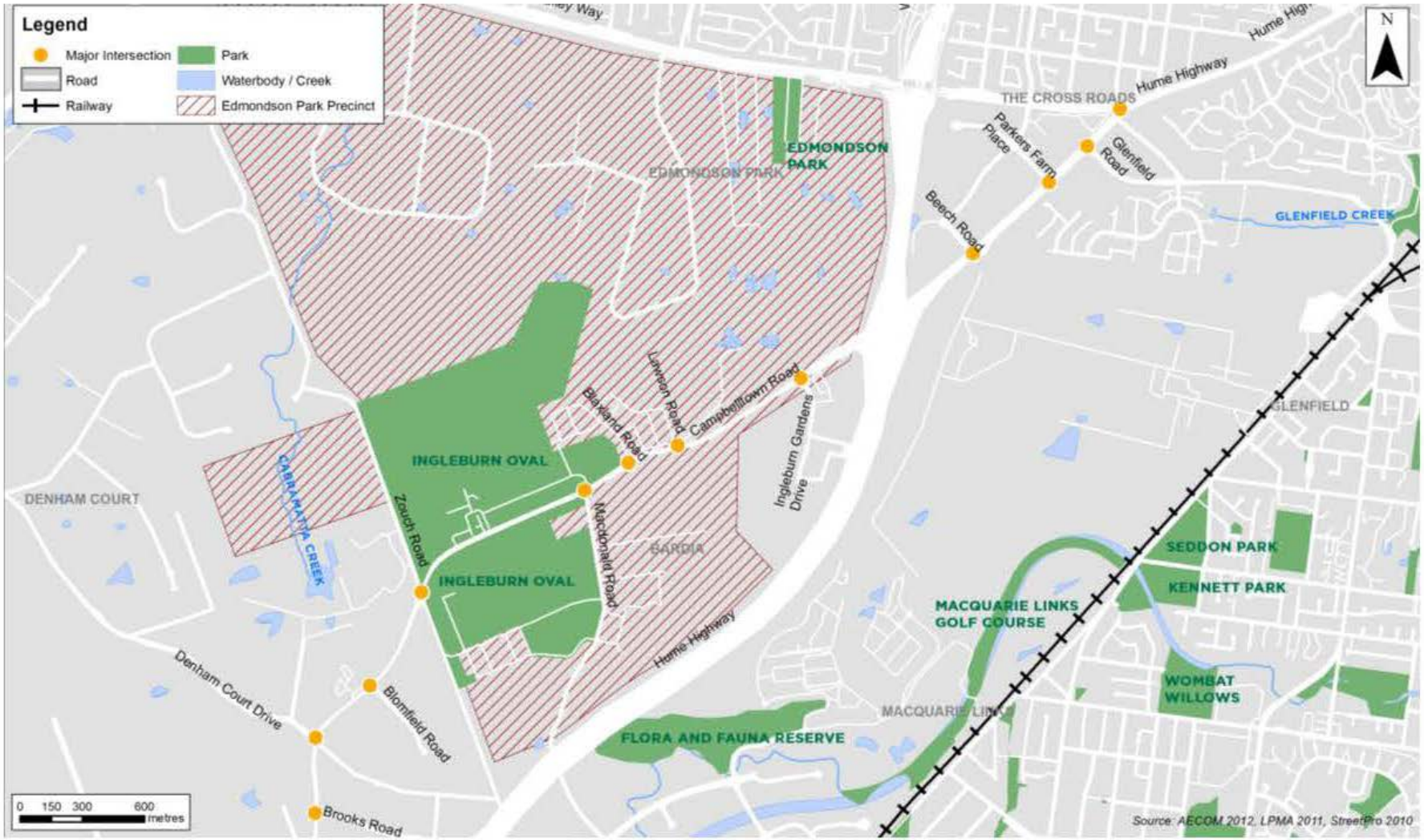


Figure 6-70: Existing intersections modelled within the proposal area (AECOM 2013)

The Glenfield Road, Beech Road, Ingleburn Gardens Drive and Macdonald Road intersections are signalised. The Denham Court Road intersection is a roundabout configuration and the remaining intersections are priority 'give way' intersections.

Current intersection performance

The Level of Service (LoS) is a six-point scale (A-F) measuring the extent of delay experienced at the intersection, as shown in Table 6-55. LoS is a measure of the overall effectiveness of the intersection. Degree of Saturation (DoS) is a measure of the ratio between traffic volumes and capacity of the intersection.

Table 6-55: Level of Service indication

Level of Service	Average delay per vehicle (seconds/veh)	Description
A	< 14	Good operation.
B	15 – 28	Good with acceptable delay.
C	29 – 42	Satisfactory.
D	43 – 56	Operating near capacity.
E	57 – 70	At capacity, at signals, incidents will cause excessive delays.
F	> 70	Extra capacity required.

Source: RMS (2002)

An assessment of the LoS at each of the signalised intersections along Campbelltown Road was undertaken using modelling software SIDRA Intersection 5.1 (SIDRA). The outcomes of the assessment are shown in Table 6-56 and Table 6-57.

Table 6-56: Existing intersection performance along Campbelltown Road (AM peak hour)

Intersection (with Campbelltown Road)	Intersection traffic volumes (veh/hr)	Intersection Level of Service (LoS)	Degree of saturation (DoS)	Average intersection delays (sec)	95% back of queue	
					Queue lengths (m)	Worst queuing approach
Glenfield Rd	3136	B	1.000*	22.8	133	Glenfield Rd – East
Beech Rd	2500	B	0.579	16.4	149	Campbelltown Rd – West
Ingleburn Gardens Dr	1164	A	0.785	9.5	128	Campbelltown Rd – West
Macdonald Rd	1476	B	0.748	18.5	110	Campbelltown Road – West
Denham	1246	A	0.570	7.4	37	Denham

Intersection (with Campbelltown Road)	Intersection traffic volumes (veh/hr)	Intersection Level of Service (LoS)	Degree of saturation (DoS)	Average intersection delays (sec)	95% back of queue	
					Queue lengths (m)	Worst queuing approach
Court Rd						Court Rd – North-west

* Right turn bay from Campbelltown Road Glenfield Road at capacity
Source: RMS (2013)

Table 6-57: Existing intersection performance along Campbelltown Road (PM peak hour)

Intersection (with Campbelltown Road)	Intersection traffic volumes (veh/hr)	Intersection Level of Service (LoS)	Degree of saturation (DoS)	Average intersection delays (sec)	95% back of queue	
					Queue lengths (m)	Worst queuing approach
Glenfield Rd	3076	B	0.658	21.9	127	Glenfield Rd – East
Beech Rd	2678	A	0.791	9.7	107	Beech Rd – North
Ingleburn Gardens Dr	1085	A	0.795	11.9	130	Campbelltown Rd – East
Macdonald Rd	1335	B	0.657	20	72	Campbelltown Rd – East
Denham Court Rd	1107	A	0.397	7.1	21	Campbelltown Rd – East

Source: RMS (2013)

The intersection modelling suggests that during 2011, the three intersections along Campbelltown Road perform at a satisfactory level with all three intersections performing at a LoS of B or better during both the AM and PM peak.

Current mid-block capacity

The mid-block is defined as the stretch of road between adjacent intersections. Mid-block capacity is measured as a volume capacity ratio. A volume capacity ratio greater than 1.00 indicates the section of roadway is over capacity and will not operate efficiently. An assessment of the mid-block capacity for Campbelltown Road was undertaken using the Austroad's Guide to Traffic Management Part 3: Traffic Studies and Analysis. The peak hour directional traffic flow at each of the surveyed locations are summarised in Table 6-58.

Table 6-58: Existing 2011 mid-block capacity

Location on Campbelltown Road	AM peak hour (veh/hr		PM peak hour (veh/hr)	
	Peak direction flow (EB / NB)	Volume capacity ratio	Peak direction flow (EB / NB)	Volume capacity ratio
Campbelltown Road, east of Ingleburn Gardens Drive	949	0.79 (1 lane)	719	0.60 (1 lane)
Campbelltown Road, west of Beech Road	918	0.38 (2 lanes)	2094	0.58 (3 lanes)

Source: AECOM (2013)

The results of the analysis suggest that current traffic flows on Campbelltown Road are relatively low and there is reserve capacity on the corridor; however, the actual capacity of the road is reduced due to a lack of overtaking opportunities.

Crash data analysis

Between 2006 and 2010, a total of 100 crashes have been recorded along Campbelltown Road between Camden Valley Way and Denham Court Road, including one crash involving a fatality and 51 injury-related crashes.

Based on the latest data, the Campbelltown Road average crash rate is 60.52 per 100 million vehicle kilometres (MVKM) travelled east of Ingleburn Gardens Drive. The latest available RMS data shows an average crash rate of 110 per 100 MVKM for urban undivided road (less than 4 lanes) and 35 per 100 MVKM for rural undivided road. In comparison the average crash rate on Campbelltown Road west of Beech Road is 61.81 per 100 MVKM travelled.

The crash analysis also noted that:

- Approximately 58 per cent of crashes occurred within 10 metres of an intersection.
- Over 94 per cent of crashes were car crashes (98 crashes), approximately six per cent were motorcycle crashes (six crashes), and approximately 29 per cent of crashes were heavy vehicle crashes (30 crashes).
- The two main manoeuvre types of crashes were rear-end and opposing vehicles, turning with approximately 50 per cent and 12 per cent, respectively.
- Approximately 82 per cent of crashes involved more than one vehicle.
- Approximately 71 per cent of crashes occurred on a weekday.
- Approximately 85 per cent of crashes occurred in fine and dry weather conditions.
- Of the 20 crashes where the contributing factor was known, nine crashes were attributed to fatigue and eight to speeding.
- Approximately 64 per cent of crashes occurred in daylight and 28 per cent occurred in darkness.
- The time periods which experienced the highest number of crashes were 7–8am and 6–7pm, with 10 and 12 recorded crashes, respectively.

Access

Existing intersections along Campbelltown Road provide direct access to a variety of adjacent roadways, suburbs, developments and businesses. Refer to Section 2.2, Table 2-3 for a description of access provided by each intersection.

6.6.2 Potential impacts

Construction

The proposal would have temporary traffic impacts during the construction phases of the works. As mentioned above, Campbelltown Road is classified as a B-double route between Casula and Campbelltown. Based on traffic data collected from October 2011, there is on average between 1400 and 2800 heavy vehicle movements per day at different sections of Campbelltown Road. As Campbelltown Road would likely be the main haulage route, the proposal would have temporary traffic impacts during the construction phases of the works. Traffic impacts would occur as a result of the movement of construction vehicles along Campbelltown Road and along service and access roads, the hauling of construction materials and service vehicles. Truck movements during the construction phase are expected to increase by 30 to 40 truck movements per day. Truck movements may increase to 60 to 100 truck movements per day at certain stages of construction; for example, during large cut and fill exercises. The additional truck movements associated with construction activities would be temporary and not result in a substantial increase on existing numbers. Minor locally concentrated impacts are expected, predominantly due to use of construction accesses during peak times.

Potential impacts caused by construction vehicle traffic would include:

- Increased travel times due to reduced speed limits around construction sites.
- Increased travel times, due to increased truck and construction machinery movements.
- Temporary partial or complete closure of roads and altered property accesses during construction; however, property access would be maintained at all times, and any impacts would be short-term. Existing properties on Campbelltown Road would continue to have direct left in/left out access until precinct development takes place.
- Temporary impact on bus services through reduced speeds.
- Traffic switching during the construction phase would likely be required in all areas involving alignment with the footprint of the existing road surface. Construction staging would consider minimising the number of traffic switches from one carriageway of Campbelltown Road to the other during construction to help minimise traffic disruption.

Public Transport

As outlined previously, there is currently limited public transport provision in the vicinity of Campbelltown Road. Several bus services traverse the northern end of Campbelltown Road between the Camden Valley Way/Hume Highway and Glenfield Road intersections. The remainder of Campbelltown Road is only serviced by school buses.

Construction may impact on these bus services through reduced speeds and temporary relocation of bus stops. However, bus services and safe stopping locations would be maintained at all times, and any impacts would be short-term. Ongoing updates on locations and access to bus stops would be provided to the community during the detailed design phase and the construction period to ensure disruption is minimised.

Walking and Cycling

Pedestrians and cyclists may experience short-term delays and inconveniences in terms of access through construction. However provision for pedestrians and cyclists would be maintained, and also consider access requirements for pre-schools, schools, existing and relocated bus stops.

Access

Access to individual properties may be affected by construction activities, either through the loss of existing access arrangements, or the alteration of access arrangements. There may be some minor detours and diversions necessary through the construction period, impacting on all road users. These would be kept to a minimum and road users would be notified in advance. Property access would be maintained at all times, and any impacts would be short-term. All existing accesses would be shown on construction staging plans to ensure that each private access is identified and addressed.

Existing properties on Campbelltown Road would continue to have direct left in/left out access until the proposed Edmondson Park precinct development takes place.

Construction at intersections of Campbelltown Road and adjoining roads may result in temporary impacts upon access. Traffic management plans would be developed to minimise traffic disruption and maintain existing access at all times, including for pedestrians and cyclists.

Operation

A number of traffic modelling studies were undertaken to identify the number of lanes required for the proposal based on traffic capacity requirements. Network modelling was undertaken as part of the Route Strategy Study (GHD 2006) while more recent modelling was undertaken by RMS Transport Planning Section in 2012 between Beech Road and Denham Court Road. This recent modelling used the RMS EMME Sydney Strategic Model and considered four sections within the study area as follows:

- Section 1: Beech Road and Hume Highway on Ramp.
- Section 2: Hume Highway on Ramp and Lawson Road.
- Section 3: Lawson Road and Zouch Road.
- Section 4: Zouch Road and Denham Court Road.

The forecast AADT traffic flows for each of the four sections of Campbelltown Road are outlined in Table 2-2.

Traffic modelling has been undertaken by RMS using all future year forecast turning movements to determine the optimum intersection layout for each design year. Using the existing intersection layouts as a starting point, each intersection along Campbelltown Road was assessed under forecast traffic flows starting with 2026 and upgraded from the existing layout (if required) based on initial concept design drawings of future intersection layouts along Campbelltown Road.

In order to meet the forecast traffic demands for 2026, the following upgrades and new intersections are proposed along Campbelltown Road:

- Campbelltown Road/Beech Road, upgrade to a four way intersection providing a southern approach.
- Campbelltown Road/Ingleburn Gardens Drive: upgrade to two lanes on both Campbelltown Road approaches.

- Campbelltown Road/East Town Centre Road: new four way intersection.
- Campbelltown Road/Croatia Avenue: new four way intersection.
- Campbelltown Road/New Macdonald Road: realigned to a new four way, approximately 220 metres west of the existing intersection.
- Campbelltown Road/Denham Court Road: upgrade to a four-way signalised intersection.

The proposed configurations of the intersections are shown in Section 3.25, Figures 3-29 to 3-40.

Traffic modelling indicated that the proposed intersection upgrades would provide an adequate level of service based on traffic forecasts to 2026, with opportunities within the road corridor for several additional intersection upgrades to be undertaken as part of future widening works (post 2026) along Campbelltown Road when required. Particularly, the traffic modelling indicated that intersections between Ingleburn Gardens Drive and New Macdonald Road would require three lanes on the Campbelltown Road approaches under the 2036 traffic forecasts. This proposed staging of intersection upgrades along Campbelltown Road is described in Table 6-59.

Table 6-59: Proposed staging of intersection upgrades to maintain Level of Service

Intersection	2011	2026 (the proposal)	2036 (possible future upgrade)
Beech Road	Existing	Upgrade to a four way intersection: • Three lanes on Campbelltown Road approaches. • Additional auxiliary lane on Campbelltown Road (E leg). • Slip lane for left turn movements on Campbelltown Road approaches. • New southern approach with two entry and exit lanes and a northbound left turn bay. • Left turn bay on southbound approach.	No upgrade required
Ingleburn Gardens Drive	Existing	Upgrade intersection: • Two lanes on both Campbelltown Road approaches.	Upgrade intersection: • Three lanes on Campbelltown Road.
East Town Centre Road	N/A	New four way intersection: • Two entry and exit lanes with a right turn bay for both Campbelltown Road approach. • Two entry and exit lanes with a left turn bay for the northbound and southbound approaches.	Upgrade intersection: Three lanes on Campbelltown Road.
Croatia Avenue	N/A	New four way intersection: • Two entry and exit lanes with a	Upgrade intersection: • Three lanes on

Intersection	2011	2026 (the proposal)	2036 (possible future upgrade)
		right turn bay for both Campbelltown Road approach. Two entry and exit lanes with a left turn bay for the northbound and southbound approaches.	Campbelltown Road.
New Macdonald Road	N/A	• Two entry and exit lanes on Campbelltown Road approaches. • Additional auxiliary entry and exit lanes on Campbelltown Road approaches. • Two entry and exit lanes with a left turn bay on the southbound approach. • Two entry and exit lanes with a right turn bay on the northbound approach.	Upgrade intersection: Three lanes on Campbelltown Road by upgrading the auxiliary entry and exit lanes.
Denham Court Road	Existing	• Two lanes on Campbelltown Road approaches. • Right turn bay and a left turn bay (slip) on the northbound approach. • Dual left turn slip bay, auxiliary through lane and dual right turn bays on the eastbound approach. • Dual right turn bays on the southbound approach. • Single entry and exit lanes on the westbound approach.	No upgrade required

Source: AECOM (2013)

Intersection performance

Impacts through the operation of the proposal due to staging of proposed 2026 and 2036 intersection upgrades are outlined in Table 6-60 in terms of the expected capacity of all six intersections in peak periods.

Table 6-60: Intersection performance summary

Intersection	Time Period	2011			2026			2036		
		Level of Service (LoS)	Degree of saturation (DoS)	Average delay per vehicle (sec)	Level of Service (LoS)	Degree of saturation (DoS)	Average delay per vehicle (sec)	Level of Service (LoS)	Degree of saturation (DoS)	Average delay per vehicle (sec)
Glenfield Road	AM	B	1.000*	22.8	B	0.796	20.7	B	0.879	22.3
	PM	B	0.658	21.9	B	0.963	26	B	0.997	26
Beech Road	AM	B	0.59	16.4	D	0.753	49.4	D	0.578	47.2
	PM	A	0.791	9.7	E	0.977	56.6	C	0.813	36.7
Ingleburn Gardens Drive	AM	A	0.785	9.5	A	0.567	7.7	A	0.448	7.4
	PM	A	0.795	11.9	A	0.547	8.8	A	0.387	8.0
East Town Centre Road	AM	N/A	N/A	N/A	C	0.848	29.2	B	0.741	28.0
	PM	N/A	N/A	N/A	C	0.811	29.5	C	0.753	31.5
Croatia Avenue	AM	N/A	N/A	N/A	B	0.732	24.4	B	0.639	25.2
	PM	N/A	N/A	N/A	B	0.775	25.1	B	0.684	26.2
New Macdonald Road	AM	N/A	N/A	N/A	D	0.905	48.6	D	0.940	55.8
	PM	N/A	N/A	N/A	D	0.915	44.9	D	0.913	50.3
Denham Court Road	AM	A (round about)	0.570	7.4	C (signalised)	0.745	35.0	C	0.769	36.2
	PM	A (round about)	0.397	7.1	D (signalised)	0.874	47.4	D	0.908	51.7

*Right turn bay from Campbelltown Road Glenfield Road at capacity
Note: Modelling was undertaken for major intersections only (not for minor local roads). Zouch Road has not been assessed as it will become a left in left out intersection in the future. No changes are proposed for the intersection of Campbelltown Road/Camden Valley Way and Campbelltown Road/Hume Highway. As a result these intersections have been excluded from analysis.
Source: RMS 2012

Mid-block capacity

Mid-block capacity analysis has been undertaken to confirm the proposal would cater for the forecast traffic volume estimated by RMS for the AM and PM peak periods in 2026 and 2036. The future mid-block capacity of the proposed upgrade route in 2026 and 2036 was assessed across the following four route components:

- Between Beech Road and the Hume Highway on-ramp (Section 1).
- Between Hume Highway on-ramp and Macdonald Road (Section 2).
- Between Macdonald Road and Zouch Road (Section 3).
- Between Zouch Road and Brooks Road (Section 4).

The analysis compared mid-block capacity results with and without the proposed upgrade. The results are shown in Table 6-61. In 2026, without the proposed upgrade, capacity would be exceeded in three of the four sections in the AM peak. This would increase to all four sections in the PM peak, indicating the necessity of the proposed upgrade in terms of traffic forecasts. Mid-block capacity results for the proposed upgrade indicate all corridor sections would be within capacity. By 2036, in the event that Campbelltown Road is not upgraded, capacity would be exceeded on the majority of the corridor in both the AM and PM peak period. With the proposed upgrade, capacity would be sufficient to cater for the projected corridor demand.

Table 6-61: Forecast mid-block capacity

Section	AM peak hour (veh/hr)				PM peak hour (veh/hr)			
	Peak direction flow (EB/NB)	Peak direction flow (EB/NB)	Volume capacity ratio	Peak direction flow (EB/NB)	Volume capacity ratio			
	2026 – no upgrade		**2026 – upgrade**		**2026 – no upgrade**		**2026 – upgrade**	
Between Beech Road and Hume Highway on ramp.	1588	0.66 (2 lanes)	1951	0.54 (3 lanes)	2709	1.13 (2 lanes)	2946	0.82 (3 lanes)
Between Hume Highway on ramp and Macdonald Road.	1588	1.32 (1 lane)	1951	0.81 (2 lanes)	1217	1.01 (1 lane)	1619	0.67 (2 lanes)
Between Macdonald Road and Zouch Road.	1602	1.34 (1 lane)	1987	0.83 (2 lanes)	1350	1.13 (1 lane)	1741	0.73 (2 lanes)
Between Zouch Road and Brooks Road.	1280	1.07 (1 lane)	1696	0.71 (2 lanes)	1166	0.97 (1 lane)	1555	0.65 (2 lanes)
	2036 – no upgrade		**2036 – Upgrade**		**2036 – no upgrade**		**2036 – upgrade**	
Between Beech Road and Hume Highway on ramp.	1722	0.72 (2 lanes)	2224	0.62 (3 lanes)	2780	1.16 (2 lanes)	2784	0.77 (3 lanes)
Between Hume Highway on ramp and Macdonald Road.	1722	1.44 (1 lane)	2224	0.62 (3 lanes)	1272	1.06 (1 lane)	1885	0.52 (3 lanes)
Between Macdonald Road and Zouch Road.	1761	1.47 (1 lane)	2354	0.65 (3 lanes)	1450	1.21 (1 lane)	2238	0.62 (3 lanes)
Between Zouch Road and Brooks Road.	1366	1.14 (1 lane)	1907	0.53 (3 lanes)	1262	1.05 (1 lane)	2001	0.56 (3 lanes)

Source: RMS EMME Model (2013)

Crashes and safety

The proposal is expected to reduce the number of head-on crashes, with the construction of two divided carriageways. The likelihood of intersection crashes would also be reduced with the provision of deceleration/slip lanes along Campbelltown Road and the introduction of signalised intersections plus a new bicycle/pedestrian lane.

Public transport

The proposal is expected to improve public transport accessibility by providing improved access to the Edmondson Park station on the South West Rail Link.

The proposal is expected to have little impact on existing school bus routes. The South West Bus Servicing strategy identifies that in the short-term future (<5 years) only one bus service would use Campbelltown Road. The route travels through Edmondson Park before turning left at Croatia Avenue and travelling to Liverpool and has a frequency of one bus every 30 minutes (AECOM 2013). In addition the Edmondson Park south Part 3A Concept Plan TMAP identifies a bus route (between 2012-2016) connecting Ingleburn Station with Liverpool Station via Edmondson Park south using Macdonald Road and Campbelltown Road. This route would be redirected with the opening of the SWRL (AECOM 2013).

The South West Bus Servicing strategy identifies that in the long-term future (2030+) no buses would travel along Campbelltown Road; however, buses would traverse across Campbelltown Road to access Edmondson Park. The long-term bus network for the SWGC in the vicinity of Campbelltown Road focuses on connectivity between Ingleburn and Edmondson Park (AECOM 2013).

Minor modifications would be made to the two existing bus stops adjacent to the Cross Roads to match the new widened alignment.

Freight transport

The proposal is expected to result in improved safety and efficiency for B-double and freight access along Campbelltown Road. With the addition of a second lane in each direction between Denham Court Road and Ingleburn Gardens Drive other vehicles and road users would be able to pass larger trucks more easily and safely.

Walking and cycling

The proposal includes provision of off road shared pedestrian paths to facilitate pedestrian and cyclist movements along the Campbelltown Road corridor between key land uses (such as the proposed Edmondson Park precinct and Ingleburn Gardens, and the proposed Town Centre and Railway Station at Edmondson Park).
Pedestrian crossings are included on all approaches at intersections of Campbelltown Road with New Macdonald Road, Croatia Avenue and East Town Centre Road, providing connectivity between land uses to the east and west of Campbelltown Road, and safe crossing points (in particular where pedestrian activity is expected to be highest in the vicinity of the proposed Town Centre).

The proposal also includes an on road cycle way accommodating for safe travel of cyclists along the full length of Campbelltown Road.

Access

Operational impacts to access along Campbelltown Road due to the proposal would result from changes to intersections and turning movements. The proposal would provide improved access to the SWGC and planned Edmondson Park precinct. In particular this includes access to the planned Town Centre and Edmondson Park Railway Station (under construction) from Campbelltown Road provided by three new four-way signalised intersections (East Town Centre Road, Croatia Avenue and Macdonald Road) Proposed intersection upgrades (as outlined in Section 3.2.6, Table 3.7).

The following local roads would no longer have access to Campbelltown Road:

- Lawson Road.
- Blaxland Road.
- Stevens Road.
- Allen Avenue.
- Kelly Road.
- Wootten Road.

These roads are to be redeveloped as part of the planned Edmondson Park precinct. Macdonald

As a result of the proposal, several minor intersections with local roads will be converted to a left in/left out arrangement. Table 6-62 outlines the maximum distance between the minor road and the nearest intersection which would facilitate a right turn movement.

Table 6-62: Proposed turnaround distances for minor intersections with local roads

Parkers Farm Place	East	250	Glenfield Road
Zouch Road (North)	East	680	Macdonald Road
Zouch Road (South)	West	860	Denham Court Road
Blomfield Road	West	370	Denham Court Road

Further to this, to facilitate u-turns Dickson Road will be widened to provide two lanes at the stop line and a single wide lane departing the intersection. The carriageway width of Dickson Road would be about 20m.

6.6.3 Safeguards and management measures

Table 6-63 outlines the proposed safeguards and management measures in terms of traffic and transport for both construction and operational phases of the proposal.

Table 6-63: Proposed traffic and transport safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Construction traffic impacts	• A Traffic Management Plan (TMP) would be prepared as part of the CEMP. The TMP would be prepared in	Construction contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	accordance with *Traffic Control at Worksites* (RMS 2010), *Australian standards AS1742* and the worksite manual *RMS Specification G10*. The TMP would be submitted in stages to reflect the progress of work and would outline: - Traffic control provided to manage and regulate traffic movements during construction, including minimising traffic switching. - Maintain the continuous, safe and efficient movement of traffic for both the public and construction workers. - Identification of haulage routes and ensuring impacts to local routes are minimised. - Determine temporary speed restrictions to ensure a safe driving environment around work zones. - Provide access to local roads and properties, including the use of temporary turn-around bays. - Maintain pedestrian and cyclists access throughout construction. - Provision of appropriate warning and advisory signposting. - Include requirements and methods to consult and inform local community of impacts on local road network and traffic. - Consider other developments that may also be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic.		
Access	• Property access would be maintained at all times, including pre-schools, places of	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	worship and all commercial premises.		
Access	• More frequently or heavily affected residents would be contacted for specific issues like driveway access or other issues that arise through construction.	Construction contractor	Construction
Temporary impact on bus services	• Access to bus stops and safe stopping locations would be maintained during construction in consultation with bus operators. • Ongoing updates on locations and access to bus stops would be provided to the community during construction period to ensure that disruption is minimised.	RMS and construction contractor	Construction

6.7 Noise and vibration

A Noise and Vibration Assessment was undertaken to assess the potential impacts from the construction and operation of the proposal (Wilkinson Murray, 2013). A complete copy of the Noise Assessment Report is available in Appendix L of this REF and is summarised below. The assessment considers the potential noise and vibration impacts of the construction and operation of the proposal including the expected future traffic flow on the upgraded road 10 years after completion.

6.7.1 Methodology

The Noise and Vibration Assessment has been prepared in accordance with the following policies and guidelines:

- The *Road Noise Policy* (RNP) (EPA 2011).
- The *Interim Construction Noise Guideline* (ICNG) (EPA 2009).
- The *Environmental Noise Management Manual* (ENMM) (RMS 2001).
- The *Assessing vibration: A technical guideline* (DECCW 2006).

Study Area

For the purpose of this assessment, the study area is defined by noise catchment areas (NCAs). NCAs are areas that are likely to have similar noise exposures on the basis of factors such as topography, road design, setbacks and types of residences or other noise receptors. The study area is divided into nine NCAs. These are described in Section 6.7.2 and shown in Figure 6-72.

Noise Monitoring

Noise measurements of existing traffic were conducted during two separate surveys (between 6 March and 14 March 2012, and between 1 May and 14 May 2012) to characterise the existing noise environment and to calibrate the traffic noise model.

Unattended long-term noise monitoring was obtained at six representative locations along the length of Campbelltown Road. In addition, short-term attended noise monitoring was conducted at the junction of Camden Valley Way and Hume Highway, at 2415 Camden Valley Way and 696 Hume Highway. The time of year sampled did not fall within public holiday or school holiday periods, and was considered to be a reasonable approximation of standard traffic flows in the study area.

Further to the unattended noise monitoring, attended noise measurements were made at appropriate "satellite" locations during the daytime period to provide more data for the traffic noise model validation process. Traffic volume and classifications were monitored concurrently during the attended noise monitoring periods. The locations were chosen to represent all potentially affected noise sensitive receivers along the route. Table 6-64 lists the noise monitoring locations, which are also displayed in Figure 6-72.

Table 6-64: Monitoring locations – attended and unattended noise survey

Location ID	Monitoring location/description	Setback distance to road (m)
U1	Comfort Inn, 8 York Street – Balcony of room 301.	44
U2	Lot 302 Campbelltown Road (Mirvac) – on side of road.	5
U3	2 Campbelltown Road – front yard.	35
U4	19 Hollyoake Crescent – balcony.	29
U5	Campbelltown Road – on side of road near Ingleburn Gardens Drive.	4.5
U6	489 Campbelltown Road – front yard.	23
A1	8 Zouch Road.	17
A2	Watch Tower Bible and Tract Society.	120
A3	Bambi Kindergarten on Stevens Road.	88
A4	Ingleburn Primary School.	>68,19
A5	Ingleburn Garden Residential Area.	140
A6	Lot 2 on Glenfield Road.	125
A7	2415 Camden Valley Way.	4.5
A8	696 Hume Highway Timber Flooring Shop.	5

Source: Wilkinson & Murray (2013)

Measured noise levels were used to generate a statistical noise model for the proposal, predicting noise levels at all sensitive receivers. Predicted noise levels were used to set criteria for noise levels at each location. The model then provides predicted noise levels for future years, both with the proposal and without. Comparisons of these noise levels against set criteria enabled the assessment of likely noise impacts as a result of the proposal.

6.7.2 Existing environment

The proposal is located in a rural-suburban growth area in south-west Sydney. Campbelltown Road is generally a multi-lane undivided road that also provides resident access to surrounding suburbs such as Casula and Denham Court. The section between Camden Valley Way and Beech Road is in an urban setting which includes some commercial and retail facilities (service station, retail and food outlets) as well as some vacant lots and paddocks/grazing fields. The remaining section between Beech Road and Brooks Road is currently in a semi-rural setting. Non-residential developments in the vicinity include a public school, a service station, early learning centre, and a commercial facility (garden supply).

Campbelltown Road is a principal arterial road with a dense graded asphaltic concrete (DGAC) pavement, and has a speed limit of 70 kilometres per hour for the majority of the road. There are a number of existing intersections along Campbelltown Road, as outlined in Section 2.2 and listed in Table 2.3.

The proposal includes existing boundary barriers, which were considered in the Noise and Vibration Assessment undertaken. The boundary barriers consist of lapped and capped timber at various heights (1.7 to 2.2 metres) at two different locations surrounding the Mirvac residential subdivision at Glenfield, opposite Parkers Farm Place, south of Glenfield Road and at Ingleburn Gardens Drive residential subdivision.

Noise sensitive receivers

Figure 6-72 shows the alignment in more detail, and the noise sensitive receivers considered in this noise assessment. It also shows various groups of residences along the alignment shown in red. These are grouped in NCAs where similar existing and future noise impacts are expected.

Table 6-65 summarises the NCAs which have been broadly identified, based on residential receivers.

Table 6-65: Noise catchment area summary

NCA	Description
A	Existing receivers on north side of Camden Valley Way near intersection with Campbelltown Road. Includes 2 motels. Mix of single and double storey receivers. Traffic noise on Camden Valley Way dominates noise environment. In this NCA, receiver 1 is closest to the road at a setback distance of approximately 10 m from the nearside carriageway.
B	Residences set further back from Campbelltown Road, which are affected by Hume Highway and Glenfield Road. In This NCA, receiver 11 is closest to Campbelltown Road at a setback distance of approximately 140 m from the nearside carriageway.
C	Along this section, there is currently a residential subdivision being developed on the lands fronting southbound lanes of Campbelltown Road after Glenfield Road. In this NCA, receiver 14 is closest to Campbelltown Road at a setback distance of approximately 28 m from the nearside carriageway.
D	Residences set further back from Campbelltown Road, which are affected by the South Western Freeway (Hume Highway) on ramp and also the main carriageways. In this NCA, receiver 22 is closest to Campbelltown Road at a

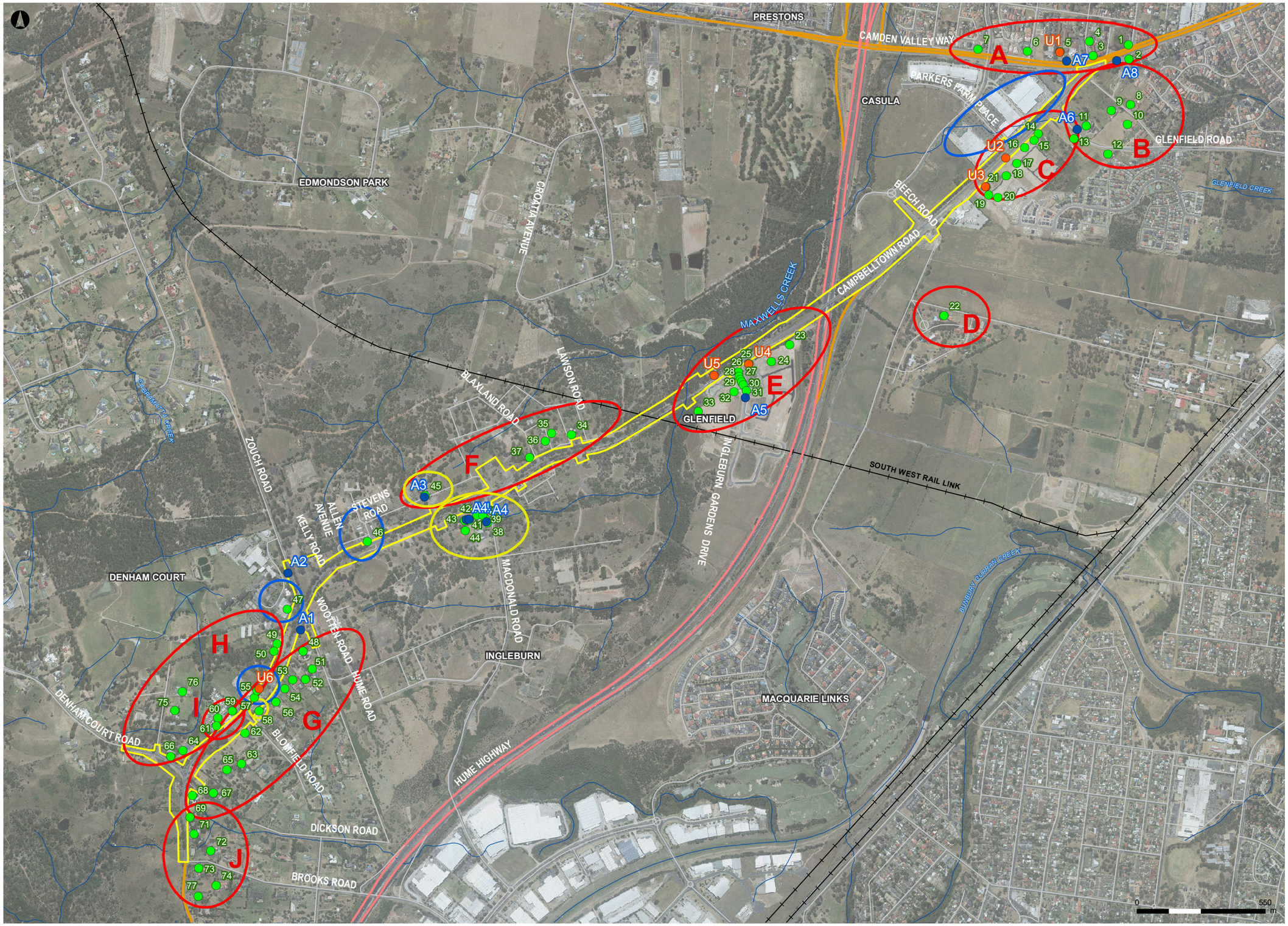
NCA	Description
	setback distance of approximately 330 m from the nearside carriageway.
E	The residential subdivision near Ingleburn Gardens Drive. Those in the eastern part are also affected by the Hume Highway. In this NCA, receiver 25 is closest to Campbelltown Road, which is at a setback distance of approximately 22 m from the nearside carriageway.
F	Isolated residences in this area, although this will be sub divided. In this NCA, receiver 37 is closest to Campbelltown Road at a setback distance of approximately 30 m from the nearside carriageway.
G	Isolated residences to the south of Campbelltown Road. Mostly single storey, with access onto Campbelltown Road. In this NCA, receiver 62 is closest to Campbelltown Road, which is at a setback distance of approximately 60 m from the nearside carriageway.
H	Isolated residences north of Campbelltown Road. Mostly single storey, with access onto Campbelltown Road. In this NCA, receiver 55 is closest to Campbelltown Road at a setback distance of approximately 31 m from the nearside carriageway and receiver 66 is closest to Denham Court Road at approximately 27 m to the nearside carriageway.
I	A caravan park north of Campbelltown Road, where the front row of receivers is approximately 40 m to the nearside carriageway of Campbelltown Road.
J	Isolated residences to the South of Denham Court Road. In this NCA, receiver 69 is closest to Campbelltown Road at a setback distance of approximately 40 m from the nearside carriageway.

Source: Wilkinson & Murray (2013)

Commercial receivers are also shown on Figure 6-72. There are commercial receivers to the north of Campbelltown Road between Camden Valley Way and the Hume Highway (receiver ID 3 and 5). There is a defence facility (where stone gates are considered to be a heritage item, see Section 6.3) north of Campbelltown Road, east of Zouch Road (receiver ID 46) and a landscaping business north of Campbelltown Road, west of Zouch Road (receiver ID 57). In addition, there is a religious organisation located in the northwest quadrant of the intersection of Campbelltown Road and Zouch Road (receiver ID 47). This receiver is not considered in the operational noise assessment as there are non-residential buildings and a car park between the worship areas, and therefore traffic noise would be shielded at this location.

Other sensitive receivers are shown on Figure 6-72 and include:

- Ingleburn Primary School in the south-west quadrant of Campbelltown Road and Macdonald Road (receiver ID 39 – 44).
- Bambi Kindergarten on Stevens Road in Noise Catchment F (receiver ID 45).
- Leaping Learner's Early Education Centre in Noise Catchment G (receiver ID 58).
- Heritage listed Denham Court House at Denham Court, on the southern side of Campbelltown Road (receiver ID 65, NCA G).
- Heritage listed St Mary the Virgin Church, on the corner of Denham Court Road and Church Road (closest receiver is receiver ID 60, which is approximately 200 metres to the east, towards Campbelltown Road, NCA I).



LEGEND

- Proposal Area
- Noise Sensitive Receivers

Noise Monitoring Locations

- Attended
- Unattended

Noise Catchment Areas

- Commercial Receivers
- Other Sensitive Receivers
- Residential Receivers

DATA SOURCES
RMS, LPI, OEH

Transport Roads & Maritime Services

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

Hyder

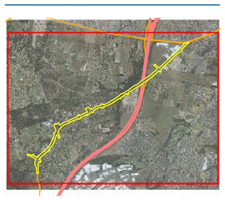


Figure 6-71: Aerial of proposal area showing noise catchments, sensitive receivers and monitoring locations

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Created by : GC
QA by : LD

Background noise levels

A summary of the noise logger data (measured in the free field with the exception of location A1 and location A2) is shown in Table 6-66, representing existing ambient noise levels along Campbelltown Road. Any extraneous noise not assumed to be typical of traffic has been excluded. This data was used to validate the noise model and set noise criteria for construction works.

Table 6-66: Campbelltown Road existing ambient noise levels (2012)

Location	L_{Aeq}, 15 hr Day (dBA)	L_{Aeq}, 9 hr Night (dBA)	L_{A90} Day (dBA)	L_{A90} Evening (dBA)	L_{A90} Night (dBA)
U1	62.7 (1)	59.7 (1)	54	53	46
U2	73.1 (1)	69.4 (1)	52	49	46
U3	61.5	58.4	53	53	43
U4	63.1	59.5	52	51	42
U5	69	67.2	51	47	43
U6	59.2	55.1	44	43	37
A1	62	57.8	49	41	38
A2	56.3	52.3	51	-	-
A3	54.5	50.5	52	-	-
A4	54.8	50.8	52-53	-	-
A5	Dominated by other roads	Dominated by other roads	49	-	-
A6	Dominated by other roads	Dominated by other roads	54	-	-
A7	73.1	69.4	57	-	-
A8	73.3	69.6	59-63	-	-

Source: Wilkinson & Murray (2013)

1 Denotes noise levels with a façade effect (exterior side of a building has a façade creating somewhat of a barrier to noise).

2. The L_{Aeq} noise levels at satellite locations A5 and A6 were perceived to be dominated by traffic noise from other arterial roads; therefore, are not appropriate for validating road traffic noise from Campbelltown Road.

The existing noise environment shows a typical pattern of traffic noise for a main road in a semi urban area, with characteristically high noise levels from early morning until late evening each day.

6.7.3 Noise and vibration criteria

Construction noise criteria

The NSW Interim Construction Noise Guideline (ICNG) presents the process to assess construction in NSW. The ICNG was developed by the Department of Environment Climate Change and Water (DECCW) taking into consideration that construction is temporary, noisy and difficult to ameliorate. As such, the ICNG was developed to focus on applying a range of work practices most suited to minimising

construction noise impacts, rather than focusing only on achieving a numeric noise level. The ICNG recommends that standard construction work hours should typically be as follows:

- Monday to Friday: 7am to 6pm.
- Saturday: 8am to 1pm.
- No work on Sundays or public holidays.

Additionally, it recommends quantitative management noise goals at residences for standard construction hours and outside of recommended standard hours. These are shown in the Noise and Vibration Assessment report (Wilkinson Murray, 2013), Appendix L.

In addition to the above criteria, where any work is conducted during the night time period (10.00pm 7.00am), the EPA recommends that to protect against sleep disturbance, $L_{A1,1min}$ noise levels should not exceed the background level by more than 15 decibels at any residence. In practice, the $L_{A1,1min}$ level can be represented by the maximum noise level. The ICNG presents the following noise management levels for non-residential premises:

- Active recreation areas (such as parks) - external L_{Aeq} (15 min) 65 decibels.
- Passive recreation areas - external L_{Aeq} (15 min) 60 decibels.
- Industrial premises - external L_{Aeq} (15 min) 75 decibels.
- Offices, retail outlets - external L_{Aeq} (15 min) 70 decibels.
- Classrooms, hospitals, places of worship - internal L_{Aeq} (15 min) 45 decibels.

The proposed construction hours are 7am to 6pm Monday to Friday and 8am to 1pm Saturday. The criteria specific to this project are based on background noise levels presented previously in Table 6-66.

For the purposes of this assessment, this section of the report focuses on the more typical works during standard construction hours and the night time “bridgeworks”.

The construction noise criteria at existing residences representative of the various NCAs along the alignment (based on proposed construction activities) are shown in Table 6-67.

Table 6-67: L_{Aeq} construction noise criteria (day-time)

Receivers	NCA	Background level (dBA)	Measurement location used (refer to Table 6-64)	Criteria L_{Aeq} (dBA)
14	C	52	U2/U3	62
21	C	52	U2/U3	62
23	E	51	U4	61
24	E	51	U4	61
25	E	51	U4	61
37	F	51	U4	61
39	N	52	A4	62
42	N	52	A4	65

Receivers	NCA	Background level (dBA)	Measurement location used (refer to Table 6-64)	Criteria L_{Aeq} (dBA)
44	N	52	A4	65
46	K	44	U6	70
46	K	44	U6	75
47	Commercial	44	U6	70
57	Commercial	44	U6	70
55	H	44	U6	54
48	G	44	U6	54
58	G	44	U6	Internal 45
66	I	44	U6	54
68	G	44	U6	54
69	J	44	U6	54

Note: Receivers listed are the closest to noise source. Not all NCAs are included due to distance of sensitive receivers from works and/or NCAs being dominated by traffic noise from other roads).
Source: Wilkinson & Murray (2013)

As it has been determined that some night works may be necessary at various locations through construction (due to bridge works), noise criteria at potentially affected residences are shown in Table 6-68.

Table 6-68: L_{Aeq} construction noise criteria (night-time)

Receivers	NCA	Night-time Background level (dBA)	Criteria (dBA)	
			L_{Aeq}	L_{Amax}
23	E	42	47	57
24	E	42	47	57

Source: Wilkinson & Murray (2013)

Construction vibration criteria

In relation to construction vibration, the bulk of the roadworks occur further than 20 metres away from residences and the construction of a new bridge occurs approximately 230 metres away from the nearest residences. Vibration limits are typically established to meet two objectives:

- Human comfort in buildings affected by construction.
- Avoidance of damage to buildings affected by construction vibration.

The DECCW's Assessing Vibration: A Technical Guideline provides acceptable values for continuous and impulsive vibration in the range 1-80 Hertz. Both preferred and maximum vibration limits are defined for various locations and are shown in Table 6-69.

Table 6-69: Preferred and maximum peak particle velocity (PPV) values for continuous and impulsive vibration

Location	Assessment period (1)	Preferred values (PPV)	Maximum values (PPV)
Continuous vibration			
Critical areas (2)	Day or night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices, schools, educational institutions and places of worship	Day or night time	0.56	1.1
Workshops	Day or night time	1.1	2.2
Impulsive vibration			
Critical areas (2)	Day or night time	0.14	0.28
Residences	Daytime	8.6	17.0
	Night time	2.8	5.6
Offices, schools, educational institutions and places of worship	Day or night time	18.0	36.0
Workshops	Day or night time	18.0	36.0

Source: Wilkinson & Murray (2013)

[1] Day time is 7am to 10pm and night time is 10pm to 7am.

[2] Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992.

In regard to potential building damage, the German Standard DIN4150 suggests a limit of 5-20 millimetres per second PPV, depending on the dominant frequency of vibration, within dwellings and buildings of similar construction. For the typical frequencies produced by construction activities this limit is usually around 10millimetres per second. Without precise knowledge of the vibration frequency, which is both activity and site specific, Wilkinson Murray conservatively applies a limit of 5 millimetres per second. For commercial buildings, these limits increase to between 20-50 millimetres per second due to their more substantial construction. *British Standard BS7385: Part 2 - 1993* also sets a limit within buildings which depends upon the vibration frequency, but is as low as 7.5 millimetres per second PPV (at 4 Hertz).

For heritage items, a limit of three millimetres per second applies.

Table 6-70 provides typical vibration levels at a range of distances from the various construction activities to be undertaken. Heavy duty vibratory rolling would be required along the alignment; however, the location of use of other vibration-generating equipment is not known at this stage.

Table 6-70: Typical vibration emission levels from construction plant

Activity	PPV vibration level (mm/s) at distance		
	10 m	20 m	30 m
10-tonne vibratory roller (high)	2.0-2.4	0.4-1.2	0.2-0.8
Hydraulic hammer (30 t)	3	1.5	1.0

Source: Wilkinson & Murray (2013)

Operational noise criteria

Criteria for assessment of road traffic noise are set out in the NSW Government's Road Noise Policy (RNP). Under the RNP, road projects are classified as either 'new road' or 'redevelopment of an existing road'. For all noise-sensitive locations considered in this assessment, the proposal would be classified as 'Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads'. Table 6-71 sets out the assessment criteria for the identified existing residences.

Table 6-71: Assessment criteria for the identified existing residences

Road category	Type of project/land use	Assessment criteria	
		Day time (7am – 10pm)	Night time (10pm – 7am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	L_{Aeq}, 15 hour 60 dBA (external)	L_{Aeq}, 9 hour 55 dBA (external)

Source: Wilkinson & Murray (2013)

In applying Table 6-71, the increase in traffic noise is to be assessed at two times:

- The noise level immediately after opening of the proposal is compared with the level under current conditions immediately before opening.
- The level 10 years after opening is to be compared with the level at the same time under a 'no-build' scenario – that is, allowing for any traffic growth that would have occurred in the absence of the proposal.

In the event that existing traffic noise levels are already just within or exceed the criteria; the RNP indicates that in considering feasible and reasonable mitigation options that 'an increase of up to two decibels represents a minor impact that is barely perceptible to the average person'.

The ENMM also identifies a category of highly affected noise sensitive receivers referred to as 'acute' that would experience noise levels greater than or equal to a daytime level of 65 decibels and/or a night time level of 60 decibels. Table 6-72 sets out the assessment criteria for non-residential receivers.

In addition to the assessment criteria, any increase in the total traffic noise level at a location due to the proposal must be considered. Residences experiencing increases in total traffic noise level above the relative increase criteria of $L_{Aeq,15hr}$ plus 12 decibels (external) and $L_{Aeq,9hr}$ plus 12 decibels (external) should also be considered for noise mitigation. For other existing sensitive land uses at outlined in Table 6-72, the relative increase criteria should be applied to the respective L_{Aeq}, period for that

land use type, except for open space. The relative increase criteria are not considered further in this noise assessment as the increase in total traffic noise at all locations due to the proposal does not increase by more than 12 decibels.

Table 6-72: Assessment criteria for operational traffic noise - non-residential receivers

Existing sensitive land use	Assessment criteria (dBA)	
	Day (7am – 10pm)	Night (10pm-7am)
1. School classrooms.	$L_{Aeq, 1hr}$ 40 (internal) when in use.	-
2. Places of worship.	$L_{Aeq, 1 hr}$ 40 (internal).	$L_{Aeq, 1 hr}$ 40 (internal).
3. Open space (active use).	$L_{Aeq, 1 hr}$ 60 (external) when in use.	-
4. Open space (passive use).	$L_{Aeq, 1 hr}$ 55 (external) when in use.	-
5. Childcare facilities.	Sleeping rooms $L_{Aeq, 1 hr}$ 35 (internal). Indoor play areas $L_{Aeq, 1 hr}$ 40 (internal). Outdoor play areas $L_{Aeq, 1 hr}$ 55 (external).	-

Source: Wilkinson & Murray (2013)

Maximum noise level

The ENMM outlines that the maximum noise level assessment method should be used to prioritise and rank mitigation strategies but should not be applied as a decisive criterion itself. The methodology employed assesses the impacts based on the emergence of the L_{Amax} over the L_{Aeq} (1 hour) noise level. A maximum noise pass-by event is defined as the emergence of the L_{Amax} level above the L_{Aeq} level by 15 decibels.

6.7.4 Potential impacts

Construction noise

Generally, construction activities during day and night would have the potential to cause some short-term impacts. Noise disturbance is likely to be dependent on:

- The location and proximity to each other of various plant items.
- The work that is being undertaken at any given time and whether it involves all machinery operating at the maximum sound power levels assessed.

Construction noise and vibration impacts have been assessed in terms of assumed construction activities and methodologies. Specific construction activities would be determined at the detailed design stage of the proposal. The proposed construction period would be approximately two to three years commencing in late 2013.

The workforce is expected to comprise between five and 50 personnel, depending on the stage of the construction works. Works would mostly be undertaken during standard working hours; however, due to the nature of the proposal it is anticipated

that some work may be required outside of the standard working hours to avoid major delays to commuter traffic and ensure the safety of the workforce. It is expected that approximately three months of out of hours works (in total over construction period) may be required to complete some of the construction works and activities such as traffic control switches and pavement works. This may include high noise generating activities such as bridge works.

These works would all require more detailed assessment prior to construction approval, to identify if and where exceedances are likely and address feasible and reasonable mitigation measures. Where works would be required outside of the standard working hours outlined above, the procedure contained in the RMS *Environmental Noise Management Manual 2001, "Practice Note vii – Roadworks Outside of Normal Working Hours"* would be followed. The Interim Construction Noise Guideline requires justification of work outside of prescribed hours and the need to incorporate all feasible and reasonable work practises to minimise potential adverse impacts. The construction noise and vibration management plan for the project (as a part of the CEMP) would address these requirements.

This section of the REF therefore focuses on the more typical works during standard construction hours and bridge works at night.

Typical construction activities and sound levels of typical construction equipment are listed in Appendix L, where sound power level based on the L_{Aeq} (L_{weq}) and L_{Amax} (L_{wmax}) are outlined.

It is expected that construction noise levels would exceed criteria for most of the construction activities at the closest receivers along the whole length of the proposal (refer to Table 6-73).

Table 6-73 also shows that at the closest receivers, noise levels would exceed the 75dBA noise level which is defined by the EPA as "highly noise affected". It should be noted that the presented noise levels represent the typical worst case use of plant and thus noise levels would be expected to be lower than those presented for much of the construction period.

Table 6-74 shows the predicted construction noise levels for night-time works. The predicted noise levels from bridge works are predicted to just comply with relevant criteria. Whilst construction activities are expected to be audible, predicted construction noise levels are lower than those from traffic on Campbelltown Road. Negligible impact is therefore expected.

Table 6-73: Predicted construction noise levels (day and night time)

Road section	ID	Receiver address	Closest distance	Day time criteria (dBA)	Evening criteria (dBA)	Predicted external $L_{Aeq.\ 15\ min}$ noise levels (dBA)				
						Site clearing	Compound,stock pile	Earthworks, paving	Bridge works	Road infrast-ructure
						113 (116)	109	116 (118)	115	111
Camden Valley Way to Hume Highway.	14	Lot 411 Campbelltown Rd	15	62	55	81 (84)	-	84 (91)	-	79
	21	2 Campbelltown Rd	20	62	55	79 (82)	-	82 (89)	-	77
Hume Highway to Macdonald Road.	23	Ingleburn DA	230 to bridge	61	52	-	-	-	58	-
	24	Ingleburn Existing	275 to bridge	61	52	-	-	-	56	-
	25	19 Hollyoake Cres	22	61	52	78 (81)	-	81 (88)	-	76
	37	2 Blaxland Rd	18	61	52	80 (83)	62	83 (90)	-	78
	41	Ingleburn Primary Classroom	35	45 Internal	-	74 (77)	57	77 (84)	-	72
Macdonald Road to Zouch Road.	42	Ingleburn Primary Play Area	36	65	-	74 (77)	56	77 (84)	-	72
	44	Ingleburn Primary Oval	65	65	-	69 (72)	-	72 (79)	-	67
	46	Ingleburn Military Heritage Precinct Front Office	8.5	70	70	86 (89)	53	89 (96)	-	84
Zouch Road to Denham Court.	47	Watchtower Bible & Tract Society Residential Area	28	54	-	76 (79)	68	79 (86)	-	74
	57	Austec Irrigation Garden Supplies	8	75	75	87 (90)	-	90 (97)	-	85
	55	489 Campbelltown Rd	13	54	59	83 (86)	-	86 (93)	-	81

Road section	ID	Receiver address	Closest distance	Day time criteria (dBA)	Evening criteria (dBA)	Predicted external $L_{Aeq.\ 15\ min}$ noise levels (dBA)				
						Site clearing	Compound,stock pile	Earthworks, paving	Bridge works	Road infrast-ructure
	48	8 Zouch Rd	41	54	48	73 (76)	54	76 (83)	-	71
	58	Leaping Learner's Early Education Centre	11	60	-	84 (87)	-	87 (94)	-	82
	66	5 Campbelltown Rd	14	54	48	82 (85)	-	85 (92)	-	80
	68	1 Dickson Rd	19	54	48	79 (82)	-	82 (89)	-	77
Denham Court to Brooks Road	69	230 Campbelltown Road	35	54	48	74 (77)	-	77 (84)	-	72

Source: Wilkinson & Murray (2013)

Table 6-74: Predicted construction noise levels (night-time)

Road section	ID	Receiver address	Closest distance (m)	Criteria (dBA)		Bridge works predicted noise levels (dBA)	
				L_{Aeq}, 15 min	L_{Amax}	$L_{Aeq, 15 min}$ 110	L_{Amax} 116
Hume Highway to Macdonald Road.	43	Ingleburn DA	230 to bridge	47	57	53	57
	46	Ingleburn existing	275 to bridge	47	57	51	54

Source: Wilkinson & Murray (2013)

Construction vibration

Construction vibration impacts have been assessed in terms of assumed construction activities and methodologies. Specific construction activities would be determined at the detailed design stage of the project. The proposed construction period is to be approximately two to three years commencing in late 2013.

The closest distance from the edge of road corridor to residential receivers is in the order of 10-15 metres. Some buildings used for commercial purposes are as close as nine metres. At this distance vibration levels from vibratory rollers are predicted to be less than structural damage criteria. Heritage listed Denham Court House is located approximately 100 metres from the edge of the proposal area. Due to the distance from proposed works, the proposal is not anticipated to impact these heritage items as a result of vibration.

The military precinct heritage stone gates are approximately 15 metres from the edge of proposed works. At this distance, the vibration damage limit of three millimetres per second is expected to be complied with, however vibration monitoring is recommended for any new vibration intensive activity within 30 metres to confirm the predicted vibration levels. This should form part of a Construction Noise and Vibration Management Plan (CNVMP) developed by the contractor prior to construction.

To ensure compliance with the adopted vibration criteria, where the construction machinery (or other potentially vibration inducing machinery or processes) is operated within 15 metres of an existing building, vibration monitoring would be undertaken during the first phases of the use of that machinery. It is further recommended that prior to any construction work being carried out, a building condition survey be carried out where the construction machinery listed above (or other potentially vibration inducing machinery or processes) would be operated within 15 metres of an existing building.

In relation to human comfort it is expected that vibration levels from vibratory rollers would exceed the human comfort criteria given the likely duration of activities.

Operational noise

Noise calculations have been carried out for four different scenarios, ‘Build’ and ‘No Build’ options in the year of opening and 10 years after project opening.

Predicted noise levels can be seen in Table 6-75, where the predicted day time and night time noise levels at representative receivers and the criteria determined in accordance with RNP and ENMM are summarised.

Table 6-75: Summary of predicted noise levels for build and no build scenarios

ID	2016 'no build' (dBA)		2016 'build' (dBA)		2026 'no build'		2026 'build'		Assessment criteria (dBA)		Criteria exceeded (if acute then bold)		Change in noise level (if acute then bold) (dBA)				Consider mitigation
													2016		2026		
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
1	75	69	73	69	75	70	74	69	60	55	Yes	Yes	-0.6	-0.5	-0.8	-0.7	-
2	71	65	69	65	71	66	70	65	60	55	Yes	Yes	-0.9	-0.9	-1.1	-1.0	-
4	63	58	62	58	63	58	63	58	60	55	Yes	Yes	-0.2	-0.2	-0.3	-0.3	-
6	71	66	70	65	71	66	71	66	60	55	Yes	Yes	0.0	-0.1	-0.2	-0.3	-
7	74	69	73	69	74	69	74	69	60	55	Yes	Yes	-0.1	0.0	-0.3	-0.2	-
8	61	56	60	55	61	56	60	56	60	55	No	No	-0.3	-0.3	-0.3	-0.3	-
9	62	57	61	57	62	57	62	57	60	55	Yes	Yes	-0.2	-0.2	-0.3	-0.2	-
10	61	56	61	57	61	57	61	56	60	55	Yes	Yes	-0.2	-0.2	-0.3	-0.3	-
11	65	60	65	60	65	60	65	60	60	55	Yes	Yes	-0.1	-0.1	-0.1	-0.1	-
12	66	62	68	63	66	62	66	62	60	55	Yes	Yes	0.0	0.1	0.0	0.0	-
13	66	62	67	62	66	62	66	62	60	55	Yes	Yes	-0.2	-0.1	-0.1	0.0	Yes
14	70	66	70	65	70	66	71	66	60	55	Yes	Yes	0.2	0.1	0.3	0.4	Yes
15	68	64	67	63	68	63	68	64	60	55	Yes	Yes	0.2	0.2	0.4	0.4	Yes
16	66	61	65	60	66	61	66	61	60	55	Yes	Yes	0.0	0.0	0.1	0.1	Yes
17-G	63	59	62	58	63	58	63	59	60	55	Yes	Yes	0.1	0.1	0.3	0.3	No
17-F	64	60	64	59	64	60	65	60	60	55	Yes	Yes	0.0	0.1	0.2	0.2	Yes
18	62	58	61	57	62	58	62	58	60	55	Yes	Yes	-0.1	0.0	0.1	0.1	No
19-1F	65	61	64	60	65	61	65	61	60	55	Yes	Yes	0.3	0.2	0.4	0.4	Yes
19-G	62	58	61	57	62	57	62	58	60	55	Yes	Yes	0.0	0.0	0.2	0.1	No
20-G	57	53	57	52	57	53	58	53	60	55	No	No	0.4	0.3	0.5	0.5	No
20-1F	60	55	59	55	60	55	60	55	60	55	No	No	0.3	0.2	0.3	0.3	No
21	65	60	64	59	65	61	65	60	60	55	Yes	Yes	-0.7	-0.7	-0.5	-0.5	Yes
22	57	53	57	53	57	53	58	53	60	55	No	No	0.8	0.8	0.9	0.8	No
23	66	59	62	58	66	61	64	59	60	55	Yes	Yes	-0.5	-0.1	-1.4	-1.3	No
24	63	57	60	55	63	58	62	57	60	55	Yes	No	1.4	0.9	-0.7	-0.8	No
25-G	62	57	60	55	62	57	63	57	60	55	Yes	No	-1.7	-2.4	0.2	0.0	No
25-1F	68	64	68	64	68	63	68	64	60	55	Yes	Yes	0.4	0.2	0.9	0.6	Yes
26-1F	66	62	67	62	66	62	67	62	60	55	Yes	Yes	0.4	0.3	0.9	0.7	Yes
26-G	62	58	62	58	62	57	62	58	60	55	Yes	Yes	0.4	0.3	0.9	0.7	No
27-G	62	59	63	58	62	58	63	59	60	55	Yes	Yes	0.6	0.5	1.0	0.9	No
27-1F	60	57	61	57	60	56	61	57	60	55	Yes	Yes	0.6	0.4	1.0	0.9	No
28-1F	61	57	61	57	61	56	62	57	60	55	Yes	Yes	0.7	0.6	1.2	1.0	No

28-G	59	56	60	56	59	55	60	56	60	55	No	Yes	0.7	0.6	1.1	1.0	No
29-G	59	55	59	55	59	54	60	55	60	55	No	No	0.8	0.6	1.1	1.0	No
29-1F	60	57	61	56	60	56	61	57	60	55	Yes	Yes	0.7	0.6	1.1	1.0	No
30-1F	58	55	59	54	58	54	59	55	60	55	No	No	0.6	0.5	0.9	0.9	No
30-G	59	56	60	56	59	55	60	56	60	55	No	Yes	0.6	0.6	1.0	1.0	No
31-1F	58	55	59	54	58	54	59	55	60	55	No	No	0.6	0.6	0.9	0.9	No
31-G	57	54	57	53	57	53	58	54	60	55	No	No	0.5	0.6	0.9	1.0	No
32	61	58	62	57	61	57	62	58	60	55	Yes	Yes	0.8	0.8	1.0	1.0	No
33	61	57	61	57	61	57	61	57	60	55	Yes	Yes	-0.1	0.0	0.4	0.3	No
34	63	59	63	59	63	59	63	59	60	55	Yes	Yes	-0.4	-0.2	0.1	0.1	No
35	60	56	59	55	60	55	60	56	60	55	No	No	-0.2	-0.1	0.2	0.4	No
36	62	58	61	57	62	57	62	58	60	55	Yes	Yes	-0.5	-0.3	-0.1	0.1	No
37	67	63	67	63	67	63	67	63	60	55	Yes	Yes	-0.6	-0.4	-0.2	0.0	Yes
38	66	54	59	54	66	63	59	54	60	-	No	-	-4.9	-6.9	-6.9	-8.1	No
39	62	60	63	59	62	57	64	60	50(ext)	-	Yes	-	3.1	2.9	2.1	2.1	Yes
40	63	57	62	57	63	59	62	57	50(ext)	-	Yes	-	0.4	-0.8	-0.9	-1.8	No
41	64	55	59	55	64	61	60	55	50(ext)	-	Yes	-	-3.2	-5.0	-4.9	-6.1	No
42	60	57	61	57	60	56	62	57	60	-	Yes	-	2.7	2.4	1.4	1.3	No
43	62	59	63	59	62	58	64	59	50(ext)	-	Yes	-	2.7	2.3	1.7	1.4	No
44	61	61	64	60	61	57	65	61	60	-	Yes	-	4.6	4.9	4.2	4.6	Yes
45	59	58	61	57	59	55	62	58	50(ext)	-	Yes	-	3.1	3.6	2.7	3.4	Yes
48-G	62	57	60	55	62	58	62	57	60	55	Yes	No	-0.1	-1.2	0.1	-0.9	No
48-1F	61	56	59	54	61	57	61	56	60	55	Yes	No	-0.3	-1.3	-0.1	-1.1	No
49	64	60	64	58	64	59	66	60	60	55	Yes	Yes	2.0	0.7	2.3	1.0	Yes
50	64	61	64	59	64	60	66	61	60	55	Yes	Yes	2.0	0.8	2.3	1.0	Yes
51	58	53	56	51	58	53	58	53	60	55	No	No	0.1	-0.7	0.1	-0.6	No
52	57	53	56	51	57	53	58	53	60	55	No	No	0.3	-0.7	0.4	-0.5	No
53	61	56	60	54	61	57	62	56	60	55	Yes	No	0.0	-1.2	0.2	-1.0	No
54	63	58	61	56	63	58	63	58	60	55	Yes	Yes	0.2	-1.1	0.4	-0.8	No
55	64	60	64	58	64	59	66	60	60	55	Yes	Yes	1.9	0.5	2.2	0.8	Yes
56	61	56	60	54	61	57	62	56	60	55	Yes	No	0.1	-1.2	0.4	-0.9	No
58	66	63	67	61	66	62	69	63	50(ext)	-	Yes	-	2.1	0.8	2.4	1.1	Yes
59	64	58	61	56	64	60	63	58	60	55	Yes	Yes	-1.5	-2.9	-1.2	-2.6	No
60	60	54	57	52	59	55	59	54	60	55	No	No	-0.8	-2.3	-0.6	-1.9	No
61	62	57	60	54	62	58	62	57	60	55	Yes	No	-0.7	-2.1	-0.4	-1.8	No
62	63	59	63	57	63	59	65	59	60	55	Yes	Yes	1.3	-0.1	1.6	0.3	No
63	57	53	55	51	56	53	57	53	60	55	No	No	0.6	-0.2	0.7	0.0	No

64	62	57	60	55	63	60	62	57	60	55	Yes	No	-2.2	-3.4	-1.9	-3.0	No
65	60	55	58	53	58	54	60	55	60	55	No	No	0.8	0.1	1.1	0.3	No
66	64	60	61	57	61	60	64	60	60	55	No	No	-1.8	-2.7	-1.5	-2.4	Yes
67	59	54	57	52	58	53	59	54	60	55	No	No	0.9	0.6	1.1	0.8	No
68	66	61	65	60	63	59	66	61	60	55	Yes	Yes	2.6	2.0	2.9	2.4	Yes
69	65	61	64	59	65	61	65	61	60	55	Yes	Yes	0.6	0.2	0.8	0.5	Yes
71	58	54	57	53	58	54	58	54	60	55	No	No	0.4	0.1	0.6	0.4	No
72	57	53	56	52	56	52	57	53	60	55	No	No	1	0.9	1	0.8	No
73	60	56	59	55	61	56	60	56	60	55	No	No	-0.1	-0.1	-0.1	0	No
74	52	48	51	47	52	48	52	48	60	55	No	No	0.3	0.3	0.3	0.3	No
75	58	53	56	51	58	54	58	53	60	55	No	No	-0.2	-1.1	0	-0.6	No
76	56	51	54	48	55	51	56	51	60	55	No	No	0.2	-0.8	0.5	-0.5	No
77	62	58	61	57	61	57	62	58	60	55	Yes	Yes	0.2	0.2	0.3	0.2	No

Note: The consideration of mitigation is based on the 2026 build option results and considers the relative increase between the build and no build scenarios, as well as where acute noise levels are expected.
Source: Wilkinson & Murray (2013)

The results indicate that out of the residential receiver locations assessed there are 48 exceedances over the night time $L_{Aeq,9hr}$ criteria of 55 decibels in 2016 for the "no build" option, of which 16 are acute. For 2016 "build" option, the number of receivers exceeding the criteria reduced from 48 to 44, and 15 are acute. For other sensitive receivers, the number of exceedances increased from seven to eight.

There are a total of 55 residential receivers exceeding the night time $L_{Aeq,9hr}$ criteria of 55 decibels, eight other sensitive receivers exceeding the relevant criteria for open space areas and for classrooms in the design year 2026 for the "build" option. Of this 23 receivers are acute. The relative increase in noise levels is more than two decibels at eight receivers (receivers 39, 44, 45, 49, 50, 55, 58 and 68). This is mainly due to the redeveloped section of the road being located closer to the receivers and relocation of Macdonald Road. Upon review of the noise levels for "build" and "no build" options, it appears that, as a whole, widening of Campbelltown Road would not impose any further noise impacts on the surrounding environment, with the exception of those beyond Zouch Road towards Denham Court Road and those located near the new Macdonald Road intersection.

As outlined, both the 2016 and 2026 "build" scenarios indicates a number of residences exceeding the assessment criteria and some are also acute. The acute residential properties in NCAs A and B are as a result of traffic noise from Camden Valley Way and Glenfield Road and are not considered further in the report as they are not part of this proposal. For those properties where Campbelltown Road is the dominant noise source the increase in noise levels is more than two decibels. For this reason, feasible and reasonable noise mitigation needs to be considered for receivers outlined in Table 6-75 above.

EPA recommends the priority for treatment is as follows:

- Road design and traffic management.
- Quiet pavement surface.
- Noise barriers/mounds.
- At property treatments or localised barriers/mounds.

A preliminary feasible and reasonable assessment has been undertaken and is outlined below. A detailed assessment would be undertaken during detailed design to confirm treatment options.

Road design and traffic management

Given the geometry of the road (predominantly flat areas with some minor undulations) and the narrow corridor through which it lies, there is little opportunity through road design to reduce noise levels. Campbelltown Road also traverses the SWGC, consisting of high levels of existing houses and current housing developments, further inhibiting opportunities for design variations.

Quiet pavement surface

A re-evaluation of potential noise impacts has been undertaken assuming a low noise pavement such as Stone Mastic Asphalt (SMA) can be included. For speeds greater than 75 kilometres per hour, representative of most of the alignment the benefit of using a low noise pavement is 2.5 decibels. Predicted noise levels for results for the "no build" and "build" options, and for the year 2026 (with low noise pavement (SMA)) are provided in Table 5-5 of the Noise and Vibration Assessment (Wilkinson and Murray 2013).

Overall, the predicted noise levels for Year 2026, 10 years after opening, are reduced by up to 2.5 decibels. The number of exceedances reduced from 63 to 39 and receivers that are acute reduced from 23 to 9. With the provision of SMA there are still a number of properties that exceed the assessment criteria (by up to 11 decibels) and those dominated by Campbelltown Road are still acute; however, at all properties the noise levels have reduced compared to the "no build" option, such that further mitigation at properties which are not acute is not deemed necessary.

Noise barriers/mounds
In the event that a low noise pavement surface is not appropriate for this section of road (to be determined through detailed design) consideration would be given to the use of noise barriers to achieve the assessment criteria. An assessment was undertaken based on continuous barriers at the roadside at certain locations adjacent to effected sensitive receivers. NCA C and NCA E are considered for noise barrier options. In other NCAs architectural treatment is preferable as they are deemed too isolated for treatment using barriers. The assessment compared noise reduction for a range of barrier heights for the most affected residences in NCA C and NCA E. This was based on the existing barrier footprint (outlined within the Noise and Vibration Assessment (Wilkinson Murray, 2013).

Noise modelling results indicate that the existing traffic noise from Campbelltown Road already exceeds the base assessment criteria at most locations and the road traffic noise levels for the design year will not increase by more than two decibels over the "no build" option noise levels. And given that there are barriers placed at the boundary of both subdivisions, re-constructing or upgrading the barriers may have minimal incremental benefits.

At property treatments or localised barriers/mounds
The preliminary analysis without at-road mitigation has identified seven ground floor residential receivers to be considered for architectural treatment. They are receivers 37, 49, 50, 55, 66, 68, and 69. Where at-road mitigation in the form of low noise pavement has been incorporated into the road design, ground floor residences to be considered for architectural treatment reduced from seven to one (receiver 37). For these properties where the exceedances are up to 10 decibels, provision of fresh air ventilation, sealing of wall vents and upgraded window and door seals is generally considered appropriate. Further acoustic investigation at these locations is recommended during the detail design stage to confirm the need for mitigation.

6.7.5 Safeguards and management measures

Interim guidance notes were developed by RMS Environment Branch in close consultation with the OEH outlining changes required in applying the RMS Environmental Noise Management Manual to address the new RNP. The guidelines outline the procedure for the evaluation and selection of noise mitigation measures for new road and road redevelopment upgrades. This assessment has considered the above guidelines. Table 6-76 outlines safeguards and management measures in relation to noise impacts for the proposal.

Table 6-76: Safeguards and management measures for noise impacts

Impact	Environmental safeguards	Responsibility	Timing
Construction noise	• A Construction Noise and Vibration Management Plan (CNVMP) in accordance with	Construction contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	OEH/EPA's *Interim Construction Noise Guideline* (DECCW 2009) would be prepared as part of the CEMP. This plan would detail the mitigation, monitoring and community liaison measures and would include but not be limited to: - Identification of potentially affected properties and residences (including a detailed map). - A map indicating the locations of likely potential impacts. - A risk assessment to determine potential risk for activities likely to affect residents. - Mitigation measures to reduce excessive noise during construction activities including those associated with truck movements, for example localised plywood barriers (at least 10 kg/m^2) to provide shielding. - A process for assessing the performance of the implemented mitigation measures. - A process for identifying management measures for highly noise affected receivers including consultation with affected residences. - A process for resolving issues and complaints.		
Construction noise	• Where practical, equipment would be selected to minimise noise emissions. Equipment would be fitted with appropriate noise control equipment and be in good working order.	Construction contractor	Construction
Construction noise	• Where practical, the layout and positioning of noise-producing plant and activities on each work site would be optimised to minimise noise emission levels.	Construction contractor	Construction
Construction noise	• Works would be carried out during standard working hours (ie	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	7am – 6pm Monday to Friday, 8am –1pm Saturdays). Any work that is performed outside normal work hours or on a Sunday or public holiday is to minimise noise impacts in accordance with *RMS's Environmental Noise Management Manual Practice Note 7 – Roadworks Outside of Normal Working Hours* (RTA 2001) and the *Interim Construction Noise Guidelines (DECC 2009)*.		
Construction noise	• The contractor would review their CNVMP in response to complaints and amend where practical throughout the construction phase. This would include consideration of respite periods.	Construction contractor	Construction
Vibration	• Where vibration is found to exceed project criteria, management measures would be implemented to control vibration. In terms of human comfort criteria, measures would include modifications of construction methods and respite periods. For potential structural damage impacts, modification of construction methods or equipment would be necessary.	Construction contractor	Construction
Vibration	• The CNVMP would include an assessment of the structures such as buildings that need building condition surveys in particular, heritage items, including the gates to the Ingleburn Military Heritage Precinct.	Construction contractor	Pre-construction
Operational noise	• During the detailed design stage of the proposal, further investigations of all feasible and reasonable mitigation options would be undertaken for affected receivers in accordance with the Road Noise Policy (DECCW 2011) and *RTA's Environmental Noise Management Manual Practice Note 4* (RTA 2001).	RMS	Detailed design

Impact	Environmental safeguards	Responsibility	Timing
Operational noise	• Where practicable, any mitigation measures provided to control operational noise impacts shall be implemented as early as practicable to also provide a benefit during some of the construction phase.	Construction contractor	Construction

6.8 Air quality

6.8.1 Existing environment

An air quality impact assessment was undertaken for the proposal. The study area for this assessment incorporated the proposal area, the general location around the proposal to capture likely air pollution sensitive receivers, as well as other identified potential sources of air pollution (such as nearby industrial areas).

Air quality in Sydney's south-west region is primarily influenced by traffic related air pollution and industrial emissions. Air quality is also influenced by the prevailing weather and climatic conditions, including extreme events such as bushfires and storms. The south-west region is more heavily affected by air pollution mainly because the prevailing sea breeze is north-easterly.

The closest Bureau of Meteorology monitoring station to the proposal is Holsworthy Control Range. Average annual rainfall for the Holsworthy Control range monitoring station is 680 millimetres. February is the highest rainfall month, receiving 111 millimetres of rainfall on average while September is the lowest rainfall month, receiving 32 millimetres of rainfall on average.

A number of NSW OEH/EPA air quality monitoring sites for the NSW Air Quality Index are located in the south-western Sydney air shed. The Bringelly and Campbelltown West monitoring stations are the closest monitoring stations to the proposal. At each monitoring station air pollutant concentrations are calculated and reported as the Regional Air Quality Index (RAQI). The RAQI provides a scaled air quality reading ranging from very good, good, fair, poor, very poor and hazardous.

A review of air quality monitoring data for these sites shows that Sydney's south-west region air quality is highly variable. Daily Regional Air Quality Index (RAQI) values for the Sydney south-west air shed are presented in Figure 6-72.

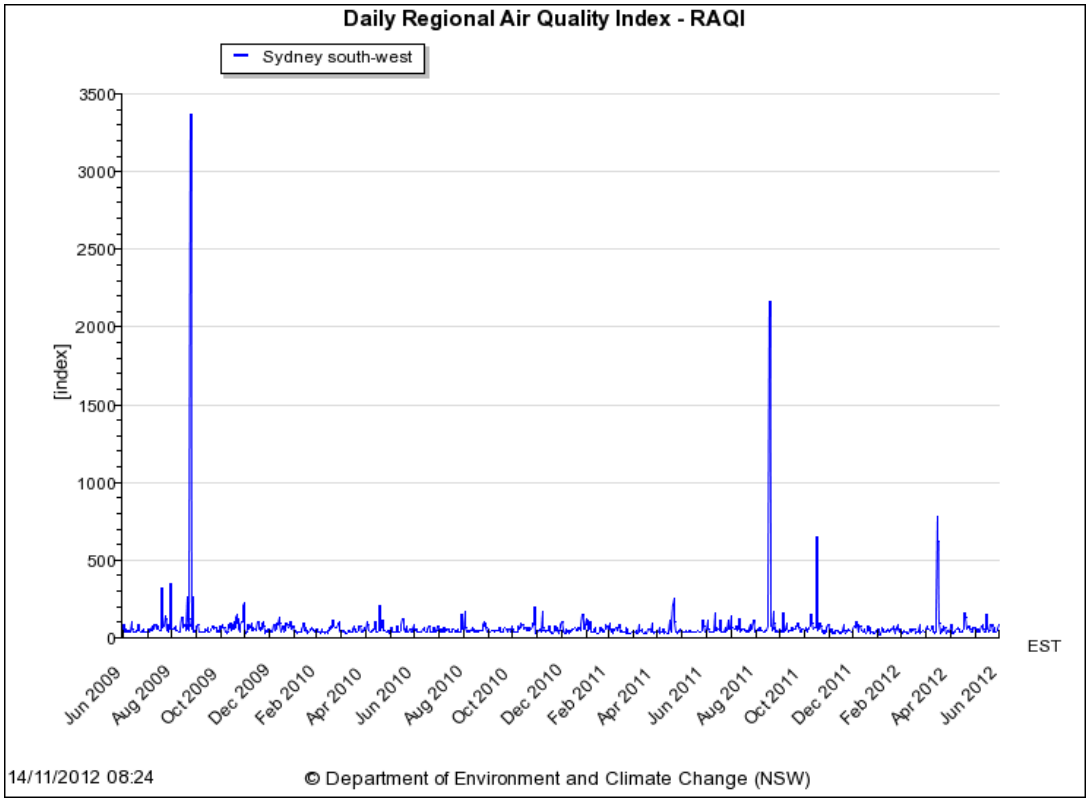

Figure 6-72: Daily RAQI values for Sydney South West Region for the period 30 June 2009 to 30 June 2012

A health alert is issued when the RAQI is likely to be poor or worse the next day (an Air Quality Index of 100 or above is considered poor or worse). Table 6-77 shows that regional air quality in Sydney's south-west air shed was rated as poor or worse at least 14 times between the period 30 June 2009 and 30 June 2012.

Table 6-77: Regional air quality index for South West Sydney Region (OEH 2012)

Regional air quality index	2009-10	2010-11	2011-12
Number of days with a rating of poor, very poor or hazardous	29	14	23

The most common pollutant in the proposal area would be vehicle emissions from traffic along Campbelltown Road and the Hume Highway. The three major pollutants emitted by motor vehicles are hydrocarbons, oxides of nitrogen and carbon monoxide. Motor vehicle emissions can include lead, sulphur oxides, carbon dioxide and other particulates.

Sensitive receptors to air quality impacts along Campbelltown Road include residential areas, predominately on the southern side of the road corridor and local businesses. The sensitive receivers that have been identified for this proposal are:

- Existing residences along Campbelltown Road and on the north-side of Camden Valley Way.
- Future residents in the subdivisions along Campbelltown Road, including the Edmondson Park precinct.
- A caravan park to the north of Campbelltown Road.
- Ingleburn Primary School, east of Campbelltown Road.
- Bambi Kindergarten, north of Campbelltown Road.

- Watch Tower Bible and Tract Society, north of Campbelltown Road.
- The defence facility north of Campbelltown Road.
- A landscaping business north of Campbelltown Road.

6.8.2 Criteria

The National Environment Protection Measure for Ambient Air Quality (AAQ NEPM) sets the national air quality standards for carbon monoxide, nitrogen dioxide, sulphur dioxide, lead, particulates and ozone. OEH specifies ground-level concentration (glc) impact assessment criteria for criteria pollutants (NSW DEC 2005), as listed in Table 6-78.

Table 6-78: NSW OEH Air Quality Assessment Criteria (DEC 2005)

Pollutant	Goal	Averaging period	Source
Carbon monoxide	30 mg/m^3 10 mg/m^3	1-hour 8-hour	WHO (2000) NEPC (1998)
Nitrogen dioxide	246 mg/m^3 62 mg/m^3	1-hour Annual	NEPC (1998) NEPC (1998)
Particulate matter <10 µm (PM_{10})	50 mg/m^3 30 mg/m^3	24-hour Annual	NEPC (1998) EPA (1998)
Deposited dust	4 g/m^2	Month	NEPC (1998)

6.8.3 Potential impacts

Construction

During construction earthworks would be required, including cutting (100,000 cubic metres), spoiling (47,000 cubic metres) and importing (29,000 cubic metres) of soil. These exposed soils have the potential to be eroded by wind resulting in airborne particles, or dust. Earthworks would be undertaken in stages along the entire length of the road upgrade for cut and fill embankments.

The establishment of stockpiles of topsoil and spoil also has the potential to result in a lowering of air quality caused by dust generation during periods of high wind. Proposed locations for compound and stockpile sites for construction activities are:

- Site 1: on the northern side of Campbelltown Road at the western corner of Croatia Avenue (1 hectare site).Closest receiver is Ingleburn Primary School, about 200 metres south-west of the site, on the southern side of Campbelltown Road.
- Site 2: on the northern side of Campbelltown Road at the eastern corner of Zouch Road (1 hectare site). Closest receiver is the Watchtower Bible and Tract Society, approximately 100 metres south-west of the site.

Activities such as vegetation removal and trucks or plant travelling over exposed ground may also generate dust emissions. Exhaust emissions from truck movements during the construction phase are expected to increase by 30 to 40 truck movements per day. Truck movements may further increase to 60 to 100 truck movements per

day at certain stages of construction (AECOM, 2013). This would be a negligible impact.

Potential air quality impacts would be limited by staging and the small number of isolated receivers along the alignment. These impacts are likely to be dust-generated, resulting from localised (staged) earthworks and use of the compound/ stockpile sites. Typically, large particulate matter emitted into the air would return to the surface closer to the emission source than smaller particulates. The dust levels (total suspended particulates) experienced on any given construction day would relate to the extent of earthmoving activities being undertaken and the area of soil exposed. The amount of dust generated is dependent upon the moisture and silt content of the soil, the type of activities being carried out and the wind speed and direction.

During periods of high wind speed, the potential for dust to become airborne from any site stockpiles and exposed surfaces is increased. During periods of extreme dust generation, including high wind speed events on dry work days, construction activities may need to stop or be re-programmed. The total amount of dust generated from all the construction activities could be minimised with the implementation of suitable mitigation measures (as outlined in Table 6-79), to ensure they do not exceed air quality targets (as outlined in Table 6-79).

Construction works would involve traffic management measures such as lane closures, traffic control and one way flows. These measures may temporarily increase the amount of time that motorists spend in the vicinity of dust-generating activities and result in localised, temporary increases in vehicle emissions. Vehicle and equipment emissions during construction are expected to be minor, as plant and equipment would be spread out and not operating at all times.

During construction works, odour can be generated from earthworks, disturbance of potentially anoxic or contaminated material, construction of ancillary infrastructure and vehicle exhaust emissions. During construction of the proposal, potential odour impacts would be negligible.

Operation

The proposal would increase the carrying capacity of Campbelltown Road to suit current volumes of traffic as well as accommodating forecast traffic growth from future planned urban expansion. Predicted traffic flows (AADT) are provided Section 6.6.2 (Potential traffic and transport impacts).

The effect of the projected increase in vehicle traffic volumes on air quality would be offset to a point by the continual improvement in average emission performance of vehicles, with newer, more efficient vehicles replacing older, less efficient vehicles. The proposed upgrade would assist emissions reduction through provision of more efficient travel movement and reduced travel times.

The general issue of air quality controls during operation of the road would be addressed by the NSW Air Quality Management Plan. The air quality impacts during operation could be minimised through maintenance and/or improvement of existing levels of service through improved traffic flow conditions as population and traffic grows.

Existing bus stops and bus routes along the alignment would be maintained. In addition, the proposal would provide access to the Edmondson Park Railway Station and public transport facilities in the Edmondson Park Town Centre. The upgrade would also incorporate off road shared paths for pedestrians and cyclists as well as an on road cycleway along the length of Campbelltown Road. These measures would provide a healthy and non-polluting means of transport for users of Campbelltown Road.

6.8.4 Safeguards and management measures

Table 6-79 outlines the proposed safeguards and management measures in terms of air quality for both construction and operational phases of the proposal.

Table 6-79: Air quality safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Air quality and dust	• An Air Quality Management plan (AQMP) would be prepared as part of the CEMP. The plan would include but not be limited to the following: - A procedure for monitoring dust on site and weather conditions. - Identification of dust generating activities and associated mitigation measures. - Limits on the area that can be opened up or distributed at any one time. - Compliance with *RMS Stockpile Site Management Guidelines* (2011). - Progressive stabilisation plans.	Construction contractor	Pre-construction
Dust	• Measures such as covering loads and water spraying unsealed access roads and open areas during conditions conducive to dust generation would be used to minimise or prevent air pollution and dust.	Construction contractor	Construction
Dust	• Vehicles transporting waste or other materials that may produce odours or dust are to be covered during transportation.	Construction contractor	Construction
Exhaust emissions	• Construction equipment (including all internal combustion engines) would be properly maintained to ensure exhaust emissions are minimised where practicable and comply with the	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	Protection of Environment Operations Act 1997 (PoEO Act).		
Exhaust emissions	• Machinery would not be kept idling when not in use.	Construction contractor	Construction

6.9 Climate change and greenhouse gas

This Section identifies the potential climate change and greenhouse gas impacts of the proposal and mitigation measures to reduce any adverse impact. It also identifies potential implications of climate change for the proposal, and measures taken to manage these implications.

6.9.1 Policy setting

NSW 2021 sets the Government's agenda for change in NSW (OEH 2012). NSW 2021 sets goals and targets that support practical action to tackle climate change, including:

- Twenty per cent renewable energy by 2020.
- Assistance for businesses and households to realise annual energy savings of 16,000 gigawatt hours by 2020, compared with 'business as usual' trends.
- Support for 220,000 low-income households to reduce their energy use by up to 20 per cent by June 2014.
- Increase in the share of commuter trips made by public transport, including increasing the proposition of total journeys to work by public transport in the Sydney Metropolitan Region to 28 per cent by 2016.
- Targets to increase walking and cycling.
- Planning policy to encourage job growth in centres close to where people live and to provide access by public transport.

RMS has also developed a Climate Change Plan to respond to impacts posed by climate change, including reducing greenhouse gas emissions and planning for physical consequences. RMS includes actions to:

- Reduce RMS' carbon footprint.
- Help reduce the carbon footprint of NSW road transport.
- Adapt the RMS road transport system to the impacts of climate change.
- Manage RMS' transition to a low carbon economy.

6.9.2 Potential impacts

Impacts of climate on the proposal

Climatic factors would not constrain construction of the proposal except during adverse weather conditions such as prolonged heavy rain or very high winds which could occur during the construction period. Adverse weather in the area would not affect the construction provided appropriate safeguards to avoid erosion and sedimentation were installed around any excavated or exposed earthworks areas. The proposal would be located along the existing Campbelltown Road alignment the operation of which is not constrained by climatic factors. It is unlikely climatic factors would impact on operations of the proposal, provided motorists and other users of the proposal took due care during adverse weather conditions.

Impacts of climate change on the proposal

The climate of NSW is changing. Average temperatures in New South Wales have been steadily rising since the 1960s. The period from 2000-2010 was the state's hottest decade on record. The NSW Climate Impact Profile (DECCW, 2010) suggests that projected climate change for the Sydney Region is likely to be significant, including:

- Average annual temperatures to increase by up to two degrees Celsius and extreme temperatures to increase significantly by 2050.
- Changes in seasonal rainfall, including increases in summer rainfall and a decrease in winter rainfall by 2050.
- Increased frequency and intensity of annual extreme rainfall events (both frequency and intensity) could increase by up to 20 per cent by 2050.

Over the long-term, increases in temperature may affect the integrity of highway pavement and other construction, either directly or indirectly through evaporative changes, along with changes to soil moisture content or soil instability which may eventually impact the foundations of road structures, through softening of pavements.

Increased rainfall and flood events associated with projected climate change may also influence the flooding behaviour of local creek systems resulting in localised flooding of Campbelltown Road, drainage and stormwater impacts and erosion impacts resulting in sediment loss from the site of the proposed road upgrade.

Impacts of climate change can be managed by adopting design standards where appropriate to reduce the vulnerability of infrastructure in high risk areas. The proposal has accounted for climate through upgrading of cross drainage structures design to convey the 100 year ARI, as measured at 2012, plus a ten per cent increase to account for predicted climate change impacts.

Construction impacts of proposal on climate change

The construction phase of the proposal would result in the production of greenhouse gases, including carbon dioxide, methane and nitrous oxide. Key sources of greenhouse gas emissions associated with construction of the proposal include:

- Vegetation removal, resulting in release of stored carbon dioxide to the atmosphere.
- Operation of construction equipment. This includes carbon dioxide and nitrous oxide generated from fuel use (petrol, diesel) in plant and vehicles in construction, disposal and transportation of materials.
- Use of materials. Some materials such as concrete have high embodied energy content.
- Methane, from landfilling any carbon-based waste, as well as possible fugitive emissions from use of natural gas.
- On site electricity usage.

It is anticipated that operation of construction equipment would be the main emissions source during construction. The amount of greenhouse gas emissions associated with the construction phase of the proposal would be heavily dependent on the quantity of bulk earthworks required as well the extent of vegetation removal.

Operation impacts of proposal on climate change

The primary source of greenhouse gas emissions during operation would be those associated with vehicles using Campbelltown Road; however, the number of vehicles

using Campbelltown Road is not anticipated to increase as a result of the proposal. Signalised intersections may add to the stop/start effect of vehicles, resulting in increased localised emissions. Notwithstanding the potential for increased emissions, the proposal would result in reduced emissions associated with increased efficiency of the road network. This is attributable to increased level of service through additional capacity, improved traffic flow and provision of new road pavement surfaces.

Other greenhouse gas emission sources likely to be associated with the operational phase of the proposal include:

- Electricity usage for street lighting and signals.
- Maintenance activities.

To understand the full effects of the proposal, a detailed greenhouse gas assessment would need to be undertaken.

6.9.3 Safeguards and management measures

Table 6-80 outlines the proposed safeguards and management measures in terms of climate change and greenhouse gases for both construction and operational phases of the proposal.

Table 6-80: Climate change and greenhouse gas safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Improving energy efficiency and sustainability	• Machinery onsite would be running efficiently to ensure optimal performance, minimise down time and improve fuel efficiency.	Construction contractor	Construction
Climate change and greenhouse gas	• Detailed design would take into consideration the potential effect of climate change on the proposal, including drainage requirements.	RMS	Detailed design
Climate change and greenhouse gas	• The energy efficiency and related carbon emissions would be considered in the selection of vehicle and plant equipment.	Construction contractor	Pre-construction and construction
Climate change and greenhouse gas	• Equipment would be serviced frequently to ensure they are operating efficiently.	Construction contractor	Construction

6.10 Landscape character and visual impacts

A landscape character and visual impact assessment was prepared for the proposal (Johnson Pilton Walker, 2013). A copy of the report is available in Appendix C of this REF and a summary is provided below.

6.10.1 Methodology

The study area for the landscape character and visual impact assessment considers the proposal area (predominantly a vehicular corridor), adjacent urban landforms and land uses, and broad landscape character precincts. The assessment was based on the *Environmental Impact Assessment Guidance Note: Guidelines for landscape character and visual impact assessment* (RMS 2009)

6.10.2 Existing environment

Topography

The northern entry to Campbelltown Road is at an elevated position with views across a shallow valley extending to where Campbelltown Road crosses the Hume Highway. The road drops about 15 metres in elevation from its start point into a shallow basin. As it approaches the Hume Highway it rises about five metres to the bridge that crosses the motorway. The road drops, but then rises again to about 40 metres above the valley floor, just beyond Zouch Road. This is the highest point of the road profile, elevated about 26 metres above the entry point of Campbelltown Road. Beyond this, the road falls slightly before rising up to meet Denham Court Road.

The landform immediately adjacent to the carriage way is essentially level with the road, with the exception of batters associated with the overpass and a few minor batters along the corridor.

The Flooding and Drainage Investigation by Lyall and Associates (2013) identified the area of the proposal associated with Maxwells Creek (the northern side of Campbelltown Road through the shallow valley between Lawson Road and the Hume Highway) as flood prone land.

Vegetation

The dominant vegetation across the proposal area comprises native trees that include Eucalypts, either naturally occurring or planted. More than 60 per cent of the existing road corridor is tree lined. A detailed description of the existing vegetation communities has been provided in Section 6.1 above.

Soils

There are three different soil landscapes mapped within the study area: the residual Blacktown soil landscape, the erosional Luddenham soil landscape and the fluvial soil landscape South Creek. A detailed description of the soil landscapes has been provided in Section 6.5.

Land use

Land use in the study area is characterised by a mix of industrial and commercial development, major linear infrastructure, remnant bushland, land zoned for future Edmondson Park development, defence-owned land and urban residential land.

Heritage

The study area of Campbelltown Road contains items of non-Aboriginal heritage significance, which have been considered in Section 6.3.

Landscape character and views

Campbelltown Road is described as a principal arterial road. The majority of the existing road corridor could generally be described as semi-rural landscape. In its June 2010 study Campbelltown Road Corridor Urban Strategy – Urban Design Analysis, RMS identified a number of broad landscape character precincts along Campbelltown Road, three of which fall within the proposal area. These are:

- Tree Lined Road: corridor tree effect along the road.
- Large Estates: large properties and large houses, generating low traffic volumes.
- Proposed residential: housing, high potential traffic generator.

These broad landscape character precincts are examined in more detail in this assessment. It is noted that when approaching Campbelltown Road from the north, the landscape character of the study area is distinctly different from that of the Hume Highway. Road users currently leave a low-rise mixed-use zone of residential and businesses and enter a semi-rural landscape where grasslands and trees dominate.

JPW (2013) identified eight different landscape character precincts within the study area:

1. Open, Elevated Entry Precinct.
2. Shallow Valley Precinct/Residential.
3. Shallow Valley Precinct/Tree-Lined Mixed Use.
4. Grassed Paddocks.
5. Alluvial Woodland/Tree-Lined Corridor.
6. Ingleburn Gardens Drive/Medium Density Residential.
7. Enclosed Tree-Lined Corridor.
8. Elevated Large Estates.

The location and relative extent of these precincts is presented in Figure 6-73.

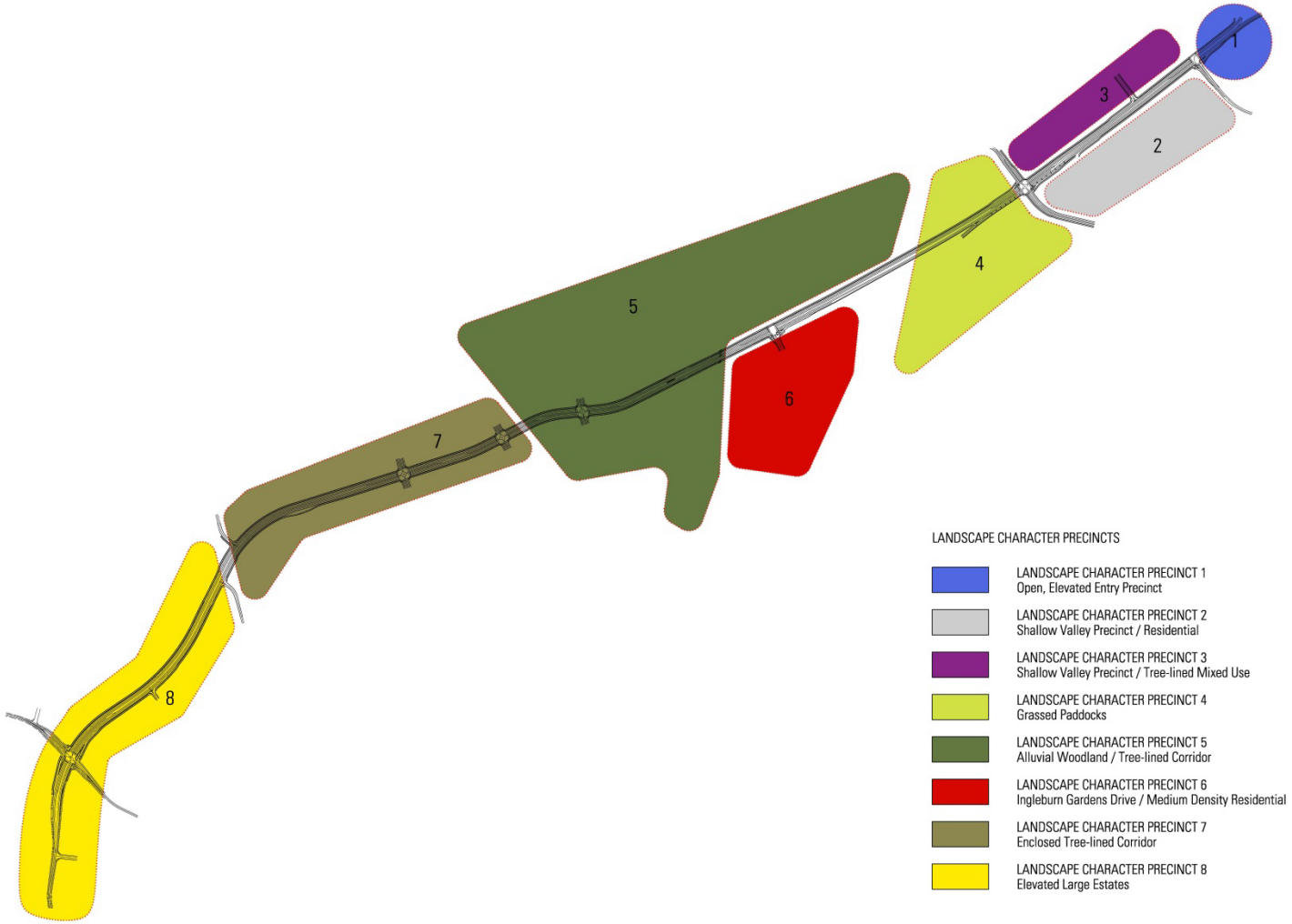

Figure 6-73: Overview of landscape character precincts (JPW 2013)

Landscape character precinct 1: Open, Elevated Entry Precinct

Precinct 1 is characterised by a low-rise entry point with a mixed use residential/business zone adjacent to the side of a six-lane carriageway. Upon entering Campbelltown Road the landscape to the west is open and somewhat barren across the Cross Roads Hotel bitumen and tree-less car park.

To the east of the road, the large semi-rural lots are predominantly grass with scattered trees with one dwelling per lot. The built form through this zone is single and double storey houses of either brick or fibro construction with the occasional farm shed.

Zoning

Land zoning in this area is under the category of “enterprise corridor” and business development at the entry point to Campbelltown Road, which encourages mixed use development, including home-based businesses. The land use zone then changes to residential on the south-eastern side of the road.

Views

As evident in Figure 6-74, the views along the Hume Highway and Camden Valley Way are generally limited as the carriage way follows the ridge-line and distant views are obscured by the planting and buildings. Once the road user turns into Campbelltown Road, the landscape opens up revealing distant views to a tree-lined horizon.

The elevated position overlooks a shallow valley where the view envelope is limited to the low ridge-line that encloses the valley to the south-east, and the road-side planting to the north-west.

Figure 6-74: Landscape character precinct 1 (JPW 2013)

Landscape character precinct 2: Shallow Valley Precinct/Residential

Beyond precinct 1, the landform sinks into a shallow bowl or valley – the Shallow Valley Precinct. The six-lane road corridor travels through the base of the shallow valley.

To the south-east of Campbelltown Road, new residential estates are under construction. These have replaced semi-rural lands that have been cleared. These buildings are generally detached double storey houses on blocks of approximately 450 square-metres, constructed of similar materials – pale rendered walls, dark grey roof tiles with occasional brick highlights. These consistent materials and built forms tend to create a bland monotonous landscape.

This residential estate is separated from Campbelltown Road by a palisade fence; however, the homes are visible due to the gently rising landform of the valley.
This precinct incorporates a service station which is also a rest-stop for truck drivers.

Zoning

This precinct is zoned '2(b) Residential B' under the Liverpool LEP 2008, which allows for low-rise detached and multi-dwelling housing, as well as community facilities and other related uses.

Views

The view envelope for the precinct is contained within the shallow valley of this precinct. The horizon visible from the road to the south-east is lined with houses (Figure 6-75).

Figure 6-75: Landscape character precinct 2 (JPW 2013)

Landscape character precinct 3: Shallow Valley Precinct/Tree-Lined Mixed Use

The north-western side of Campbelltown Road through the shallow valley is enclosed by low batters planted with Eucalyptus trees that screen long warehouse-like walls of the Mixed Use zone. The six-lane road is tree-lined with predominantly Eucalypts. This tree planting generally continues along the north-west side of the road until the intersection with Beech Road.

Zoning

The zoning within this precinct is 'Business Development' to the north-west, just south of Camden Valley Way. The land use in this precinct is generally characterised by large scale retail outlets of the Homemaker genre.

Views

Views within this precinct are limited and generally contained by the road-side planting. Views to and from Campbelltown Road beyond the planting are limited to the side streets that enter Campbelltown Road (Figure 6-76).

Figure 6-76: Landscape character precinct 3 (JPW 2013)

Landscape character precinct 4: Grassed Paddocks

The existing landform around Beech Road is flat, grassed sites that are awaiting development to the north-west and school playing fields to the south-east. The road carriage way narrows from six lanes to four lanes in this precinct, ultimately narrowing down to two lanes to cross the Hume Highway. The landform of the roadway gently rises to meet the bridge that crosses the Hume Highway. The exit ramp also rises and disappears beyond the low ridge line that encloses the valley. Scattered trees dot the landscape of the Hurlstone Agricultural High School paddocks while denser trees and shrubs line the road closer to the Hume Highway ramp and corridor. High voltage transmission towers and power lines cut across this

precinct, extending beyond the horizon.

Zoning

The area to the north-west of the road, between Campbelltown Road and the Hume Highway is zoned 'Heavy Industrial' under the Liverpool LEP 2008; however, this site is yet to be developed. To the south-east, it is zoned '5(a) Special Use – Schools' under the Campbelltown LEP.

Views

The western views open up across flat grassed development blocks and are terminated by screen planting of the Hume Highway corridor. To the east they terminate along the low ridge that defines the shallow valley. To the south, the views are confined by the land rising with the road carriageway to the bridge that crosses the Hume Highway corridor. To the north, views are confined to the Hume Highway/Camden Valley Way ridgeline (Figure 6-77).

Figure 6-77: Landscape character precinct 4 (JPW 2013)

Landscape character precinct 5: Alluvial Woodland/Tree-Lined Corridor

The majority of the precinct consists of a two lane carriage way. The bridge that crosses the Hume Highway is a delineating feature between precincts. The landform drops away from the overbridge to the floodplain zone. This flood prone land is the overflow zone for the Maxwells Creek. This creek runs through the woodland on both sides of the road and under Campbelltown Road through box culverts.

Tree planting and bushland to both sides of the road gives the appearance of a heavily vegetated landscape. The majority of this precinct lies to the north of Campbelltown Road, extending to the south side of the road, and occupying both sides beyond the rail corridor. The tree-lined corridor creates a sense of being in a bush land area, and is a key characteristic of Campbelltown Road, within the study

area.

The tree-lined corridor extends beyond landscape character precinct 5 and into landscape character precinct 7. To the road user, the character of these two precincts is essentially the same, continuing through to Zouch Road.

Precinct 5 also comprises bushland that includes stands of Cumberland Plain Woodland communities and is the subject of the conservation agreements pertaining to the non-certified lands as discussed in section 6.1.

Zoning

The majority of this area is zoned 'E1 Environmental Protection – National Parks and Nature Reserves'. There are also small areas of Public Recreation. The SWRL (under construction) cuts through this precinct. The construction of the railway would impact on the character of this portion of the road, which is discussed below in assessing the landscape character impact.

Views

From the road user's view, the view catchment narrows as Campbelltown Road runs through the floodplain forest. The view envelope is restricted by the vegetation through this precinct, creating a green corridor (Figure 6-78).

Figure 6-78: Landscape character precinct 5 (JPW 2013)

Landscape character precinct 6: Alluvial Woodland/Tree-Lined Corridor

Precinct 6 presents a very distinctly different landscape character to the adjacent bushland, being a suburban development with higher densities than single dwellings, and few trees. This precinct is currently under residential development.

Existing built forms include town houses as well as single and double storey

detached houses on suburban sized blocks. The built forms are not as uniform in design and materials as precinct 2; however, masonry and rendered walls dominate the material palette.

Few trees currently exist within this precinct though it is anticipated that trees would be part of the development and would soften the built forms over time.
This precinct is separated from the kerb-less 2-laned Campbelltown Road by a wall constructed from brick pillars and timber panels.

Zoning

This site is zoned as 2(c) Higher Density Residential development under the Campbelltown Council LEP 2002.

This zoning classification "makes provisions for land to be used for housing and a range of associated uses; permits a range of housing types, with identified density standards; and encourages the provision of a variety of housing types that are higher in density than traditional dwelling houses within locations that are accessible to public transport, employment and retail, commercial and service facilities" Campbelltown (Urban Area), Local Environmental Plan 2002 (Amendment No 12). As a result of this classification, it is expected that multi-dwellings such as villas, possibly low-rise units, duplexes and the like would continue to be constructed in this area.

Views

The stone boundary wall approximately two metres high limits views into and out of the residential estate from Campbelltown Road. The road is visible only from properties along the first 200-300 metres of Ingleburn Gardens Road (Figure 6-79).

Figure 6-79: Landscape character precinct 6 (JPW 2013)

Landscape character precinct 7: Enclosed Tree-Lined Corridor

The character of this precinct is largely of a tree-lined corridor which, to the road user, is an extension of precinct 5. This 'green tunnel' extends from the site of the rail corridor to Zouch Road, with few breaks. One of the breaks includes the Ingleburn Military Heritage Precinct and Mont St Quentin Oval and Entry Gates.

The kerb-less two-laned road gently winds and rises through this Eucalypt-lined landscape to the top of the hill near the newly constructed water tower, where it opens up to a landscape of large residential estates. Campbelltown Road cuts through the centre of the SWGC Edmondson Park development. The continuing development of the growth centre would understandably result in a substantial change to the character of the road corridor as it currently stands.

Zoning

Previously zoned as Defence Land, precinct 7 would comprise B4 Mixed Use, R1 General Residential (similar to 2(b) Residential), Public Recreation and E1 National Parks and Nature Reserve. The land zoned B4 Mixed Use under the SEPP (Major Development) 2005 Edmondson Park South Land Zoning Map, would "integrate suitable business, office, residential, retail and other development in accessible locations so as to maximise public transport patronage and encourage walking and cycling." (www.planning.nsw.gov.au, viewed 2 April 2013).

Views

Views from within the corridor are generally limited to the tree planting along the edge of the road. Glimpses beyond the tree planting are seen, however the trees in the foreground tend to dominate the views, particularly from a driver's perspective (Figure 6-80).

Figure 6-80: Landscape character precinct 7 (JPW 2013)

Landscape character precinct 8: Elevated Large Estates

This precinct primarily consists of large residential properties of approximately one to two hectares. These are often large single or double storey homes surrounded by extensive lawn areas with scattered tree planting. The majority of these properties have transparent fences along the front boundary. The built form of each property is unique. The material of choice is brick or rendered masonry and tiled roofs. The plant material is a mix of exotics and native planting. Campbelltown Road ceases to be a tree-lined road with the predominance of vegetation being found within the defined property boundaries. The Arboricultural Assessment prepared by Footprint Green (2013) indicates that 47 trees are of 'significant' or 'high' landscape significance within the proposal corridor between Denham Court Road and the BP Petrol Station (Chainage 4800).

This precinct sits on the top of a hill and is the highest elevation of the study area. The kerb-less two-laned road tends to follow the ridge line through this precinct.

Zoning

This precinct is zoned '7(d5) Environmental Protection 1 ha minimum' under the Campbelltown LEP 2002 and 'RU2 Rural Landscape' under the Liverpool LEP 2008. Both of these land use zones require a minimum lot size of one hectare, with the objective of retaining the rural character of the area.

Views

Though the road tends to follow the ridge line, views beyond the large estates are difficult due to tree planting and built forms. This also means that views to the road corridor from beyond the immediate properties are also unlikely. As the majority of the existing front boundary fences are transparent to a degree, views from the immediate adjacent properties to and from the road are common (Figure 6-81).

Views open up between Denham Court Road and Brooks Road. Views to the west of Campbelltown Road overlook the rolling landscapes of the large estates.

Figure 6-81: Landscape character precinct 8 (JPW 2013)

6.10.3 Potential impacts

A full description of the results of the landscape character impact assessment is presented in Appendix C. The results and key comments have been summarised in Table 6-81.

Table 6-81: Landscape character summary assessment

Landscape character precinct	Impact assessment result	Comment
1. Open Elevated Entry Precinct	Low	• Width of road corridor similar to the proposal • Open landscape. • Future development will increase presence of built forms.
2. Shallow Valley Precinct/ Residential	Moderate-low	• Built up nature of residential development. • Width of road corridor similar to the proposal. • Reduction of screening vegetation. • Future development is built up residential.
3. Shallow Valley Precinct/ Tree-Lined Mixed Use	Moderate-low	• Width of road corridor similar to the proposal. • Additional width required for shared/pedestrian paths. • Built up warehouse nature of development. • Proposed elevated road alignment compared to existing. • Reduction of vegetation screening. • Business development zone will continue.

Landscape character precinct	Impact assessment result	Comment
4. Grassed Paddock	Moderate	• Width of road corridor similar to the proposal. • Open nature of landscape. • Removal of existing trees. • Bridge duplication. • Elevated road alignment (4 m above ground). • Ultimately an area for industrial development.
5. Alluvial Woodland/ Tree-Lined Corridor	Moderate-high	• Width of proposal road corridor is twice existing width. • Removal of trees from sensitive areas. • 8 m high batter for bridge duplication.
6. Ingleburn Gardens Drive/ Medium Density Residential	Moderate-low	• Absence of trees requiring removal. • Built up nature of residential development. • Narrow existing width of corridor. • Minimal direct interaction of proposal on this precinct.
7. Enclosed Tree Corridor	Moderate-high	• Removal of what is presently a visually continuous line of trees. • Presence of heritage items. • Width of proposal road corridor is twice existing width. • Future zoning for Edmondson Park development.
8. Elevated Large Estates	Moderate-high	• Zoned for environmental protection. • Width of proposal road corridor is twice existing width. • Future land use zoning remains the same.

Source: JPW (2013)

The landscape character impact of the proposed Campbelltown Road upgrade, between Camden Valley Way and Brooks Road, ranges from low to moderate-high with an overall average of moderate. Generally, the landscape character precincts that currently have a six lane carriageway are rated as having a low or moderate-low Impact (precincts 1-3).

All other areas where the carriageway is predominantly two lane, the impacts are rated as moderate to moderate-high (precincts 4-8). These ratings are essentially due to the character of the road corridor changing from a rural/semi-rural scale to a highway style profile. The road widening requires the removal of vegetation that creates the 'genius loci' of Campbelltown Road. Cut and fill required for the road works also impacts upon the landscape through landform modification and additional vegetation removal.

Visual impact assessment

The true visual catchment area of the Campbelltown Road study area is somewhat

limited due to the landform, vegetation and built elements that exist along the road corridor. The view catchment for the majority of the proposal is generally contained within the road corridor. There are some properties that have views onto portions of the road corridor; however, the visual impacts of the proposal would be mostly from within the corridor itself, rather than “key viewpoints”.

This visual impact assessment has been based upon the landscape character precincts (presented above) as the landscape character and visual aesthetic are inextricably linked. This also provides continuity and clarity for the purpose of this assessment.

The key view points within the road corridor would be from the driver’s perspective. Where appropriate, views from the adjoining residential properties would be considered.

The visual impact assessment is based on existing conditions and the impact of the proposal. It does not take into consideration the impact of future alterations (apart from the proposal) resulting from development and mitigating strategies.

Generally, the main impact would be the removal of trees along the road corridor – this alters the landscape character as well as the visual aesthetic of the road corridor. Figure 6-82 shows the theoretical visual catchment or the Visual Envelope Map (VEM).

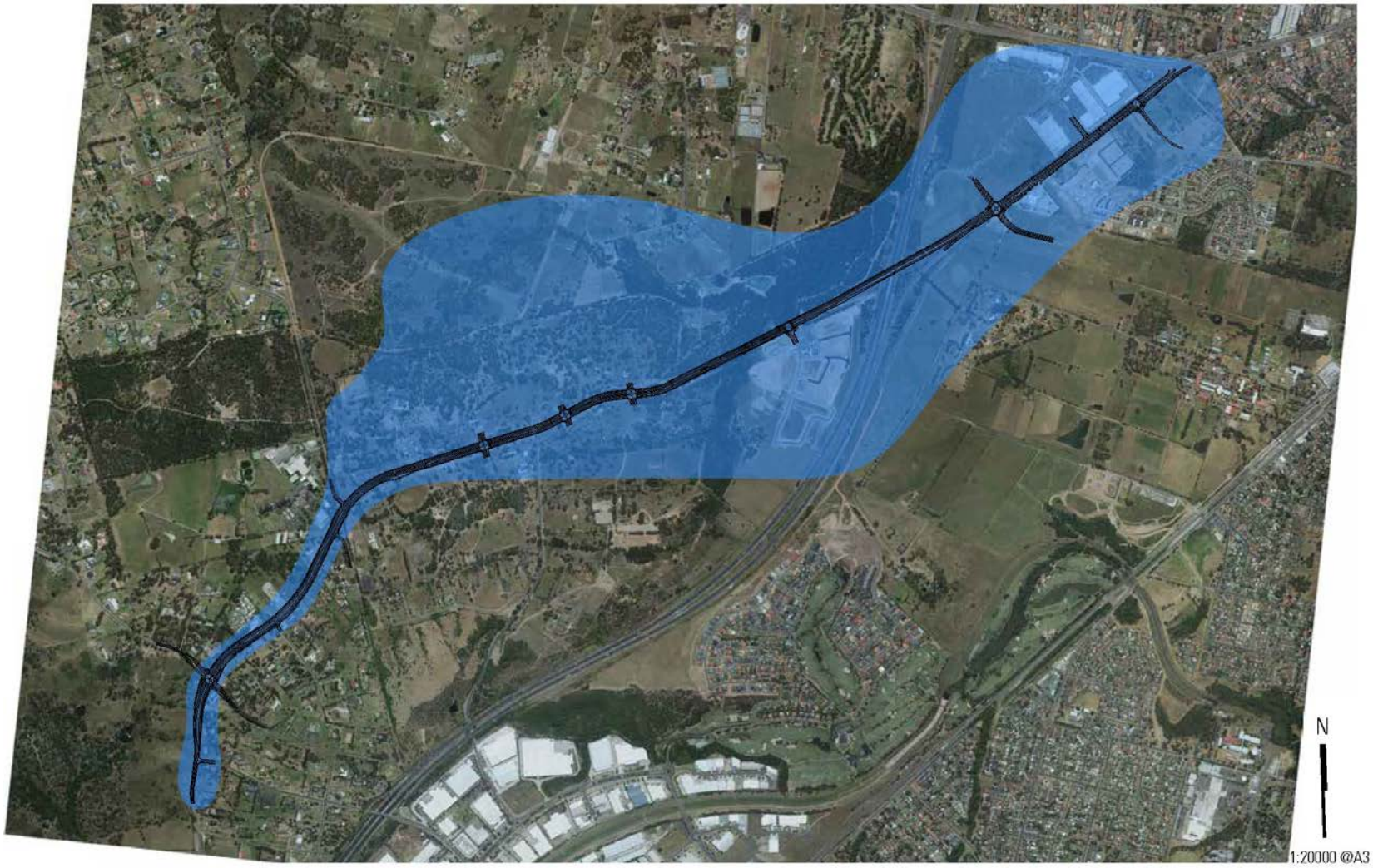

Figure 6-82: Visual Envelope Map (JPW 2013)

A full description of the results of the visual impact assessment is presented in Appendix C. The results and key comments have been summarised in Table 6-82.

Table 6-82: Visual impact assessment summary

Landscape character precinct	Impact assessment result	Comment
1 Open Elevated Entry Precinct	Negligible	• Width of road corridor similar to the proposal. • Open landscape. • Future development will increase presence of built forms.
2 Shallow Valley Precinct/ Residential	Moderate-low	• Built up nature of residential development. • Width of road corridor similar to the proposal. • Reduction of screening vegetation. • Future development is built up residential.
3 Shallow Valley Precinct/ Tree-Lined Mixed Use	Moderate-low	• Width of road corridor similar to the proposal. • Additional width required for shared/pedestrian paths. • Built up warehouse nature of development. • Proposed elevated road alignment compared to existing. • Reduction of vegetation screening. • Business development zone will continue.
4 Grassed Paddock	Low	• Width of road corridor similar to the proposal. • Open nature of landscape. • Removal of existing trees. • Bridge duplication. • Elevated road alignment (4 m above ground). • Ultimately an area for industrial development.
5 Alluvial Woodland/ Tree-Lined Corridor	Moderate-high	• Proposed width of road corridor is more than triple the existing road width. • Removal of trees from sensitive areas. • 8 m high batter for bridge duplication.
6 Ingleburn Gardens Drive/ Medium Density Residential	Moderate-high	• Low-moderate visual impact of tree removal. • Built up nature of residential development.
7 Enclosed Tree Corridor	High	• Removal of what is presently a visually continuous line of trees. • Encroaching on Mont St Quentin Oval.
8 Elevated Large Estates	High	• The Watch Tower and Bible Tract Society building has been identified as a key view point. • Heritage listed Denham Court House and Chapel will be affected due to the removal of a

Landscape character precinct	Impact assessment result	Comment
		number of trees. • Reconfiguration of the intersection of Campbelltown Road and Denham Court Road.

Source: JPW (2013)

The overall visual impact of the proposed upgrade to Campbelltown Road can be divided into two broad areas: one area to the east of the Hume Highway – (landscape character precincts 1-4) and the other to the west of the Hume Highway (landscape character precincts 5-8).

In the area to the east of the Hume Highway, the visual impact would be considered moderate-low as the existing road corridor is similar to the proposed upgrade and the visual impact from key view points and from within the road corridor, largely due to the proposed removal of trees along the boundary of precinct 3.

In the area to the west of the Hume Highway, the visual impact would be, on average, moderate-high. This is primarily due to the road carriageway increasing from a two lane 'rural' road to a four to six lane principal arterial road. The road upgrade would require the removal of a number of trees which would have a moderate impact on the visual aesthetic on the existing landscape, from key view points and from within the road corridor. This impact would need to be addressed by mitigation works, which would be part of the urban design concept plan.

Construction impacts

During construction of each of the four stages, the potential visual impacts would include:

- Temporary construction compounds and ancillary facilities.
- Temporary stockpiles.
- Vegetation clearing.
- Presence of plant and equipment on site.

Construction activities and plant would be visible from the surrounding land uses and road corridor. These impacts shall be short-term and not extensive, due to the linear, staged nature of the proposal. Overall, the impact would be minor, given the transient nature of views from vehicles. In the long-term, with the development of the surrounding residential land, the visual impact of the proposal would be negligible.

6.10.4 Safeguards and management measures

This assessment has described the impacts on landscape character and the visual landscape for eight defined landscape character precincts. Potential impacts on landscape character precincts 1-4 and 6 range from negligible to moderate-low. For this reason, safeguards and mitigation measures were not required. Table 6-83 outlines the safeguards and mitigation measures that would be implemented as part of the proposal within landscape character precincts 5, 7 and 8.

Table 6-83: Safeguards and management measures for landscape character and visual impacts

Impact	Environmental safeguards	Responsibility	Timing
Landscape character and visual impacts	• If cut-off drains or swales are required as a permanent fixture, their location, size and treatment would be finalised during detailed design so that they blend into the landform and landscape character.	RMS	Detailed design
Precinct 5: Vegetation clearance and erection of 8 m high batter as part of bridge duplication	• During construction, the use of fill through this zone would be minimised. • Trees would be retained where possible as screening.	RMS and construction contractor	Detailed design and construction
Precinct 6: Vegetation clearing.	• The following would be investigated further during detailed design: - Vegetation screening along the boundary fence. - Dense tree planting along the boundary of designated open space areas.	RMS	Detailed design
Precinct 7: Vegetation removal and widening	• Tree and shrub planting would be established early, particularly in areas closest to existing buildings, such as at the Watch Tower Bible and Tract Society property where possible. • Use of designated open space areas at Mont St Quentin Oval and near the intersection of Zouch Road to increase the density of tree planting along the road corridor would be investigated during detailed design.	RMS and construction contractor	Detailed design and construction
Precinct 8: Road corridor widening and increased cut and fill batters.	• Tree and shrub planting would be established early where possible. • The heritage post and rail fence would be salvaged for relocation and reconstruction along the new boundary as detailed in the Non-Aboriginal Heritage Assessment and Statement of Heritage Impact	RMS and construction contractor	Detailed design and construction

Impact	Environmental safeguards	Responsibility	Timing
	(Artefact Heritage 2013), Appendix M. • Subtle landmark planting along Denham Court Road at intersection would be investigated during detailed design.		
Vegetation clearance	• Revegetation of cut/fill batters would be undertaken with local species of trees, shrubs and groundcovers.	RMS and construction contractor	Detailed design and construction
Retaining walls	• Visually recessive materials, textures and colours would be used for retaining walls to reduce their visual dominance and blend with the landscape of this area. • Screen planting would be used to reduce the visual dominance of retaining walls where possible.	RMS	Detailed design
Landscape character and visual impacts	• The landscape and urban design strategy for the proposal would be finalised during detailed design in consideration of design principles and objectives as described in Section 3.2 of the REF and Appendix C	RMS	Detailed design
Landscape character and visual impacts	• Bridge design and integration with the existing one would follow Bridge Aesthetics – design guidelines to improve the appearance of bridges in NSW (RTA, 2003).	RMS	Detailed design

6.11 Land use and socioeconomic impacts

6.11.1 Existing environment

Demographic profile

The proposal is split longitudinally by the Liverpool and Campbelltown LGA boundaries.

Campbelltown LGA

The Australian Bureau of Statistics presents a demographic profile for the Campbelltown LGA. It outlines that the estimated resident population at 30 June 2012 was 153,222, an increase of 1 per cent since June 2009. The SWGC would bring new land releases, which is expected to increase the growth rate in this LGA.

Two parent households with young children make up the majority of households in the Campbelltown LGA. This demographic has a dependency on access to employment, recreation, internet and community facilities. The 2006 census outlined

that 17.1 per cent of employed people travelled to work on public transport and 66.1 per cent by car (either as driver or as passenger). A large proportion of the local population are thought to work outside the Campbelltown LGA.

Liverpool LGA

Data obtained from the Australian Bureau of Statistics indicate that Liverpool LGA grew to an estimated population of 185,481 in June 2010 which represents a 1.9 per cent increase for the year. As with the Campbelltown LGA, this rate of growth is anticipated to rise sharply with the new land releases in the area as a result of the SWGC.

The Liverpool LGA is also characterised by young families with children dependent on access to employment, community and recreational facilities. A high proportion of the local population works outside of the Liverpool area. According to the 2006 census, 74.1 per cent of workers within the Liverpool LGA travelled to work by motor vehicle, 13.2 per cent travelled by public transport (train or bus).

Land use

As outlined in Section 6.10, existing land use across the proposal is predominated by residential, heavy industry, business development, mixed use, special uses, rural landscape and National Parks and Nature Reserves. A consolidated plan of existing land use zones is presented in Figure 4-44.

There are approximately 86 Lots along the proposed Campbelltown road alignment. The number of estimated properties that are situated along the proposed alignment based on desktop aerial survey are described as follows:

- Dwellings – 45 (with direct driveway access to Campbelltown Road).
- Businesses – four (Crossroads Hotel, M&A Landscapes, BP Service Station, Caltex Road House, Denham Court Caravan Park).
- Institutions – four (Ingleburn Army Barracks Museum, Kindergarten, Hurlstone Agricultural High School, Watch Tower and Tract Society).

There are also numerous dwellings situated on roads that branch off Campbelltown Road, including:

- Ingleburn Garden Estate under construction, which would comprise approximately 270 dwellings, an aged care facility and school.
- Edmondson Park residential development, currently under construction, which would include 6000 dwellings.
- Established urban developments located off Glenfield Road.
- Numerous rural/residential properties.

The Cross Roads Homemaker Centre is located adjacent to the proposal area. It includes multiple retail businesses including (but not limited to) Bunnings Warehouse, Freedom Furniture, Kmart and Clive Peters. None of the businesses have direct driveway access to Campbelltown Road, however, these businesses utilise Parkers Farm Place, which intersects Campbelltown Road.

South West Growth Centre

The SWGC is expected to accommodate an additional 110,000 new dwellings for 300,000 people (DoP 2005, 2010). The NSW DP&I has released various development areas in the SWGC including the Edmondson Park precinct.

Edmondson Park was one of the first precincts to be planned in the SWGC, with the potential for 6000 new dwellings, local shops, associated jobs and services. The precinct is zoned for urban development under the LEPs for both Liverpool and Campbelltown Councils (DP&I 2012).

Concept planning for the Edmondson Park development along Campbelltown Road outlines incorporation of residential dwellings, Edmondson Park Town Centre (including up to 45,000 square metres of commercial retail and associated land uses) and protection of approximately 150 hectares of conservation lands within the proposed Edmondson Regional Park.

6.11.2 Potential impacts

During construction and operation the proposal would impact the local community and other road users in a number of ways, as discussed in detail in many of the following sections:

- Land acquisition (Section 3.6).
- Biodiversity (Section 6.1).
- Traffic and transport (Section 6.6).
- Noise and vibration (Section 6.7).
- Air quality (Section 6.8).
- Landscape character and visual impact (Section 6.10).

Construction impacts

The construction phase would potentially increase construction traffic, noise, dusts and degradation to the visual amenity (addressed in previous sections). Although associated impacts would be temporary, they would reduce the overall amenity of the area. Road users and users of bus services, cyclists and pedestrians would be impacted through construction due to traffic delays. Disruptions to services such as power, sewerage, water, gas and telecommunications due to necessary relocation of utilities, whilst considered minimal and short-term, would impact neighbouring properties. Construction of the proposal may also include some night works, which would adversely impact neighbouring properties in terms of noise and light spill.

The proposal also has the potential to adversely impact on sensitive non-residential land uses located within the vicinity of the proposal (schools, childcare centres, places of worship, cultural items, parks and recreational areas, commercial areas). Previous sections of this REF have addressed the environmental impacts on these sensitive land uses (noise, traffic and transport, air quality, Non-Aboriginal cultural heritage).

Economic and employment impacts associated with the proposal include impacts to local business both positive and negative. There is the potential to increase business during the construction phase as a result of the workforce that the proposal would generate. However, this would mostly be applicable to the type of businesses that members of the construction workforce would frequent such as food and beverage outlets.

Negative impacts to local businesses are expected to be minimal in terms of access as this would be maintained throughout the construction period. However temporary delays in traffic flow during construction may deter users from use of local businesses within the area.

It is not anticipated that there would be any impacts to land use as a result of the leasing of land for ancillary facilities (including compound areas) during construction.

Operation impacts

The proposal would provide new infrastructure for improved local and regional access, improved road safety and traffic capacity, improved capacity for public transport, improved pedestrian and cyclist facilities and improved landscaping along this section of Campbelltown Road.

Potential adverse operational socioeconomic impacts due to the proposal would be associated with property access, increased traffic, and amenity of businesses and operation of Campbelltown Road closer to a number of dwellings.

The proposal would upgrade the majority of Campbelltown Road to two lanes each way, permanently changing property and business access arrangements to left in/left out movements only due to the median. These changes may result in increased travel times due to increased distances required to be travelled to turning points. The maximum additional travel distance would be 860 metres. Section 6.6.2 discusses traffic and transport impacts associated with the proposal in more detail. Detailed design would further define suitable distances between the u-turn facility at Dickson Road and signalised intersections to reduce impacts to the community.

Bus routes along Campbelltown Road are not expected to be impacted through operation. Detailed design would provide for any adjustments to locations required to improve safety. Future bus routes would benefit from the associated upgrades of the proposal in terms of increased capacity and safety.

The proposal would incorporate positive changes to pedestrian and cycle facilities along Campbelltown Road by providing off-road shared paths along the road corridor between key land uses (Section 6.6). Proposed improvements to pedestrian and cycle facilities would benefit the wider community by improving access along Campbelltown Road. New paths would also improve safety for pedestrians and cyclists as it is separated from the new carriageways.

The informal parking within the road shoulder in some locations along the existing road alignment would no longer be available, as the proposal includes widening into the existing road shoulder.

Businesses would experience minimal negative impacts through operation of the proposal. In some places, Campbelltown Road would be brought closer to the place of business, which would maintain or improve opportunities from passing trade in terms of exposure. Businesses that would be most sensitive to operational noise (such as the Caravan Park) would still be at least 20 metres from the nearest carriageway of Campbelltown Road, refer to Section 6.7.4 for further details.

The proposal shall impact on the use of the proposed Edmondson Regional Park for conservation purposes. It has been estimated that 1.13 hectares of land that was to be part of the Regional Park would be directly impacted by the proposed upgrade of Campbelltown Road. Offsets are proposed to compensate for these impacts.

The zoning of future land uses associated with the Edmondson Park South precinct that has been planned under the Growth Centres SEPP is generally consistent with the proposal (refer to Figure 4-44). There would be some land acquisitions required in order to accommodate the proposed road corridor; however, it is anticipated that these impacts would be offset by the improved accessibility that the precinct would

experience as a result of the proposed upgrade. It is anticipated that the upgrade of Campbelltown Road would not only service the proposed Edmondson Park development, but also the wider SWGC.

6.11.3 Safeguards and management measures

Table 6-84 outlines the proposed safeguards and management measures in terms of socioeconomic impacts and land use for both construction and operational phases of the proposal.

Table 6-84: Safeguards and management measures for land use and socioeconomic impacts

Impact	Environmental safeguards	Responsibility	Timing
Impacts on businesses and the community during construction	• A complaints handling procedure and register would be included in the CEMP.	Construction contractor	Pre-construction and construction
Impacts on businesses and the community during construction	• Access would be maintained wherever possible. Prior to any unavoidable disruption to access, consultation would be undertaken with the affected property owner.	Construction contractor	Pre-construction and construction
Impacts on businesses and the community during construction	• Safe access to bus stops would be maintained at all times and bus companies would be advised prior to any changes to traffic conditions.	Construction contractor	Pre-construction and construction
Impacts on businesses and the community during construction	• Cyclist and pedestrian access would be maintained although may need to be altered during construction to ensure safety.	Construction contractor	Construction
Impacts on businesses and the community during construction	• Residents would be informed prior to any interruptions to utility services that may be experienced as a result of utilities relocation.	Construction contractor	Pre-construction and construction
Impacts on businesses and the community during construction	• Road users, pedestrians and cyclists would be informed of changed conditions, including likely disruptions to access during construction.	Construction contractor	Pre-construction and construction
Impacts on businesses and the	• Community consultation would be undertaken in accordance with the RTA *Community Involvement*	Construction contractor	Pre-construction and

Impact	Environmental safeguards	Responsibility	Timing
community during construction	*Practice Notes and Resource Manual.*		construction
Impacts to property owners due to land acquisition for construction	• Property acquisition would be managed in accordance with the provisions of the RTA's *Land Acquisition Policy* and the *Land Acquisition (Just Terms Compensation) Act 1991.*	RMS	Pre-construction

6.12 Resource use and waste management

6.12.1 Policy setting

In NSW, waste storage, handling, transport, recovery and disposal is regulated by the *Protection of the Environment Operations Act 1997* (PoEO Act) and the Protection of the Environment Operations (Waste) Regulation 2005. This Act and Regulation are administered by the EPA to prevent degradation of the environment, eliminate harmful wastes, reduce the amount of waste generated and establish priorities for waste re-use, recovery and recycling.

The *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) requires the consideration of resource management options against the following priorities:

- Avoidance, including actions to reduce the amount of waste generated.
- Recovery, including reuse, recycling, reprocessing and energy recovery.
- Disposal, in a way that is environmentally responsible.

RMS is committed to implementing this hierarchy throughout operations. The *Waste Reduction and Purchasing Policy* (2007) requires state government agencies to act as 'model' waste managers, in order to help increase the market for materials containing recycled content and minimise waste generated by government activities. Within the RMS Sustainability Strategy (2010), RMS specifies materials that are targeted for reuse or recycling. Those relevant to this proposal are detailed in Table 6-86.

Table 6-86: Relevant targeted wastes for reuse

Targeted wastes	Recover target
Asphalt removal and replacement.	Recover 95% of all asphalt for reuse by 2014.
Concrete pavement and infill areas.	Recover 76% of concrete for reuse by 2014.
Waste steel from traffic control devices, including signage and electrical infrastructure.	Recover 76% of steel for reuse by 2014.
Waste aggregate.	Recover 76% of aggregate for reuse by 2014.
Excavated materials.	Recover 95% of all VENM for reuse by 2014.

Source: RMS Environmental Sustainability Strategy (2010)

RMS contractors are required to propose recycled-content materials where they are cost and performance competitive and are at least the environmental equivalent of the non-recycled alternatives. Waste minimisation quantities, initiatives and barriers are also reported on all projects.

6.12.2 Potential impacts

The proposal would generate and require earthwork, concrete, steel, asphalt, fill materials and landscaping supplies as detailed in Sections 3.3.4 and 3.3.5. During construction, the proposal would generate the following waste:

- General solid waste (non-putrescible), including: scrap metal, from reconstruction and/or replacement of existing road infrastructure; construction waste, from excess materials such as asphalt and concrete; and redundant pavement material, from restoration and/or reconstruction of sections of the existing road.
- General waste (putrescible) including: paper waste, food waste and general rubbish generated by the construction workforce.
- Green waste, from vegetation clearing and grubbing required for the proposal.
- Liquid waste, including: stormwater runoff from construction areas; sewage; and small volumes of excess fuel, oils and other chemicals, from vehicle maintenance.
- Excess spoil from earthworks, where excavated material is neither suitable nor required within the proposal.

Moderate quantities of waste (including vehicle oils and greases, and green waste) would be generated during operation of the proposal.

During detailed design, the quantities of the above waste streams would be estimated, taking into account excess cut material that would be suitable for reuse, asphaltic concrete which would be suitable for re-use, and whether the workforce would use portable toilet facilities or sewer connections.

Stockpile site management is to comply with management principles consistent with the RMS *Stockpile Site Management Procedure*.

Where possible, materials would be sourced on site, locally or within the Sydney region. It would be preferred that any excess or unsuitable material be recycled on other RMS projects. If neither of these is possible, waste would be disposed of at a licensed facility.

Guideposts, signage, fuel (for the operation of machinery and vehicles), chemicals and water would also be required during construction. The quantity of water required for the proposal is not yet available, but would be estimated during detailed design. During construction, water for construction shall be harvested from the sediment sumps. This water saving would be implemented by the construction contractor.

None of the materials required for the proposed upgrade are in short supply or difficult to obtain; however, options for using materials with recycled content and lower carbon footprint would be investigated during procurement, where these options are considered cost and performance effective.

6.12.3 Safeguards and management measures

Table 6-87 outlines the proposed safeguards and management measures in terms of waste and resource use for both construction and operational phases of the proposal.

Table 6-87: Safeguards and management measures for waste and resource management

Impact	Environmental safeguards	Responsibility	Timing
Increases in production of waste materials	• A Resource and Waste Management Plan (RWPM) would be developed as a component of the CEMP, which would include: - The type and volume of all materials. - Destinations for each resource/waste type either for on-site reuse or recycling, off-site reuse or recycling, or disposal at a licensed waste facility. - Quantity and classification of excavated material generated as a result of the proposal. - Disposal strategies for each type of material. - Details of how waste would be stored and treated on-site. - Identification of all non-recyclable waste. - Identification of strategies to 'avoid', 'reduce', 'reuse', and 'recycle'. - Identification of available recycling facilities on and off site. - Identification of suitable methods and routes to transport waste. - Procedures and disposal arrangements for unsuitable excavated material or contaminated material. - Site clean-up for each stage.	Construction contractor	Pre-construction and construction
Increases in production of waste materials	• Waste management measures developed in accordance with the waste hierarchy established under the WARR Act for the proposal would be included in the	Construction contractor	Pre-construction and construction

Impact	Environmental safeguards	Responsibility	Timing
	CEMP. • Training in waste management principles would be included in site inductions. • Types of waste collected, amounts, date/time and details of disposal shall be recorded in a waste register.		
Sourcing of recycled materials	• RMS contractors would be required to propose recycled-content materials where they are cost and performance competitive.	Construction contractor	Construction
Reuse and recycling of materials	• Workspaces would be maintained, kept free of rubbish and cleaned up at the end of each working day.	Construction contractor	Construction
Waste disposal	• Solid and liquid wastes, as well as fuels, lubricants and chemical containers would be disposed of in accordance with OEH requirements. • Suitable waste disposal locations would be identified and used to dispose of litter and other wastes on-site. Suitable containers would be provided for waste collection. • Material identified for recycling shall be stockpiled in an adequately bunded area (in accordance with the *RMS Stockpile Site Management Guidelines,* 2011). • Fuel and chemical storage areas would be appropriately sized and imperviously bunded.	Construction contractor	Construction
Procurement	• Procurement would endeavour to use materials and products with a recycled content and low carbon footprint where it is cost and performance effective to do so.	Construction contractor	Pre-construction and construction
Waste management	• All wastes would be managed in accordance with the Protection of the Environment Operations Act 1997.	Construction contractor	Construction
Waste management	• A dedicated concrete washout facility would be provided during construction so that runoff from the washing of concrete	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	machinery and equipment could be collected and disposed of at an appropriate waste facility.		

6.13 Cumulative impacts

The interaction of individual elements within the proposal and the additive effects of the proposal with other concurrent and future projects has the potential to give rise to cumulative impacts.

6.13.1 Potential impacts

Current road works

The proposal forms part of a series of planned and under construction upgrades in the south-west region of Sydney. Works are currently being undertaken on Camden Valley Way, The Northern Road and Narellan Road. Therefore, there is potential for short-term negative cumulative impacts associated with traffic delays and access. Changes to the visual amenity of the area could result from associated construction activities. Construction noise, air pollution, resource use and waste management would also have negative cumulative impacts to the area. The effect of upgrading this and other sections of roads in the surrounding areas would, however, have a positive cumulative impact on road safety and travel times in the medium-term. In addition, a positive cumulative impact arises from providing support to anticipated traffic volume increases as a result of expected population growth in the south-west region.

Concurrent development – South West Rail Link

The SWRL is an improved public transport facility which has commenced construction and is anticipated to finish in 2016. Associated construction in the vicinity of and interacting with Campbelltown Road includes a rail bridge over Campbelltown Road between the Hume Highway and Lawson Road, as well as Edmondson Park Railway Station and bus interchange (currently under construction and scheduled for completion in 2014).

Coordination between designers of the proposal and the SWRL has occurred where access and linkages are relevant and would be ongoing throughout detailed design and construction.

Negative cumulative impacts would be associated with resource use, waste management, air pollution, and potential dust impacts. Negative cumulative visual impacts are also a potential due to changes to the visual amenity of the area as a result of combined construction activities.

Positive cumulative impacts would result from cumulative effects of upgrading transport infrastructure in the south-west Sydney region in terms of reduction of travel times, improvements to traffic congestion, associated pollution, and road safety. This outcome is consistent with the Metropolitan Transport Plan (DoP 2010) which is an integrated, long-term planning framework focused on managing Sydney's growth to 2036, with a focus on a more connected city with improved accessibility. The proposed Campbelltown Road Upgrade and the SWRL would improve transport infrastructure in the south-west region, facilitating the anticipated increase in future population growth in the area.

Concurrent development – South West Growth Centre

The SWGC is proposed development comprising 18 precincts with capacity for around 110,000 new dwellings. Edmondson Park, along Campbelltown Road, is one of the first precincts to be planned in the SWGC, being zoned for urban development under LEPs prepared by Liverpool and Campbelltown Councils.

As outlined in previous sections, the SWGC Road Network Strategy has been prepared to confirm the nature of the future road network in the SWGC. This is particularly relevant to the proposal as Edmondson Park Town Centre is proposed adjacent to Campbelltown Road in the vicinity of the proposed Edmondson Park Railway Station.

As with other concurrent roadwork and development, coordination is required between design and development parties to minimise negative cumulative impacts associated with short-term traffic delays and access during construction. In addition, waste and resource use, air pollution, and potential dust impacts would also have cumulative effects in the area. Negative cumulative visual impacts are also a potential due to changes to the visual amenity of the area as a result of combined construction activities.

Concurrent development has the opportunity to enhance positive cumulative effects through adequate planning and linkage, by minimising traffic conflict and congestion that may occur due to the cumulative increase in vehicle traffic due to expected growth in the region.

Cumulative biodiversity impacts

The proposal is located within the SWGC, in an area where substantial development of infrastructure (such as the SWRL) and residential development of precincts and town centres is planned. Impacts associated with these developments and the proposal in terms of possible reductions in biodiversity across the area are managed through the biodiversity certification conditions for the SWGC, which are designed to offset the cumulative impacts of all planned development within non-certified areas. Impacts of the proposal on the vegetation and habitat in non-certified areas include the removal of 1.01 hectares of Cumberland Plain Woodland and 0.82 hectares of River-Flat Eucalypt forest. Consultation with OEH, DP&I and SEWPaC regarding the proposed offset of impacts in non-certified areas and the proposed Edmondson Regional Park are in progress. The conditions of approval would be incorporated into any documentation developed to manage any offset package developed for the proposal, the CEMP and the OEMP.

Socioeconomic impacts

The proposal, as well as other current road works and work on the SWRL, would result in cumulative benefits for the SWGC in terms of enhanced accessibility, road safety, increased capacity of the traffic network, improved flow of traffic, and improved pedestrian/cyclist facilities. These transport upgrades would also, cumulatively, result in localised increases in traffic noise and air pollution within the region. Air quality impacts would be managed by the NSW Air Quality Management Plan. Noise impacts would be addressed on a project-by-project basis, during design to minimise impacts on sensitive receivers.

6.13.2 Safeguards and management measures

The impacts of other projects do not form part of this assessment and would be assessed separately. Table 6-88 outlines the specific safeguards and management measures that would be employed for this proposal in managing potential cumulative impacts.

Table 6-88: Safeguards and management measures for cumulative impacts

Impact	Environmental safeguards	Responsibility	Timing
Cumulative impacts during construction	• Works would be staged to avoid and minimise impacts along the entire length where possible.	Contractor	Construction
Cumulative impacts during construction	• Cumulative impacts would be incorporated into the traffic, noise and vibration, and air quality management plans as required.	Contractor	Pre-construction and construction
Cumulative impacts during construction	• Cumulative impact management measures within the CEMP would be reviewed in response to any complaints received.	Contractor	Construction

6.14 Summary of beneficial effects

- The proposal would ensure that the lanes of Campbelltown Road do not become untrafficable, minimise congestion and accommodate future traffic flows generated by the Edmondson Park precinct and SWGC. It would also become an important link to Edmondson Park Railway Station.
- The proposal would improve accessibility within the SWGC.
- The proposal would improve safety through the installation of new signalised intersections, constructing turning lanes at intersections and the construction of a new, and widening of an existing, central median to separate opposing traffic.
- The proposal would also improve safety for cyclists and pedestrians through creation of a new shared path accommodated within the verge of the northbound carriageway.
- The proposal is necessary for conveying the 100 year ARI stormwater flows (the existing structures would not cater for the 100 year ARI event). It would improve control of direct runoff along the upslope side of Campbelltown Road towards cross drainage structures.

6.15 Summary of adverse effects

The key adverse impacts associated with this proposal include:

- The proposal would disturb several Aboriginal Heritage items, including:
  - One site complex assessed as having moderate archaeological significance.
  - Two items assessed as having moderate archaeological significance.
- The proposal would include removal of approximately 1.88 hectares of moderate to good condition threatened ecological communities (TECs), including both CPW and RFEF. Other indirect impacts on native vegetation communities in the study area include edge effects and weed invasion.
- Cumberland Plain Land Snails are likely to be impacted where clearing would be undertaken in remnant woodland, particularly where snails have been

recorded along the margin of the subject site.

- Noise and air quality are likely to be affected during construction.
- There would be some short-term minor impacts on traffic along Campbelltown Road during construction.
- Construction of the proposal would place Campbelltown Road closer to a number of dwellings along this section of the road.
- Land acquisition would be required.
- Construction activities have the potential to contribute to soil erosion and impacts on water quality.
- There would be an increase in surface flows volume and velocity across the site during construction and the associated mobilisation of debris and soils. An increase in surface flow also has the potential to contribute to increased erosion, surface scouring and scouring of water channels.
- The proposal would impact on the existing landscape character and visual amenity.

A range of management and mitigation measures have been developed for avoiding, minimising and mitigating potential adverse impacts (refer to Table 7-89).

7 Environmental management

This chapter describes how the proposal would be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A framework for managing the potential impacts is provided with reference to environmental management plans and relevant RMS QA specifications. A summary of site-specific environmental safeguards is provided in Table 7-89 as detailed in Chapter 6 and the licence and/or approval requirements required prior to construction are also listed in Table 7-90.

7.1 Environmental management plans (or system)

A number of safeguards and management measures have been identified in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

A Project Environmental Management Plan (PEMP) and a Contractors Environmental Management Plan (CEMP) would be prepared to describe safeguards and management measures identified. These plans would provide a framework for establishing how these measures would be implemented and who would be responsible for their implementation.

The plans would be prepared prior to construction of the proposal and must be reviewed and certified by the RMS Environmental Officer, Sydney region, prior to the commencement of any on-site works. The CEMP would be a working document, subject to ongoing change and updated as necessary to respond to specific requirements. The CEMP and PEMP would be developed in accordance with the specifications set out in the *QA Specification G36 – Environmental Protection (Management System), QA Specification G38 – Soil and Water Management (Soil and Water Plan) and the QA Specification G40 – Clearing and Grubbing*.

7.2 Summary of safeguards and management measures

Environmental safeguards outlined in this document would be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards would minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The safeguards and management measures are summarised in Table 7-89.

Table 7-89: Summary of site specific environmental safeguards

No.	Impact	Environmental safeguards	Responsibility	Timing
1	General	• All environmental safeguards must be incorporated within the following documents: - Project Environmental Management Plan - Detailed design stage - Contract specifications for the proposal - Contractor's Environmental Management Plan	Project manager	Pre-construction
2	General	• A risk assessment has been carried out on the proposal in accordance with the RMS Audit Pack and OSD risk assessment procedures to determine an audit and inspection program for the works. The recommendations of the risk assessment are to be implemented. • A review of the risk assessment must be undertaken after the initial audit or inspection to evaluate the level of risk chosen for the project is appropriate. • Any works resulting from the proposal and as covered by the REF may be subject to environmental audit(s) and/or inspection(s) at any time during their duration.	Project manager and regional environmental staff	Pre-construction After first audit
3	General	• The environmental contract specifications, QA Specification G36 – Environmental Protection (Management System), QA Specification G38 – Soil and Water Management (Soil and Water Plan) and the QA Specification G40 – Clearing and Grubbing, must be forwarded to the RMS Regional Environmental Officer for review at least 10 working days prior to the	Project manager	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		tender stage. • A contractual hold point must be maintained until the CEMP is reviewed by the RMS Regional Environmental Officer Sydney Region.		
4	General	• The RMS Project Manager must notify the RMS Regional Environmental Officer at least 5 days prior to work commencing.	Project manager	Pre-construction
5	General	• All businesses and residences likely to be affected by the proposed works must be notified at least 5 working days prior to the commencement of the proposed activities.	Project manager	Pre-construction
6	General	• Environmental awareness training must be provided, by the contractor, to all field personnel and subcontractors.	Contractor	Pre-construction and during construction as required.
7	Impacts on threatened species	• A Flora and Fauna Management Plan would be prepared in accordance with *RMS Biodiversity Guidelines* (RTA 2011) as part of the CEMP. The plan would include but not be limited to the following: - A map which clearly shows vegetation clearing boundaries and no-go zones. - A site walk with the RMS Environmental Officer to confirm clearing boundaries prior to the commencement of work. - A procedure for a suitably qualified ecologist to undertake pre-clearing surveys immediately prior to vegetation removal. Target species would include: *Pimelea spicata*, *Marsdenia viridiflora* subsp*. viridiflora*,	RMS and construction contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		Cumberland Plain Land Snail and threatened microbats. - Incorporate management measures identified as a result of the pre-clearing survey report and nominate actions to respond to the recommendations made. - A procedure for clearing potential habitat including hollow-bearing trees in accordance with RMS Specification G40. An experienced, licenced wildlife carer or ecologist would be present to supervise vegetation clearing and capture then relocate fauna if required. Fauna handling and vegetation removal would be in accordance with the RMS Biodiversity Guidelines 2011. An experienced, licensed wildlife carer or ecologist would be notified/on call to supervise vegetation clearing and capture then relocate fauna if required. Fauna handling would be in accordance with the *RMS Biodiversity Guidelines 2011 – Guide 9*. - Protocols to prevent introduction or spread of pathogens (eg chytrid fungus and *Phytophthora*) should be implemented in accordance with RMS *Biodiversity Guidelines 2011 – Guide 7*. • Provision of education to all personnel taking part in construction activities with regards to the importance of clearing limits, land uses (e.g. non-certified areas, proposed Edmondson Regional Park) and threatened species population and communities and their legislative responsibilities for the same.		
8	Impacts on	• If unexpected threatened flora or fauna are discovered,	RMS and construction	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
	threatened species	works would stop immediately and the *RTA Unexpected Threatened Species Find Procedure in the RMS Biodiversity Guideline 2011* implemented.	contractor	
9	Impacts on Cumberland Plain Land Snail	• A relocation plan for the Cumberland Plain Land Snail would be prepared as part of the Flora and Fauna Management Plan. This plan would be developed in consultation with OEH and would consider salvaging snails from habitat within the proposal area and relocation to suitable habitat that would not be affected by the proposal.	RMS	Detailed design and pre-construction
10	Impacts on Cumberland Plain Land Snail	• A license application to OEH for Cumberland Plain Land Snail relocation under Section 91 would be undertaken prior to works and requirements incorporated into management plan.	RMS	Pre-construction
11	Loss of native vegetation	• The extent of vegetation removal (including riparian) would be minimised where possible.	RMS and construction contractor	Detailed design and construction
12	Impacts to riparian areas	• A riparian plan would be prepared as part of the Landscape Plan for areas impacted as a result of the creek realignment and bridge construction. The plan would be prepared in consultation with a qualified ecologist and would include but not be limited to the following measures: - Riparian areas disturbed by the proposal would be rehabilitated as soon as practicable. - Where vegetation would be planted to rehabilitate the newly aligned creek, only native species indigenous to the region would be used.	RMS and construction contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		- Vegetation regeneration/weed removal would be undertaken in areas within and adjacent to the proposed construction areas until the areas that are being rehabilitated have become established. - Rehabilitated riparian areas would be maintained for a minimum period of two years after final planting.		
13	Impacts on the aquatic environment	• Creek bank stabilisation would be installed prior to and during the creek realignment works in order to minimise bank erosion, topsoil loss and sedimentation of the waterway.	RMS and construction contractor	Detailed design and construction
14	Impacts on the aquatic environment	• Should fish passage needs to be temporarily blocked for construction purposes, a permit under part 7 of the FM Act would be sought.	RMS and construction contractor	Pre-construction and construction
15	Impacts on the aquatic environment	• Creek diversion would be scheduled during periods of predicted low flow to minimise impacts.	RMS and construction contractor	Construction
16	Impacts on the aquatic environment	• Notification to DPI (Fisheries) of reclamation/dredging works would be undertaken prior to construction. Consideration would be given to any response within 28 days of notification.	RMS	Pre-construction
17	Weeds and pathogens	• Actions for weed management would be developed as part of the Vegetation Management Plan in accordance with the requirements of RMS Specifications G36 and G40. The plan would include, but not be limited to, the following: - Type and location of weeds of concern (including	RMS and construction contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		noxious weeds) within the proposal area. - Identify sensitive receivers (such as native vegetation and waterways) within or adjacent to the proposal area. - Measures to prevent the spread of weeds and fungi, including hygiene procedures for equipment, footwear and clothing. - Management and disposal weeds (including Declared noxious weeds) which would be in accordance to requirements under the Noxious *Weeds Act 1993* and *RMS Biodiversity Guidelines 2011 - Guide 6* (Weed Management). - A monitoring program to measure the success of weed management until site has been established. - Communication strategies to improve contractor awareness of weeds and weed management.		
18	Weeds and pathogens	• Any application of herbicide for weed management would be undertaken in accordance with the requirements of the *Pesticides Act 1999* and an herbicide that is appropriate to the sensitivity of the area would be used. Approval by the RMS Regional Environmental Officer would be obtained prior to use	Construction contractor	Pre-construction and construction
19	Offsets	• A biodiversity offset strategy would be developed to compensate for loss of ENV within the non-certified areas, loss of EPBC CPW within the proposed Edmondson Regional Park and the reduction in the land area of the proposed Edmondson Regional Park.	RMS	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		These offsets would satisfy the terms of the agreements (biodiversity certification and conservation agreement) and requirements under the EPBC Act and Growth Centres and Major Development SEPPs as well as conditions of the existing land zoning. • The offset strategy would be prepared in consultation with OEH, DP&I and SEWPaC and would be in place prior to construction.		
20	Impacts to known Aboriginal heritage sites	• An Aboriginal Heritage Management Plan would be prepared prior to commencement of works and included in the CEMP. This plan would include but not be limited to the following: - The location of all Aboriginal sites within and adjacent to proposal area. These would be marked on relevant site plans. - An environmental risk assessment to determine potential risks for discrete work elements or activities likely to affect Aboriginal heritage items. - Specific mitigation measures to avoid risk of harm or protect Aboriginal heritage. - Clearly defined boundaries for site CRSC1, including a map representing areas that would need to be protected as no go zones. - If sites are within 25 m of the proposal area, these would be identified on construction plans and exclusion fencing and signage would be placed at the boundary of the proposal area at this location in order	RMS and construction contractor	Pre-construction and construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		to prevent indirect or inadvertent impacts to the site. - A stop works procedure in the event of actual or suspected potential harm to a heritage feature/place. - Workers would be made aware of the location of sites and their responsibilities under the *National Parks and Wildlife Act* and any relevant permits during an Aboriginal heritage induction prior to works commencing.		
21	Impacts to known Aboriginal heritage sites	• An area based AHIP would be obtained prior to construction and any salvage would be undertaken in accordance with the proposed salvage methodology and any conditions of approval (if granted).	RMS	Pre-construction
22	Possible disturbance to unknown Aboriginal heritage due to construction activities	• In the event of an unexpected find of an Aboriginal heritage item (or suspected item), work would cease in the affected area and RMS Regional Environmental Officer and the RMS Senior Environmental Specialist (Aboriginal heritage), would be contacted for advice on how to proceed. The *RMS Unexpected Archaeological Finds Procedure* (2011) would be implemented.	RMS and construction contractor	Construction
23	Non-Aboriginal heritage impacts	• A Non-Aboriginal Heritage Management prepared prior to commencement of works and included in the CEMP. This plan would include but not be limited to the following: - Sensitive areas mapped which clearly identifies all known non-Aboriginal heritage items (including curtilages) and exclusions zones. - Mitigation measures to avoid risk of harm including	RMS and construction contractor	Pre-construction and construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		dilapidation surveys (including measures outlined in Noise and Vibration Management Plan). - Fencing to control access to exclusion zones during construction - A non-Aboriginal heritage induction to all site personnel prior to commencing works. Aspects such as location of heritage items, their significance, responsibilities under the *Heritage Act 1977* and any relevant permits would be discussed.		
24	Impacts to Denham Court	• Impacts to curtilage of Denham Court would be minimised where possible.	RMS and construction contractor	Detailed design and construction
25	Impacts to Denham Court	• Archival recording of existing curtilage, trees, fence and gate would be undertaken prior to commencing works.	RMS	Pre-construction
26	Impacts to Denham Court	• A relocation plan for the fence and gate to Denham Court would be prepared as part of the Non-Aboriginal Heritage Management Plan by a qualified heritage consultant and in consultation with OEH (Heritage Branch). • The fence and gate would be relocated outside of the area of impact and replacement trees of the same or similar species would be replanted along the fence in the same number and configuration.	RMS and construction contractor	Pre-construction and construction
27	Impacts to Denham Court	• Works would be undertaken in accordance with a Section 60 permit which would be obtained from NSW Heritage Council prior to works commencing at this location.	RMS and construction contractor	Pre-construction and construction

No.	Impact	Environmental safeguards	Responsibility	Timing
28	Impacts to St Mary the Virgin Church and Cemetery Group	• If any trees are removed as part of the proposal, replacement trees of a similar species would be planted along the southern boundary of the item's curtilage following completion of works in consultation with the landowner.	RMS and construction contractor	Pre-construction and construction
29	Impacts to three milestones	• A relocation plan for the affected milestones would be prepared as part of the Non-Aboriginal Heritage Management Plan by a qualified heritage consultant. This relocation plan would include the following measures: - The milestones would be repositioned beside the upgraded road, each at its original distance along the road, as indicated in the Non-Aboriginal Heritage Assessment and Statement of Heritage Impacts (Artefact Heritage 2013). - Methods to prevent damage during movement, options for storage before reinstatement (including measures to prevent the milestones or their provenance details being lost). - Options for landscaping and heritage interpretation near the milestones once they are reinstated would be considered.	RMS and construction contractor	Pre-construction and construction
30	Impacts to former Ingleburn Defence Site	• Archival recording of the former Ingleburn Defence Site elements which would be impacted by the proposal in their existing context would be undertaken prior to works commencing.	RMS	Pre-construction
31	Impacts to	• Prior to commencement of works, an exception under	RMS	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
	former Ingleburn Defence Site	Section 139 of the *NSW Heritage Act 1977* would be obtained for impacts to identified relics within the proposal area.		
32	Impacts to former Ingleburn Defence Site	• A condition survey would be undertaken before the start of work by a qualified contractor to minimise vibration impacts in the vicinity of Bardia Barracks (refer to noise and vibration safeguards Section 6.7.5).	Construction contractor	Pre-construction
33	Impacts to former Ingleburn Defence Site	• A fenced exclusion zone would be established around the original fabric of the entrance to Bardia Barracks and the entrance gates to the oval, in order to prevent incidental impacts during construction. If necessary, insulating material would be used to further protect the fabric from accidental damage.	Construction contractor	Pre-construction
34	Impacts to former Ingleburn Defence Site	• Further consideration of the configuration of the path and both sets of entry gates to Mont St Quentin oval would be undertaken in detailed design (as per the Statement of Heritage Impacts (Artefact Heritage 2013)).	RMS	Detailed design
35	Impacts to former Ingleburn Defence Site	• Impacts to the trees on either side of Campbelltown Road in the vicinity of the former Ingleburn Defence Site road would be minimised or avoided where possible. Where trees are removed, similar species would be replanted along roadsides following the completion of works.	RMS and construction contractor	Detailed design and construction
36	Impacts to former Ingleburn Defence Site	• If the draft SHR listing for the Ingleburn Military Heritage Precinct and Mont Saint Quentin Oval is finalised prior to the commencement of works, a Section 60 permit would be obtained from the NSW	RMS	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		Heritage Council prior to commencement of works at this location.		
37	Impacts to unanticipated heritage items	• If unexpected archaeological remains or potential relics are uncovered during the works, all works would cease in the vicinity of the material/find and the RMS Unexpected Archaeological Finds Procedure 2012 would be followed.	RMS and construction contractor	Construction
38	Impacts to water quality	• During detailed design an Erosion and Sedimentation Management Report is to be prepared. The report is to include: - Proposed staging plans for the project to ensure appropriate erosion and sediment control measures are possible. - The likely run-off from each road sub-catchment and direction of off and on site water flow. - Diversion of off site water around or through the site. - The direction of runoff and drainage points during each stage of construction. - The locations and sizing of sediment basins / sumps. - Appropriate scour protection for all drainage outlets, bridge abutments and the creek diversion and realignment. - Requirements for erosion and sediment controls during construction according to the Department of Housing's publication *Managing Urban Stormwater – Soils and Construction*.	RMS	Detailed design

No.	Impact	Environmental safeguards	Responsibility	Timing
39	Impacts to water quality	• A soil conservationist from the RMS Erosion, Sedimentation and Soil Conservation Consultancy Services Register is to be engaged to review the Erosion and Sedimentation Management Report.	RMS	Detailed design
40	Impacts to water quality	• A Soil and Water Management Plan (SWMP) would be prepared as part of the CEMP in accordance with the requirements of RMS contract specification G38 prior to the commencement of construction. The SWMP would also address the following: - The *RMS Code of Practice for Water Management.* - The *RMS Erosion and Sedimentation Procedure* (RTA, 2008). - The *Blue Book- Managing Urban Stormwater: Soils and Construction, Volume 1and 2* (Landcom, 2004). - RMS Technical Guidelines – Temporary Stormwater Drainage for Road Construction (RMS, 2011).	Construction contractor	Pre-construction
41	Impacts to water quality	• The SWMP would also address the following: - Identification of catchment areas and the direction of on-site and off-site water flow - The likely run-off from each road sub-catchment - Separation of on-site and off-site water - The direction of run-off and drainage points during each stage of construction - The locations and sizing of sediment traps such as	Construction contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		sump or basin. - The locations of other erosion and sediment control measures (eg rock check dams, swales, scour protection and sediment fences) - The staging plans, location, sizing and details of creek alignment and relaingment controls for scour protection and bank and bed stabilisation including those used during construction and long term. - Location and staging of scour protection - Include progressive site specific Erosion and Sedimentation Control Plans (ESCPs). The ESCP is to be updated at least fortnightly. - Process for monitoring and preparing for wet weather. - The SWMP is to be reviewed by a soil conservationist and would be updated to address the recommendations - Provision of an inspection and maintenance schedule for ongoing maintenance of temporary and permanent erosion and sedimentation controls.		
42	Impacts to water quality	• A rain event plan is to be included and shown on the ESCP which outlines the controls to be implemented in preparation for a rain event.	Construction contractor	Pre-construction and construction
43	Impacts to water quality	• Measures would be put in place to make sure any debris from the construction of the bridges over Maxwells Creek is captured prior to reaching the waterway.	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
44	Impacts to water quality	• Progressive re-vegetation and mulching of the proposal area would be undertaken as each section of work is completed.	Construction contractor	Construction
45	Construction impacts to drainage lines and flow paths causing scouring	• Restoration of the natural creek geomorphology would be undertaken to reduce velocity and scour during high flow events and ensure natural bed forms, such as an alternating sequence of pools, riffles and runs.	Construction contractor	Construction
46	Construction impacts to drainage lines and flow paths causing scouring	• Channel bank and bed stabilisation measures would be maintained until riparian vegetation is completely re-established.	Construction contractor	Construction
47	Spills	• Emergency wet and dry spill kits would be kept on site at all times. All staff would be made aware of the location of the spill kit and trained in its use.	Construction contractor	Construction
48	Spills	• All refuelling of vehicles and equipment on site would be undertaken on an impermeable surface, within a bunded area located at least 40 m away from water bodies and surface water drains.	Construction contractor	Construction
49	Spills	• Any fuel, oils or other liquids stored on site would be stored in an appropriately sized impervious bunded area away from water bodies.	Construction contractor	Construction
50	Flooding due to increases in peak flow	• Further flood modelling, including a detailed afflux assessment, would be undertaken during detailed	RMS	Detailed design

No.	Impact	Environmental safeguards	Responsibility	Timing
	velocities	design to confirm impacts to surrounding land uses.		
51	Soils and water quality	• Environmental Work Method Statements (EWMS) would be prepared for high risk activities such as: - Clearing and grubbing. - Earthworks - Creek realignment works. - Works around the bridge and culverts. - Drainage works. - Utilities works. - Bridge and culvert construction works.	Construction contractor	Pre-construction and construction
52	Soils and water quality	• EWMS must include the following: - Description of the works/activities including machinery. - Outline of the sequence of the work/activities, including interfaces with other construction activities. - Identification of potential environmental risks/impacts due to the works/activities and associated with wet weather events. - Evaluation of methods to eliminate/reduce the environmental risk. - Mitigation measures to reduce environmental risk. - Any safeguards resulting from consultation with public authorities and other stakeholders, where appropriate. - A map indicating the locations of sensitive locations	Construction contractor	Pre-construction and construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		(such as threatened species), likely potential environmental impacts, and work areas. - Identification of work area and exclusion areas. - Operational and monitoring measures to eliminate/reduce environmental impact. - A process for assessing and reporting the performance of the implemented environmental control measures. - A process for resolving environmental issues or conflicts and reporting outcomes		
53	Soils and water quality	• Control measures at egress points to minimise dirt and mud tracking.	Construction contractor	Construction
54	Soils and water quality	• All stockpiles would be designed, established, operated and decommissioned in accordance with *RMS Stockpile Management Procedures* (RTA 2011a). Stockpile sites would be located: - At least 50 metres from the nearest waterway. - In an area of low ecological and heritage conservation significance. - At least 100 metres distance from residential dwellings and other land uses that may be sensitive to noise. - On relatively level ground. - Outside the 1 in 10 year ARI floodplain.	Construction contractor	Construction
55	Soils and water	• Topsoil would be stockpiled separately for possible	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
	quality	reuse for the landscaping and rehabilitation works.		
56	Soils and water quality	• An accredited soil conservationist would be engaged to regularly inspect works throughout the construction phase.	Construction contractor	Construction
57	Soils and water quality	• Any material transported onto pavement surfaces would be swept and removed at the end of each working day and prior to rainfall.	Construction contractor	Construction
58	Contamination	• A Stage 2 – Detailed site investigation in accordance with NSW EPA guidelines would be prepared and would include preparation of a sampling, analysis and quality plan in accordance with the RTA Contaminated Land Management Guidelines 2005. This plan would include site specific sampling and analysis of soil at the following locations along Campbelltown Road: - The Caltex Service Station. - Ingleburn Army Barracks. - M & A Landscapes. - BP Service Station.	RMS	Pre-construction
59	Contamination	• Following the Stage 2 – Detailed site investigation, a Contaminated Land Management Plan would be prepared in accordance with the *Contaminated Land Act 1997 and* relevant OEH Guidelines as part of the CEMP and would include: - Outline of occupational health and safety measures - Contamination management measures.	RMS and construction contractor	Pre-construction and construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		- Incident reporting in according with the RMS Environmental Incident Management Procedure. - Identification of rehabilitation requirements, classification, transport and disposal requirements of any contaminated land within the construction footprint. • In the event that indications of contamination are encountered (known and unexpected, such as odorous or visually contaminated materials), work in the area would cease until an contamination assessement can be prepared to advise on the need for remediation or other action, as deemed appropriate.		
60	Construction traffic impacts	• A Traffic Management Plan (TMP) would be prepared as part of the CEMP. The TMP would be prepared in accordance with *Traffic Control at Worksites* (RMS 2010), *Australian standards AS1742* and the worksite manual *RMS Specification G10*. The TMP would be submitted in stages to reflect the progress of work and would outline: - Traffic control provided to manage and regulate traffic movements during construction, including minimising traffic switching. - Maintain the continuous, safe and efficient movement of traffic for both the public and construction workers. - Identification of haulage routes and ensuring impacts to local routes are minimised. - Determine temporary speed restrictions to ensure a safe driving environment around work zones.	Construction contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		- Provide access to local roads and properties, including the use of temporary turn-around bays. - Maintain pedestrian and cyclists access throughout construction. - Provision of appropriate warning and advisory signposting. - Include requirements and methods to consult and inform local community of impacts on local road network and traffic. - Consider other developments that may also be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic.		
61	Access	• Property access would be maintained at all times, including pre-schools, places of worship and all commercial premises.	Construction contractor	Construction
62	Access	• More frequently or heavily affected residents would be contacted for specific issues like driveway access or other issues that arise through construction.	Construction contractor	Construction
63	Temporary impact on bus services	• Access to bus stops and safe stopping locations would be maintained during construction in consultation with bus operators. • Ongoing updates on locations and access to bus stops would be provided to the community during construction period to ensure that disruption is minimised.	RMS and construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
64	Construction noise	• A Construction Noise and Vibration Management Plan (CNVMP) in accordance with OEH/EPA's *Interim Construction Noise Guideline* (DECCW 2009) would be prepared as part of the CEMP. This plan would detail the mitigation, monitoring and community liaison measures and would include but not be limited to: - Identification of potentially affected properties and residences (including a detailed map). - A map indicating the locations of likely potential impacts. - A risk assessment to determine potential risk for activities likely to affect residents. - Mitigation measures to reduce excessive noise during construction activities including those associated with truck movements, for example localised plywood barriers (at least 10 kg/m^2) to provide shielding. - A process for assessing the performance of the implemented mitigation measures. - A process for identifying management measures for highly noise affected receivers including consultation with affected residences. - A process for resolving issues and complaints.	Construction contractor	Pre-construction
65	Construction noise	• Where practical, equipment would be selected to minimise noise emissions. Equipment would be fitted with appropriate noise control equipment and be in	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		good working order.		
66	Construction noise	• Where practical, the layout and positioning of noise-producing plant and activities on each work site would be optimised to minimise noise emission levels.	Construction contractor	Construction
67	Construction noise	• Works would be carried out during standard working hours (ie 7am – 6pm Monday to Friday, 8am –1pm Saturdays). Any work that is performed outside normal work hours or on a Sunday or public holiday is to minimise noise impacts in accordance with *RMS's Environmental Noise Management Manual Practice Note 7 – Roadworks Outside of Normal Working Hours* (RTA 2001) and the *Interim Construction Noise Guidelines (DECC 2009)*.	Construction contractor	Construction
68	Construction noise	• The contractor would review their CNVMP in response to complaints and amend where practical throughout the construction phase. This would include consideration of respite periods.	Construction contractor	Construction
69	Vibration	• Where vibration is found to exceed project criteria, management measures would be implemented to control vibration. In terms of human comfort criteria, measures would include modifications of construction methods and respite periods. For potential structural damage impacts, modification of construction methods or equipment would be necessary.	Construction contractor	Construction
70	Vibration	• The CNVMP would include an assessment of the structures such as buildings that need building condition surveys in particular, heritage items, including the gates to the Ingleburn Military Heritage Precinct.	Construction contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
71	Operational noise	• During the detailed design stage of the proposal, further investigations of all feasible and reasonable mitigation options would be undertaken for affected receivers in accordance with the Road Noise Policy (DECCW 2011) and *RTA's Environmental Noise Management Manual Practice Note 4* (RTA 2001).	RMS	Detailed design
72	Operational noise	• Where practicable, any mitigation measures provided to control operational noise impacts shall be implemented as early as practicable to also provide a benefit during some of the construction phase.	Construction contractor	Construction
73	Air quality and dust	• An Air Quality Management plan (AQMP) would be prepared as part of the CEMP. The plan would include but not be limited to the following: - A procedure for monitoring dust on site and weather conditions. - Identification of dust generating activities and associated mitigation measures. - Limits on the area that can be opened up or distributed at any one time. - Compliance with *RMS Stockpile Site Management Guidelines* (2011). - Progressive stabilisation plans.	Construction contractor	Pre-construction
74	Dust	• Measures such as covering loads and water spraying unsealed access roads and open areas during conditions conducive to dust generation would be used to minimise or prevent air pollution and dust.	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
75	Dust	• Vehicles transporting waste or other materials that may produce odours or dust are to be covered during transportation.	Construction contractor	Construction
76	Exhaust emissions	• Construction equipment (including all internal combustion engines) would be properly maintained to ensure exhaust emissions are minimised where practicable and comply with the *Protection of Environment Operations Act 1997* (PoEO Act).	Construction contractor	Construction
77	Exhaust emissions	• Machinery would not be kept idling when not in use.	Construction contractor	Construction
78	Improving energy efficiency and sustainability	• Machinery onsite would be running efficiently to ensure optimal performance, minimise down time and improve fuel efficiency.	Construction contractor	Construction
79	Climate change and greenhouse gas	• Detailed design would take into consideration the potential effect of climate change on the proposal, including drainage requirements.	RMS	Detailed design
80	Climate change and greenhouse gas	• The energy efficiency and related carbon emissions would be considered in the selection of vehicle and plant equipment.	Construction contractor	Pre-construction and construction
81	Climate change and greenhouse gas	• Equipment would be serviced frequently to ensure they are operating efficiently.	Construction contractor	Construction
82	Landscape character and	• If cut-off drains or swales are required as a permanent fixture, their location, size and treatment would be	RMS	Detailed design

No.	Impact	Environmental safeguards	Responsibility	Timing
	visual impacts	finalised during detailed design so that they blend into the landform and landscape character.		
83	Precinct 5: Vegetation clearance and erection of 8 m high batter as part of bridge duplication	• During construction, the use of fill through this zone would be minimised. • Trees would be retained where possible as screening.	RMS and construction contractor	Detailed design and construction
84	Precinct 6: Vegetation clearing.	• The following would be investigated further during detailed design: - Vegetation screening along the boundary fence. - Dense tree planting along the boundary of designated open space areas.	RMS	Detailed design
85	Precinct 7: Vegetation removal and widening	• Tree and shrub planting would be established early, particularly in areas closest to existing buildings, such as at the Watch Tower Bible and Tract Society property where possible. • Use of designated open space areas at Mont St Quentin Oval and near the intersection of Zouch Road to increase the density of tree planting along the road corridor would be investigated during detailed design.	RMS and construction contractor	Detailed design and construction
86	Precinct 8: Road corridor widening and increased cut and fill batters.	• Tree and shrub planting would be established early where possible. • The heritage post and rail fence would be salvaged for relocation and reconstruction along the new boundary as detailed in the Non-Aboriginal Heritage Assessment and Statement of Heritage Impact (Artefact Heritage	RMS and construction contractor	Detailed design and construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		2013), Appendix M. • Subtle landmark planting along Denham Court Road at intersection would be investigated during detailed design.		
87	Vegetation clearance	• Revegetation of cut/fill batters would be undertaken with local species of trees, shrubs and groundcovers.	RMS and construction contractor	Detailed design and construction
88	Retaining walls	• Visually recessive materials, textures and colours would be used for retaining walls to reduce their visual dominance and blend with the landscape of this area. • Screen planting would be used to reduce the visual dominance of retaining walls where possible.	RMS	Detailed design
89	Landscape character and visual impacts	• The landscape and urban design strategy for the proposal would be finalised during detailed design in consideration of design principles and objectives as described in Section 3.2 of the REF and Appendix C	RMS	Detailed design
90	Landscape character and visual impacts	• Bridge design and integration with the existing one would follow Bridge Aesthetics – design guidelines to improve the appearance of bridges in NSW (RTA, 2003).	RMS	Detailed design
91	Impacts on businesses and the community during construction	• A complaints handling procedure and register would be included in the CEMP.	Construction contractor	Pre-construction and construction
92	Impacts on businesses and the community	• Access would be maintained wherever possible. Prior to any unavoidable disruption to access, consultation would be undertaken with the affected property owner.	Construction contractor	Pre-construction and construction

No.	Impact	Environmental safeguards	Responsibility	Timing
	during construction			
93	Impacts on businesses and the community during construction	• Safe access to bus stops would be maintained at all times and bus companies would be advised prior to any changes to traffic conditions.	Construction contractor	Pre-construction and construction
94	Impacts on businesses and the community during construction	• Cyclist and pedestrian access would be maintained although may need to be altered during construction to ensure safety.	Construction contractor	Construction
95	Impacts on businesses and the community during construction	• Residents would be informed prior to any interruptions to utility services that may be experienced as a result of utilities relocation.	Construction contractor	Pre-construction and construction
96	Impacts on businesses and the community during construction	• Road users, pedestrians and cyclists would be informed of changed conditions, including likely disruptions to access during construction.	Construction contractor	Pre-construction and construction
97	Impacts on businesses and the community during construction	• Community consultation would be undertaken in accordance with the RTA *Community Involvement Practice Notes and Resource Manual.*	Construction contractor	Pre-construction and construction
98	Impacts to	• Property acquisition would be managed in accordance	RMS	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
	property owners due to land acquisition for construction	with the provisions of the RTA's *Land Acquisition Policy* and the *Land Acquisition (Just Terms Compensation) Act 1991.*		
99	Increases in production of waste materials	• A Resource and Waste Management Plan (RWPM) would be developed as a component of the CEMP, which would include: - The type and volume of all materials. - Destinations for each resource/waste type either for on-site reuse or recycling, off-site reuse or recycling, or disposal at a licensed waste facility. - Quantity and classification of excavated material generated as a result of the proposal. - Disposal strategies for each type of material. - Details of how waste would be stored and treated on-site. - Identification of all non-recyclable waste. - Identification of strategies to 'avoid', 'reduce', 'reuse', and 'recycle'. - Identification of available recycling facilities on and off site. - Identification of suitable methods and routes to transport waste. - Procedures and disposal arrangements for unsuitable excavated material or contaminated material. - Site clean-up for each stage.	Construction contractor	Pre-construction and construction

No.	Impact	Environmental safeguards	Responsibility	Timing
100	Increases in production of waste materials	• Waste management measures developed in accordance with the waste hierarchy established under the WARR Act for the proposal would be included in the CEMP. • Training in waste management principles would be included in site inductions. • Types of waste collected, amounts, date/time and details of disposal shall be recorded in a waste register.	Construction contractor	Pre-construction and construction
101	Sourcing of recycled materials	• RMS contractors would be required to propose recycled-content materials where they are cost and performance competitive.	Construction contractor	Construction
102	Reuse and recycling of materials	• Workspaces would be maintained, kept free of rubbish and cleaned up at the end of each working day.	Construction contractor	Construction
103	Waste disposal	• Solid and liquid wastes, as well as fuels, lubricants and chemical containers would be disposed of in accordance with OEH requirements. • Suitable waste disposal locations would be identified and used to dispose of litter and other wastes on-site. Suitable containers would be provided for waste collection. • Material identified for recycling shall be stockpiled in an adequately bunded area (in accordance with the *RMS Stockpile Site Management Guidelines,* 2011). • Fuel and chemical storage areas would be	Construction contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		appropriately sized and imperviously bunded.		
104	Procurement	• Procurement would endeavour to use materials and products with a recycled content and low carbon footprint where it is cost and performance effective to do so.	Construction contractor	Pre-construction and construction
105	Waste management	• All wastes would be managed in accordance with the Protection of the Environment Operations Act 1997.	Construction contractor	Construction
106	Waste management	• A dedicated concrete washout facility would be provided during construction so that runoff from the washing of concrete machinery and equipment could be collected and disposed of at an appropriate waste facility.	Construction contractor	Construction
107	Cumulative impacts during construction	• Works would be staged to avoid and minimise impacts along the entire length where possible.	Contractor	Construction
108	Cumulative impacts during construction	• Cumulative impacts would be incorporated into the traffic, noise and vibration, and air quality management plans as required.	Contractor	Pre-construction and construction
109	Cumulative impacts during construction	• Cumulative impact management measures within the CEMP would be reviewed in response to any complaints received.	Contractor	Construction

7.3 Licensing and approvals

Table 7-90 lists all of the relevant licenses, permits, notifications and/or approvals needed to construct/operate the proposal.

Table 7-90: Summary of licensing and approvals required.

Requirement	Timing
In accordance with Section 199 of the *Fisheries Management Act 1994*, RMS would have to give the Minister written notice and consider any matters raised by the Minister in order to carry out any dredging and reclamation activities within a waterway. It is likely that the proposal would temporarily cause a barrier to fish passage during the construction of culverts and Maxwells Creek bridge and accordingly a permit to block fish passage would be required under Section 220(1) of the Act. Notification would be given to the Minister and any matters raised by the Minister would be considered within 28 days after the giving of the notice.	This would be obtained prior to any dredging and reclamation being undertaken. This would be obtained prior to disruption to fish passage should Maxwells Creek be determined 'Key Fish Habitat' by Department of Primary Industries (Fisheries).
The proposal would impact upon 2 Aboriginal heritage sites and one site complex. An Aboriginal Heritage Impact Permit (AHIP) under Section 90 of the *National Parks and Wildlife Act 1974* would be required for disturbance to known Aboriginal heritage sites as identified in Section 6.2 of this REF.	An Aboriginal Heritage Impact Permit (AHIP) would be obtained prior to any construction works that may impact the identified sites.
A Section 60 application would be required due to impact on the curtilage of Denham Court. A Section 60 application would also be required due to impacts to the Ingleburn Military Heritage Precinct and Mont St Quentin Oval if they are listed on the SHR prior to commencement of construction. An exception permit under Section 139 of the *Heritage Act 1977* would be required prior to commencement of works at the former Ingleburn Defence Site.	This would be undertaken prior to commencement of works on or near Denham Court and/or the Ingleburn Military Heritage Precinct and Mont St Quentin Oval. This would be undertaken prior to the commencement of works on or near the former Ingleburn Defence Site.
The proposal would be a scheduled activity under the *Protection of the Environment Operations Act 1997*. An environment protection license would be required under Section 48 of this Act to	This would be required prior to undertaking the proposed work. Each period of 12 months (commencing from the issue of a license) is a license fee period for a license. The administrative

authorise the carrying out of scheduled development work. For the purposes of section 48, any activity that is declared by this Part to be a scheduled activity is taken to be an activity for which a license is required for the premises at which it is carried out (the activity is 'premises-based').	fee for any license fee period of a license must be paid not later than 60 days after the beginning of that license fee period.
Relocation of the threatened Cumberland Plain Land Snail would require a licence issued under Section 91 of the *Threatened Species Conservation Act 1995*. NPWS has prepared *Policy for the Translocation of Threatened Fauna in NSW* (NPWS 2001) which guides the planning and implementation of translocation programs for threatened fauna in NSW and the relocation plan would be developed in accordance within this guideline.	A relocation licence would be obtained prior to relocation of the Cumberland Plain Land Snail.

8 Conclusion

This chapter provides the justification for the proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the proposal is in the public interest. The proposal is also considered in the context of the objectives of the EP&A Act, including the principles of ecologically sustainable development as defined in Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*.

8.1 Justification

The proposal has been developed through consideration of a number of options and selection of a preferred option through a detailed options analysis process. Three options were assessed, including a 'do nothing' approach. The proposal, as described in Section 3, was selected as the preferred option because it best addresses the proposal objectives and strategic and operational needs of the SWGC. Some of the key features of the proposal include:

- Alleviation of congestion and improvement in travel times.
- Improved safety through installation of new signalised intersections, turning lanes at intersections and a wider central median.
- Improved safety and accessibility for cyclists and pedestrians.
- Accommodation of 100 year ARI flood events.

8.2 Objects of the EP&A Act

This section demonstrates how the proposal is consistent with the objectives of the EP&A Act. The below table summarises how the proposal performs against the objects of the Act, and references earlier sections of this REF where greater detail is provided.

Object	Comment
5(a)(i) To 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.	The proposal would contribute to the continued management of traffic and facilitation of development of the SWGC, by ensuring that Campbelltown Road continues to provide an acceptable level of service (refer to Chapter 2). The upgrade will be designed and constructed so as to maintain the environmental values of the surrounding area (refer to Chapter 6).
5(a)(ii) To encourage the promotion and co-ordination of the orderly economic use and development of land.	The proposal would facilitate improved efficiency of transport within the SWGC corridor. The upgrade would reduce travel costs and times, and help strengthen the economic viability of the SWGC corridor by integrating with planned development (refer to Section 6.6).
5(a)(iii) To encourage the protection, provision and co-ordination of communication and utility services.	A Strategic Assessment of Utilities has been prepared (Appendix E). This has identified several utility services within

	the proposal area, including: Sydney Water, Telstra, Optus, Vodafone, Jemena Gas, Gorodok Gas, Endeavour Energy and TransGrid. Potential impacts on these utilities have been identified, including relocations, adjustments and protection work (Section 3.5). This will be considered further during detailed design.
5(a)(iv) To encourage the provision of land for public purposes.	This proposal includes the upgrade of a major public road and provision of a shared pathway for cyclists and pedestrians. Works will also be undertaken to compensate for loss of vegetation communities in the form of offsets (refer to Section 6.1).
5(a)(v) To encourage the provision and co-ordination of community services and facilities.	Not relevant to the proposal.
5(a)(vi) To 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 proposal has been assessed against relevant environmental legislation that protects and conserves native animals and plants (including threatened species, populations and ecological communities, and their habitats), refer to Section 6.1.
5(a)(vii) To encourage ecologically sustainable development.	Ecologically sustainable development is considered in Sections 8.2.1 – 8.2.4 below.
5(a)(viii) To encourage the provision and maintenance of affordable housing.	Not relevant to the proposal.
5(b) To promote the sharing of the responsibility for environmental planning between different levels of government in the State.	Not relevant to the proposal.
5(c) To provide increased opportunity for public involvement and participation in environmental planning and assessment.	To date, consultation has included the Aboriginal community, with respect to Aboriginal heritage; councils and public agencies, in accordance with ISEPP requirements; DP&I, with regard to the Growth Centres SEPP; and DP&I, OEH and SEWPaC with regard to the biodiversity and offset requirements. Ongoing consultation will centre around obtaining community comments, feedback and suggestions on the proposal, particularly during the public exhibition of this REF.

The principles of ecologically sustainable development as defined under Section 6(2) of the *Protection of the Environment Administration Act 1991* have been incorporated into the concept design and considered as part of the environmental assessment of the proposal.

8.2.1 The precautionary principle

The precautionary principle requires evaluation of the threat of serious or irreversible harm to biodiversity. Options have been considered and assessed with the purpose of reducing the risk of serious and permanent impacts on the environment. Specialist studies were undertaken for the following issues to provide accurate and impartial information to assist in the evaluation of options and development of the proposal:

- Aboriginal heritage.
- Non-Aboriginal heritage.
- Ecology (aquatic and terrestrial).
- Flooding and drainage.
- Noise and vibration.
- Traffic and transport.
- Urban design and visual impact.

These specialist studies did not identify any issues that may cause serious and irreversible environmental damage as a result of the proposal. Best available technical information, environmental standards and measures have been used to minimise environmental risks.

8.2.2 Intergenerational equity

The intergenerational equity principle is concerned with ensuring that the current generation preserves natural and built assets so that wellbeing and productivity are not compromised for future generations. A preferred route alignment that minimises environmental impacts such as vegetation clearance within sensitive ecological areas and disturbance to or destruction of important heritage items, to ensure that such areas are conserved for future generations has been selected. In addition, the proposed road upgrade would provide for the future population growth in the SWGC by improving the capacity, safety and facilities of Campbelltown Road.

Should the proposal not proceed, the principle of intergenerational equity may be compromised, as future generations would inherit a lower level of service on the road transport network. The proposal would benefit future generations of road users by improving road safety and travel times, notwithstanding predicted increases in volume of traffic on Campbelltown Road.

8.2.3 Conservation of biological diversity and ecological integrity

This principle reinforces the previous two principles in requiring that the diversity of genes, species, and communities, as well as the ecosystems and habitats to which they belong, be maintained and improved to ensure their survival. A comprehensive assessment of the existing local environment has been undertaken in order to recognise and manage any potential impacts of the proposal on local biodiversity. Particular effort has been made at the design stage of the proposal to minimise impacts upon local biodiversity.

The proposal is not considered to significantly impact on biological diversity or ecological integrity. An Ecological Assessment and appropriate site-specific safeguards are provided in Section 6.1 and Appendix K of this REF.

8.2.4 Improved valuation, pricing and incentive mechanisms

This principle requires that costs to the environment are incorporated or internalised in terms of the overall project costs. This REF has examined the environmental

consequences of the proposal and identified mitigation measures for areas which may possibly experience adverse impacts. Implementation of these mitigation measures would result in an economic cost to RMS. The implementation of mitigation measures would increase both the capital and operating costs of the proposal. This signifies that environmental resources have been valued in economic terms during proposal concept design.

The proposed concept design has been developed with an objective of minimising potential impacts on the surrounding environment, thereby minimising costs to the environment.

8.3 Conclusion

The proposed Campbelltown Road upgrade between Camden Valley Way and Brooks Road is subject to assessment under Part 5 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity. This has included consideration of conservation agreements and plans of management under the NPW Act, joint management and biobanking agreements under the TSC Act, wilderness areas, critical habitat, impacts on threatened species, populations and ecological communities and their habitats and other protected fauna and native plants.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design development and options assessment. The proposal as described in the REF best meets the proposal objectives but would still result in some impacts on the surrounding environment in terms of noise, cultural heritage, biodiversity and landscape and visual amenity. Mitigation measures as detailed in this REF would ameliorate or minimise these expected impacts. The proposal would also ensure that Campbelltown Road can continue to provide an acceptable level of service by increasing capacity to cater for future increases in travel demand. On balance the proposal is considered justified.

The environmental impacts of the proposal are not likely to be significant and therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought for the proposal from the Minister for Planning under Part 5.1 of the EP&A Act. The proposal is unlikely to affect threatened species, populations or ecological communities or their habitats, within the meaning of the *Threatened Species Conservation Act 1995* or *Fisheries Management Act 1994* and therefore a Species Impact Statement is not required. The proposal is also unlikely to affect Commonwealth land.

The proposal would have a direct impact on 0.40 hectares of EPBC-listed CPW within the proposed Regional Park. Negotiations are ongoing around an offset strategy that will fulfil requirements stipulated in the Edmondson Park Conservation Agreement to suitably offset this impact to MNES. The proposal would have no further impacts to MNES.

9 Certification

This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.

Amanda McGuane
Associate Technical Director – Environment
Hyder Consulting Pty Ltd
Date:

I have examined this review of environmental factors and the certification by Amanda McGuane of Hyder Consulting and accept the review of environmental factors on behalf of Roads and Maritime Services.

Emma Davies Senior Project Manager
Roads and Maritime Services Sydney Region
Date:

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Terms and acronyms used in this REF

AHIMS	Aboriginal Heritage Information System
AHIP	Aboriginal Heritage Impact Permit
ANZECC	Australia and New Zealand Environment and Conservation Council
ARI	Average Rainfall Recurrence Interval
ATC	Former Australian Transport Council
CEMP	Construction environmental management plan
CPW	Cumberland Plain Woodland
DECC	Former NSW Department of Environment and Climate Change
DECCW	Former NSW Department of Environment, Climate Change and Water
DIPNR	Former Department of Infrastructure, Planning and Natural Resources
DO	Dissolved oxygen
DoP	Former NSW Department of Planning
DoS	Degree of saturation
DPI	NSW Department of Primary Industries
DP&I	NSW Department of Planning and Infrastructure
DUAP	Former NSW Department of Urban Affairs and Planning
EC	Electrical conductivity
EIA	Environmental impact assessment
ENV	Existing Native Vegetation
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
EPI	Environmental Planning Instrument
EPTC	Edmondson Park Town Centre
ESCP	Erosion and Sedimentation Control Plan
ESD	Ecologically sustainable development. Development which uses, conserves and enhances the resources of the community so that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased
FM Act	*Fisheries Management Act 1994* (NSW)
GCRF	Growth Centres Road Framework
Heritage Act	*Heritage Act 1977* (NSW)
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
KTP	Key Threatening Processes
LALC	Local Aboriginal Land Council
LCC	Liverpool City Council
LEP	Local Environmental Plan. A type of planning instrument made

	under Part 3 of the EP&A Act.
LGA	Local Government Area
LoS	Level of Service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
MASL	Metres above sea level
MVKM	Million vehicle kilometres
NES	Matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*
NOW	New South Wales Office of Water
Noxious Weeds Act	*Noxious Weeds Act 1993* (NSW)
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
OEH	NSW Office of Environment and Heritage
PACHCI	RMS Procedure for Aboriginal Cultural Heritage Consultation and Investigation
PAHs	Polycyclic aromatic hydrocarbons
PEI	Preliminary Environmental Investigation
PEMP	Project Environmental Management Plan
PoEO Act	*Protection of the Environment Operations Act* 1997
RCP	Reinforced concrete pipe
REF	Review of Environmental Factors
REP	Regional Environmental Plan
RFEF	Riverflat Eucalypt Forest
RMS	NSW Roads and Maritime Services
RUSLE	Revised Universal Soil Loss Equation
SAS	Site Audit Statement
SEPP	State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act.
SEWPaC	Australian Government Department of Sustainability, Environment, Water, Population and Communities
SHR	State Heritage Register
SoHI	Statement of Heritage Impact
SWGC	South West Growth Centre
SWMP	Soil and Water Management Plan
SWRL	South West Rail Link
TLALC	Tharawal Local Aboriginal Land Council
TMP	Traffic management plan
TNSW	Transport for New South Wales
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
USTs	Underground storage tanks
UXO	Unexploded ordinance
VEM	Visual Envelope Map
WM Act	*Water Management Act*, 2000
WSUD	Water sensitive urban design