Henry Lawson Drive Stage 1B

Soils, Surface Water and Groundwater Working Paper

Transport for NSW

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Glossary

Acronym	Definition
NSW AIP	NSW Aquifer Interference Policy
AFFF	Aqueous film forming foam
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines
ARI	Annual Recurrence Interval
ASS	Acid Sulphate Soils
ASSMP	Acid Sulphate Soils Management Plan
bgl	Below ground level
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CSSI	Critical State Significant Infrastructure
DPI	Department of Planning and Industries
DPIE	Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
DSI	Detailed Site Investigation
EP&A Act	Environmental Planning and Assessment Act 1979
ESMR	Erosion and Sediment Management Report
EPL	Environment Protection Licence
GDEs	Groundwater Dependant Ecosystems
GPT	Gross Pollutant Trap
ha	Hectares
HGL	Hydrogeological Landscape
KFH	Key Fish Habitats
kL	Kilolitres

Acronym	Definition
km	kilometre
ML	Megalitres
NorBe	Neutral or beneficial effect
NRAR	Natural Resources Access Regulator
NSW	New South Wales
PESA	Preliminary Environmental Site Assessment
PFAS	Per- and Poly-Fluoroalkyl Substances
PFOS	Perfluorooctane Sulfonic Acid
POEO	Protection of the Environment Operations Act 1997
PFOS	Perfluorooctane Sulfonate
REF	Review of Environmental Factors
SEAR	Secretary’s Environmental Assessment Requirement’s
SEED	Sharing and Enabling Environmental Data
SEPP	State Environmental Planning Policy
SSWGW	Soil, Surface Water and Groundwater
SWMP	Soil and Water Management Plan
TfNSW	Transport for NSW
VRZ	Vegetated Riparian Zone
WM Act	Water Management Act 2000
WQOs	Water Quality Objectives
WRP	Water Resource Plans
WSP	Water Sharing Plans

Executive summary

Transport for NSW (TfNSW) proposes the Stage 1B upgrade of Henry Lawson Drive between Auld Avenue to the north and Western Motorway (M5) to the south. The proposal aims to alleviate traffic issues at key intersections to meet growing demand as a result of residential, commercial, and industrial development.

The proposal consists of widening a 1.8-kilometre (km) section of Henry Lawson Drive motorway southbound and northbound to two lanes. Each lane will be 3.5 m wide, with the addition of a footpath on each side along the proposed road. The total area of the proposed Henry Lawson Drive Stage 1B project is approximately 13.4 hectares (ha). Construction is expected to take two years and commence in early 2024.

This report contains a desktop review of publicly available information and site visits to identify risks to soils, surface water and groundwater during the construction and operation of the proposal. Additionally, mitigations measures were identified on associated impacts.

The proposal area lies within different surface and groundwater catchments. For surface water, the proposal lies within the Georges River catchment. Regarding groundwater catchments, the proposal lies within two hydrogeological landscapes (HGL), Bankstown and Moorebank, with groundwater flowing through alluvial sediment in both HGLs. The majority of the proposal area is situated within an area of moderate to high risk of saline soils. There are possibly acid sulphate soils (ASS) present at the northern end of the proposal area.

The main concerns during construction to soils, surface and groundwater sources include erosion, sedimentation and contamination. Vegetation removal and earthworks could destabilise and erode exposed soils, especially along waterfront lands as proposed near Milperra Drain. With the risk of saline soils and ASS present within proposal area, unmitigated runoff from construction sites could increase the acidity and salinity of nearby waterways, including the Milperra Drain and Georges River, or leach into underlying groundwater aquifers. Other impacts to consider are contamination from accidental leaks and spill of hydrocarbons or grease from refuelling and operation of machinery and equipment.

During operation, the main impact is likely to be contamination arising from increased stormwater runoff from the increased impervious areas. Motor vehicles using the proposal will generate road dust that may contain heavy metals. Stormwater runoff will transport these road dusts into waterways, which may leach into groundwater sources. Additionally, greater volumes of runoff will introduce higher risks of scour and erosion at stormwater outlets, degrading the bank stability and exacerbating soil erosion if unmitigated.

A range of mitigation measures will be implemented during the detailed design, construction and operational phases of the project to minimise impacts to soils, surface water and groundwater. These include:

- Soil and Water Management Plan (SWMP) as part of the Construction Environmental Management Plan (CEMP) to mitigate soil erosion and water pollution during construction
- Acid Sulphate Soils Management Plan as part of the CEMP to address encountering and disturbing ASS during construction
- Erosion and Sediment Control Plan as part of the SWMP to minimise soil erosion and sediment transport to nearby waterways during wet weather events
- Dewatering Assessment and procedure to mitigate pollution from dewatered groundwater
- site-specific emergency spill plans to address accidental spills and leaks of hydrocarbons,

Additionally, the construction methodologies would consider the following:

- appropriately designed scour protection at stormwater discharge points.
- end-of-line water quality treatment of stormwater runoff.
- Management of stockpiles, material laydown areas and bulk chemical storage areas to minimise the risk of water pollution.

Overall, with the implementation of the proposed mitigation measures, the project is expected to have acceptable and minimal impacts on existing soil, surface water and groundwater resources and environmental values during both the construction and operation phases.

1 Proposal description

Transport for NSW (Transport) proposes to upgrade a 1.8-kilometre section of Henry Lawson Drive between Auld Avenue, Milperra and the approach to the M5 Motorway (known as the Henry Lawson Drive Upgrade Stage 1B) (the proposal). This include road widening to increase traffic capacity and improve travel time as well as upgrades of key intersections to enhance capability and driver safety. Key features of the proposal would include:

- widening Henry Lawson Drive from two to four lanes between Auld Avenue, Milperra and the M5 Motorway, Milperra with a raised central median
- upgrading the Henry Lawson Drive / Bullecourt Avenue signalised intersection, including:
  - an additional right-turn lane from Henry Lawson Drive (northbound) to Bullecourt Avenue (two right-turn lanes total)
  - an additional right-turn lane from Bullecourt Avenue to Henry Lawson Drive (northbound) (two right-turn lanes total)
  - converting the existing dedicated left-turn lane from Bullecourt Avenue to Henry Lawson Drive (southbound) into a dedicated left-turn slip lane
  - maintaining the dedicated left-turn lane from Henry Lawson Drive (southbound) to Bullecourt Avenue
- upgrading the Henry Lawson Drive / Pozieres Avenue signalised intersection, including:
  - a new dedicated right-turn lane from Henry Lawson Drive (southbound) to Pozieres Avenue
  - a new dedicated left-turn lane from Henry Lawson Drive (northbound) to Pozieres Avenue and relocation of the existing bus stop north of the intersection
- providing a new two-lane local link road between Auld Avenue and Keys Parade (about 160 metres), crossing over Milperra Drain, providing access to / from southbound lanes of Henry Lawson Drive and Auld Avenue, and removing up to eight parking spaces on Auld Avenue to accommodate the link road
- extending Raleigh Road about 120 metres to connect with Keys Parade at a roundabout, and removing the direct connection between Raleigh Road and Henry Lawson Drive
- converting the Henry Lawson Drive intersections to be left-in left-out only, at:
  - Ruthven Avenue
  - Whittle Avenue
  - Amiens Avenue
  - Ganmain Crescent
  - Fromelles Avenue
  - Hermies Avenue
- modifying the Bullecourt Avenue / Ashford Avenue intersection to better accommodate heavy vehicle movements
- constructing a three-metre-wide shared path:
  - on the western side of Henry Lawson Drive between Pozieres Avenue and Keys Parade
  - along Keys Parade, the new Auld Avenue local link road and the extended section of Raleigh Road
- reconstruction of some existing shared paths within the proposal area
- constructing a new footpath within the proposal area:
  - on the eastern side of Henry Lawson Drive between the Flower Power and Ingram Avenue
  - along the northern side of Ingram Avenue
  - along the eastern side of Fromelles Avenue

- installing new drainage infrastructure and water quality controls within the proposal area, including:
  - an upgraded longitudinal and transverse drainage pits and pipes network along Henry Lawson Drive
  - a bioretention basin between Henry Lawson Drive, Bullecourt Avenue and Fleurbaix Avenue and maintenance access to this basin
  - swales along Henry Lawson Drive and Keys Parade and installation of Gross Pollutant Traps
- construction activities and ancillary work, including:
  - relocation of utilities (including electrical, gas, water and telecommunications)
  - civil earthworks, drainage work, water quality controls and tie-in work to adjoining sections of Henry Lawson Drive and local roads
  - final roadworks including pavement, kerb and gutters, signs, road furniture, landscaping, lighting and line marking
  - new traffic signals and intelligent transport systems including, but not limited to, closed-circuit television
  - establishment of temporary ancillary facilities to support construction, including compound sites, site offices, stockpile and laydown locations, temporary access tracks and water quality devices.

The concept design would be further refined during detailed design to minimise environmental and social impacts and to consider community feedback to the exhibition of the REF. Key feautures of the proposal are presented in Figure 1-1

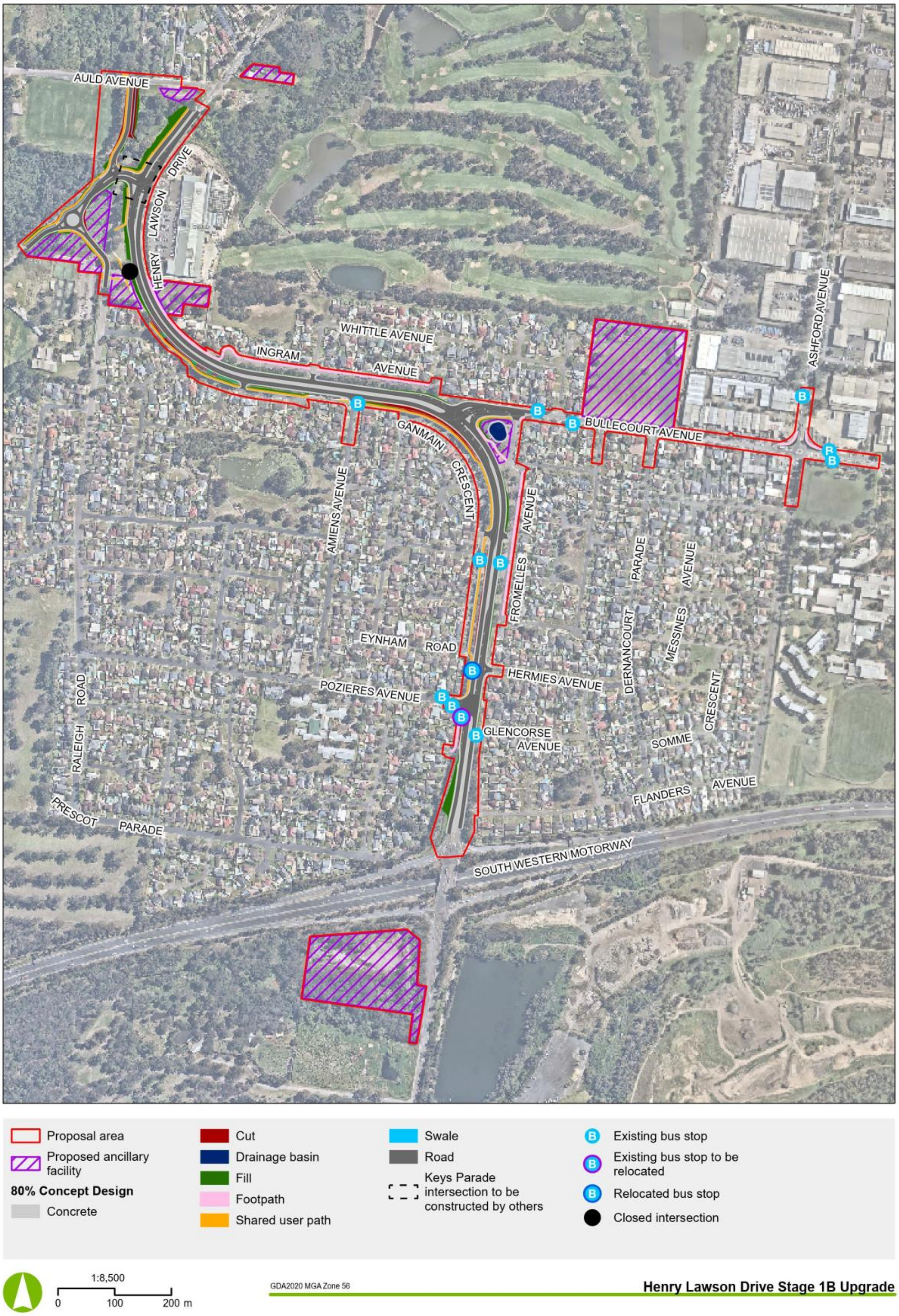
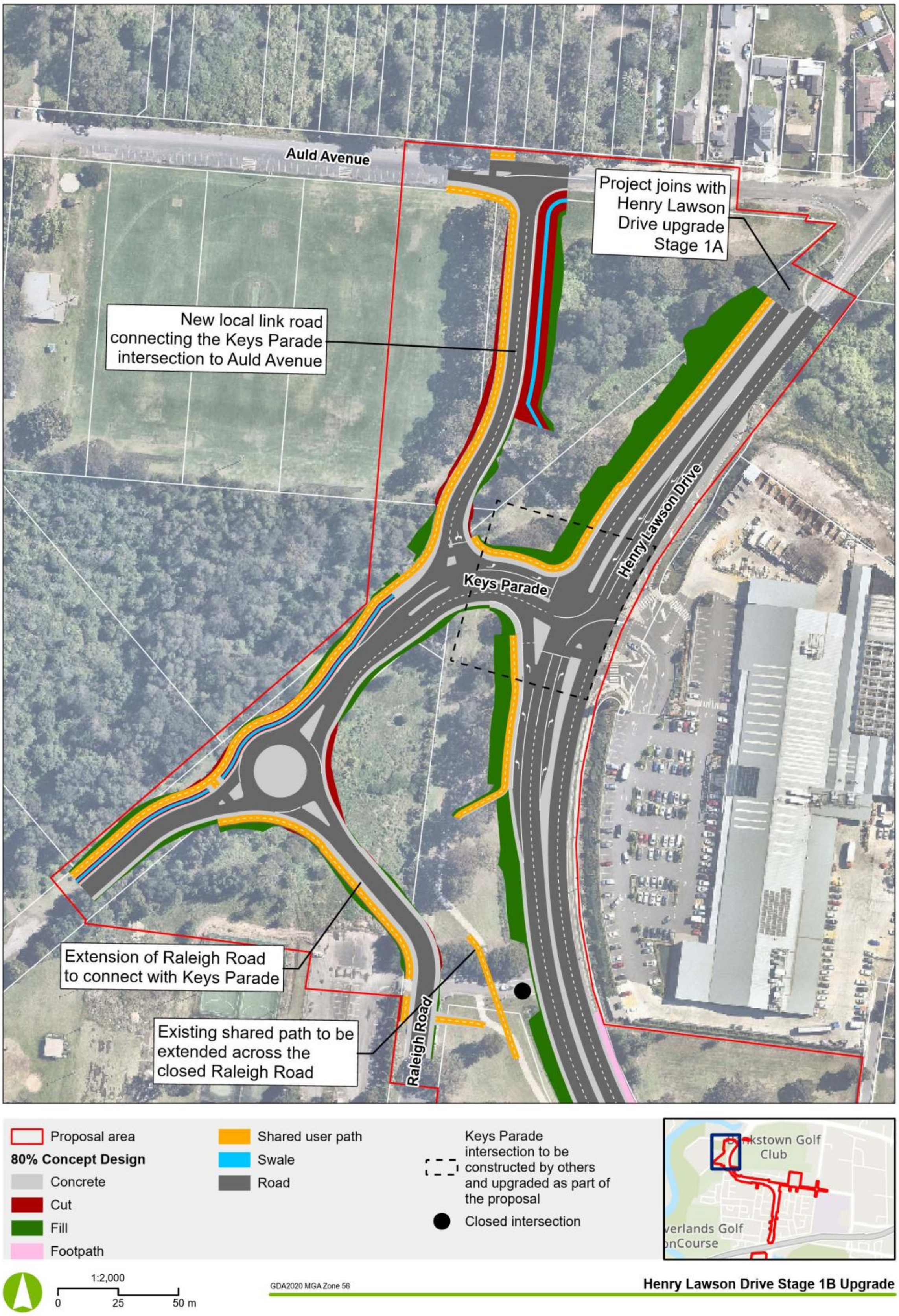
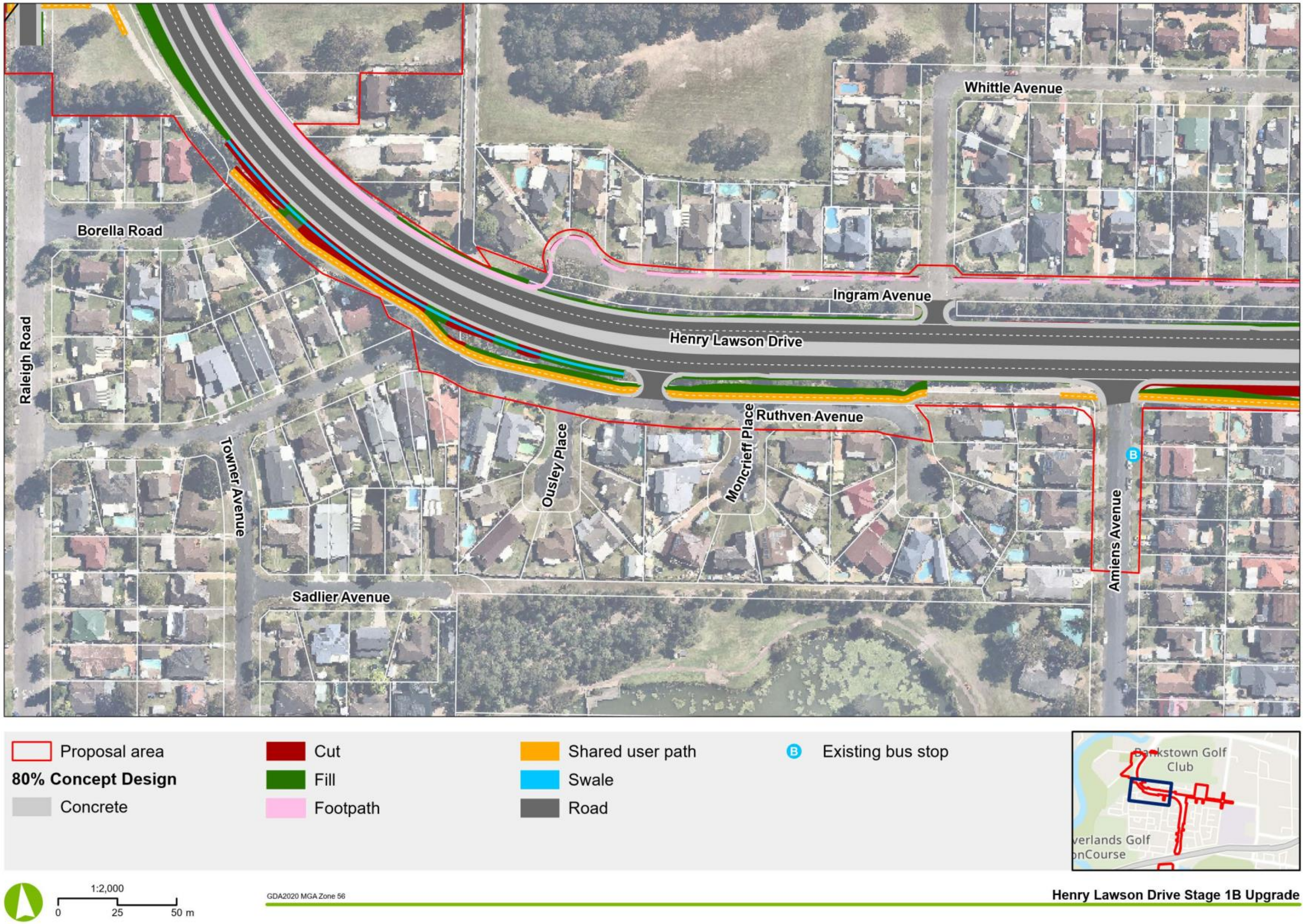
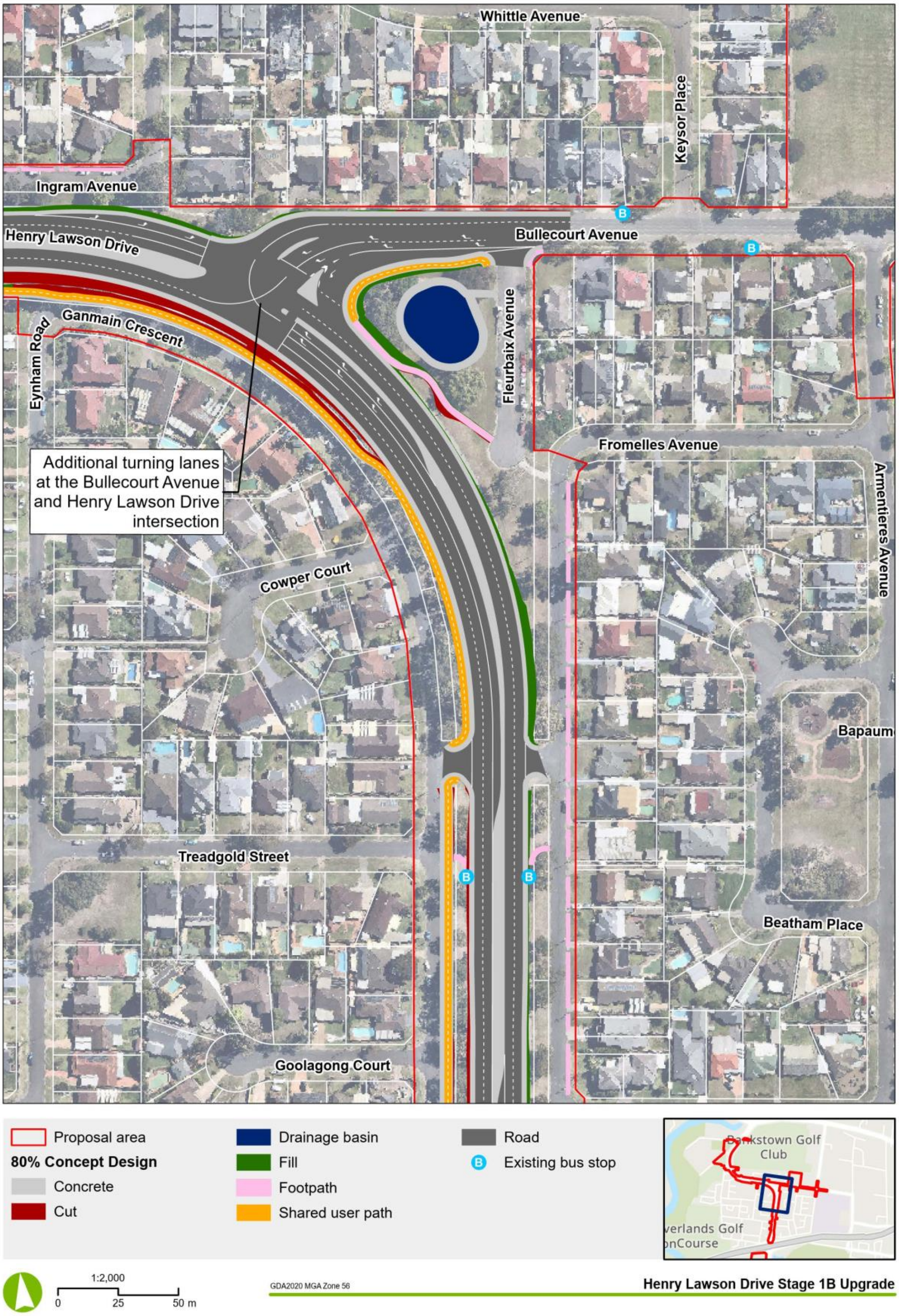


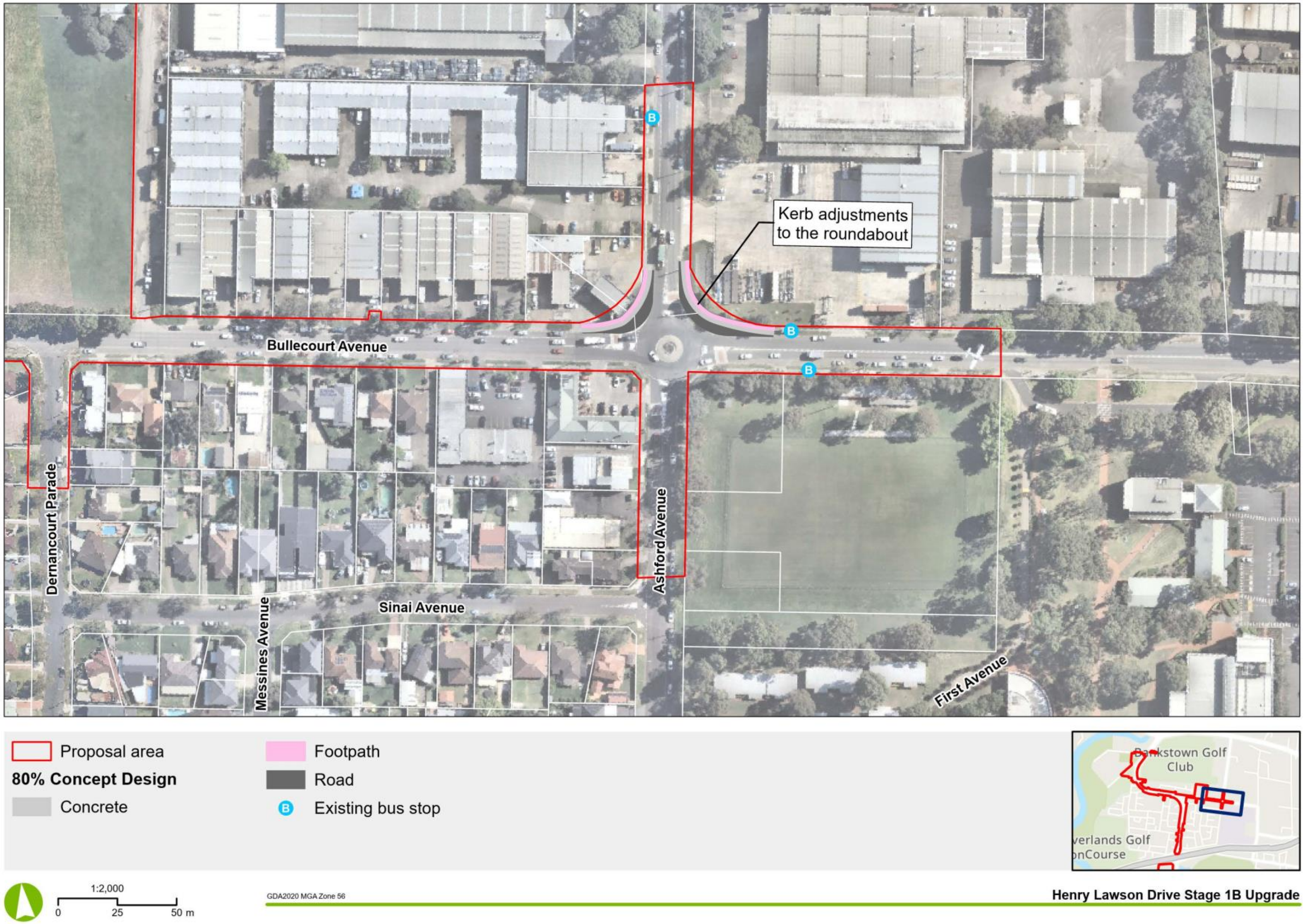
Figure 1-1 **Key features of the proposal**


Auld Avenue
Project joins with Henry Lawson Drive upgrade Stage 1A
New local link road connecting the Keys Parade intersection to Auld Avenue
Keys Parade
Henry Lawson Drive
Extension of Raleigh Road to connect with Keys Parade
Existing shared path to be extended across the closed Raleigh Road
Raleigh Road
Proposal area
80% Concept Design
Concrete
Cut
Fill
Footpath
Shared user path
Swale
Road
Keys Parade intersection to be constructed by others and upgraded as part of the proposal
Closed intersection
1:2,000
0
25
50 m
GDA2020 MGA Zone 56
Henry Lawson Drive Stage 1B Upgrade

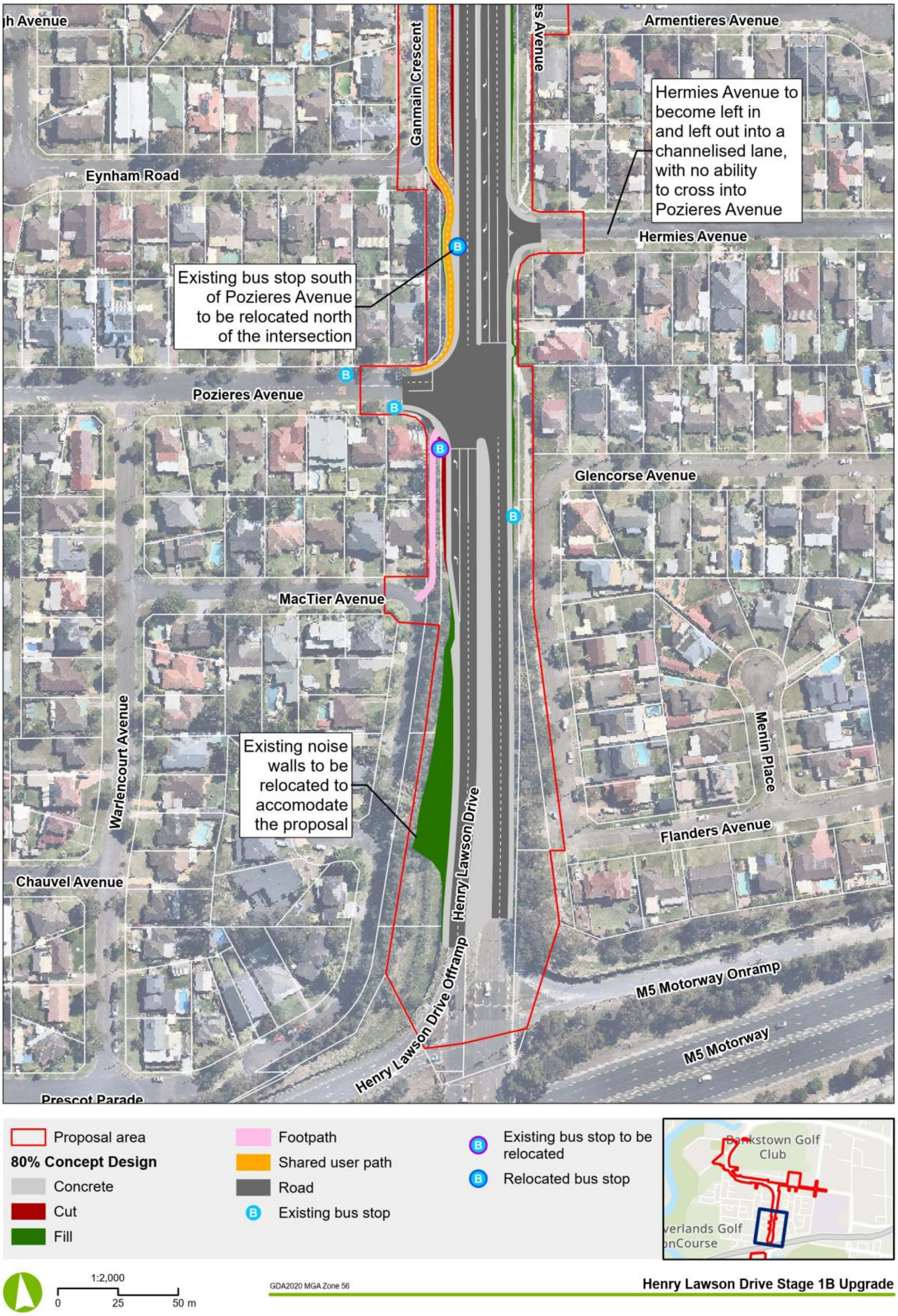

Whittle Avenue
Borella Road
Ingram Avenue
Henry Lawson Drive
Raleigh Road
Ruthven Avenue
Moncrieff Place
Ousley Place
Towner Avenue
Amiens Avenue
Sadlier Avenue
Proposal area
80% Concept Design
Concrete
Cut
Fill
Footpath
Shared user path
Swale
Road
Existing bus stop
Bankstown Golf Club
Overlands Golf Course
1:2,000
0
25
50 m
GDA2020 MGA Zone 56
Henry Lawson Drive Stage 1B Upgrade



Whittle Avenue
Keysor Place
Ingram Avenue
Henry Lawson Drive
Bullecourt Avenue
Ganmain Crescent
Eynham Road
Fleurbaix Avenue
Fromelles Avenue
Armentieres Avenue
Additional turning lanes at the Bullecourt Avenue and Henry Lawson Drive intersection
Cowper Court
Bapaum
Treadgold Street
Beatham Place
Goolagong Court
Proposal area
80% Concept Design
Concrete
Cut
Drainage basin
Fill
Footpath
Shared user path
Road
Existing bus stop
Bankstown Golf Club
1:2,000
0
25
50 m
GDA2020 MGA Zone 56
Henry Lawson Drive Stage 1B Upgrade



Henry Lawson Drive Stage 1B Upgrade



Armentieres Avenue
Ganmain Crescent
Eynham Road
Hermies Avenue to become left in and left out into a channelised lane, with no ability to cross into Pozieres Avenue
Hermies Avenue
Existing bus stop south of Pozieres Avenue to be relocated north of the intersection
Pozieres Avenue
Glencorse Avenue
MacTier Avenue
Menin Place
Warlencourt Avenue
Existing noise walls to be relocated to accomodate the proposal
Henry Lawson Drive
Flanders Avenue
Chauvel Avenue
Henry Lawson Drive Offramp
M5 Motorway Onramp
M5 Motorway
Prescot Parade
Proposal area
80% Concept Design
Concrete
Cut
Fill
Footpath
Shared user path
Road
Existing bus stop
Existing bus stop to be relocated
Relocated bus stop
Bankstown Golf Club
1:2,000
0
25
50 m
GDA2020 MGA Zone 56
Henry Lawson Drive Stage 1B Upgrade

2 Methodology

2.1 Report scope

The following report provides a Soil, Surface Water and Groundwater (SSWGW) Assessment Working Paper that was prepared by Aurecon to support the Stage 1B Proposal Review of Environmental Factors (REF). The purpose of this working paper is to assess the impacts of the project to soils, surface water and groundwater.

Key considerations for soils include:

- soil contamination
- salinity
- acid sulphate soils
- erosion risks.

Key considerations for surface water include:

- surface water quality
- geomorphology
- sedimentation impacts
- water supply and disposal.

Key considerations of this assessment with relation to groundwater include:

- Groundwater resource (e.g. resources (eg aquifer conditions, resource potential, vulnerability, recharge, levels)
- Groundwater users (e.g. irrigation, stock and domestic, commercial/industrial, potable water supply)
- Groundwater quality (physical parameters and chemistry)
- Groundwater dependent ecosystems (GDE) (e.g. watercourses, wetlands, springs).

2.2 Overview of approach

The steps and tasks listed below were carried out as part of the surface and groundwater assessment:

- desktop review of available information and data collation
- field verification: general regional walkover and targeted waterway geomorphological survey to define:
  - existing environment
  - potential construction and operational impacts
  - construction and operational mitigation measures
- assessment against relevant requirements and waterway objectives, evaluated on a qualitative basis
- write-up of impact assessment findings and identification of any appropriate management measures to be implemented during construction and operation.

2.3 Desktop review

A desktop review was conducted to gain an understanding of the existing conditions of the area. The defined study areas (**Section 2.3.1**) and the data sources (**Section 2.3.2**) were used to undertake the desktop study.

2.3.1 Study area

The study area includes the proposal footprint only (including any laydown areas) for soils and an arbitrary industry standard 1,600 metre radius around the centroid of the footprint for groundwater.

The study area for surface waters includes Milperra Drain, Newland Reserve Pond, Riverlands Golf Course Drain / Ponds and extending down gradient to the Georges River as the ultimate surface water receptor.

The surface and groundwater study area are shown in **Figure 2-1**.

Figure 2-1 **Study area**

2.3.2 Data sources

To support the understanding and documentation of the existing environment, including local watercourses, catchments and groundwater systems, the databases listed in **Table 2-1** were searched and the relevant data extracted to inform both the description of the existing environment as well as the significance of the potential impacts resulting from the project.

Table 2-1 Data sources

Data	Description	Source
Australia Groundwater Explorer	Database of registered bores, associated drilling, water depth and quality data.	http://www.bom.gov.au/water/groundwater/explorer/map.shtml
Climate Data	Rainfall and evaporation data from BoM and modelled data from SILO	http://www.bom.gov.au/climate/data/ https://www.longpaddock.qld.gov.au/silo/
Elevation Data	Elevation and topographical data	https://elevation.fsdf.org.au/
Erosion (Modelled)	Modelled erosion risk	https://datasets.seed.nsw.gov.au/dataset/modelled-hillslope-erosion-over-new-south-wales
GDE Atlas	GDE types and locations	http://www.bom.gov.au/water/groundwater/gde/
Geology	Seamless Geology of NSW	https://data.gov.au/dataset/ds-nsw-0e598ae6-f566-4036-aa61-3f1a1f73ade9/details?q=
Hydro-Line	The *Water Management (General) Regulation 2018* hydro line spatial data is a dataset of mapped watercourses and waterbodies in NSW. It is based on the Spatial Services (Department of Finance, Services & Innovation) NSW Hydro Line dataset. Dataset was used to determine Stream order.	https://www.industry.nsw.gov.au/water/licensing-trade/hydroline-spatial-data
Hydrologic Soil Groups	Hydrologic Soil Group data which indicates infiltration rates for different soil groups	https://datasets.seed.nsw.gov.au/dataset/hydrologic-groups-of-soils-in-nsw7f9e8
Key Fish Habitat	A policy definition of the term KFH was developed to guide the compilation of maps. KFH was defined to include all marine and estuarine habitats up to highest astronomical tide level (that are reached by 'king' tides) and most permanent and semipermanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank.	https://www.dpi.nsw.gov.au/fishing/habitat/publications/pubs/key-fish-habitat-maps
NSW River Style Database	The River Styles Database classifies river character, behaviour, condition and recovery potential. It has been used extensively in Australia and overseas to categorise river types and describe river behaviour.	https://water.dpie.nsw.gov.au/science-data-and-modelling/surface-water/monitoring-changes/river-styles-in-nsw
Ramsar Wetlands	National dataset of Australia's Ramsar Wetlands	https://data.gov.au/dataset/ds-dga-8f4b957c-a5af-42c2-86bc-1bf967675f3f/details

Data	Description	Source
Threatened Aquatic Species	Indicative distributions for a number of freshwater threatened species and populations in NSW were modelled using records collected over the last 20 years. They represent either the last remaining areas of known presence of those species in NSW, or river reaches that have a similar suite of environmental variables suitable for those species.	https://www.dpi.nsw.gov.au/fishing/threatened-species/threatened-species-distributions-in-nsw
Water Resource Plans	Location of the water resource plans which are applicable for surface water and groundwater.	https://data.gov.au/dataset/ds-dga-7b0c274f-7f12-4062-9e54-5b8227ca20c4/details https://data.gov.au/dataset/ds-dga-b027244a-726b-4201-b641-538295183d48/details?q=Murray-Darling%20Basin%20Water%20Resource%20Plan%20Areas%20%E2%80%93%20groundwater
Water Sharing Plans	Location of the Water Sharing Plans which are applicable for surface water and groundwater.	https://data.nsw.gov.au/data/dataset/surface-water-sharing-plan-water-sources https://data.nsw.gov.au/data/dataset/water-sharing-plan-groundwater-sources
Waterways and Water Bodies	Location of NSW defined waterways and waterbodies.	https://data.gov.au/dataset/ds-nsw-7cedd51b-d6c4-40b8-b08a-53abc824be87/distribution/dist-nsw-34beb27c-4c34-4967-8565-2b300b114980/details?q=
Wetlands	Location of wetlands within NSW Nationally important wetlands	https://data.nsw.gov.au/data/dataset/nsw-wetlands047c7 https://datasets.seed.nsw.gov.au/dataset/directory-of-important-wetlands-in-australia
WaterNSW Real-time data	Surface water monitoring sites and associated collected data.	https://realtimedata.waternsw.com.au/

2.4 Impact assessment

The impact assessment is based on identified key construction activities and their associated direct and indirect impacts on soils, surface water and groundwater, outlined in **Chapter 5**. Mitigation measures are presented **Chapter 6**. The Risk Matrix for the impact assessment along with the corresponding descriptions of consequence and likelihood levels are presented in **Table 2-2**, **Table 2-3** and **Table 2-4**.

Table 2-2 Likelihood Descriptor

Descriptor	Frequency	Probability
Almost Certain	Twice or more per year	Event will occur during the Project / period under review.
		High number of known incidents.
Likely	Once per year	Event likely to occur during the Project / period under review.
		Regular incidents known.
Possible	Once in 5 years	Event may occur in some instances during the Project / period under review.
		Occasional incidents known.
Unlikely	Once in 10 years	Event is not likely to occur during the Project / period under review.
		Some occurrences known.
Rare	Once in 20 years	Event will occur in exceptional circumstances during the Project / period under review.
		Very few or no known occurrences.

Table 2-3 Consequence Descriptors

Insignificant	Minor	Moderate	Major	Severe
Negligible change to hydrological/hydrogeological processes, water availability or water quality.	Short-term modification of hydrological/hydrogeological processes, water availability and quality within project tenure, but no change in beneficial use	Medium-term modification of hydrological/hydrogeological processes, water availability and water quality within project tenure, but no change in beneficial use. Short-term modification of hydrological processes, water availability and water quality outside project tenure, but no change in beneficial use.	Long-term modification of hydrological/hydrogeological processes, water availability and water quality within project tenure, but no change in beneficial use. Medium-term modification of hydrological processes, water availability and water quality outside project tenure, with change in beneficial use	Long-term or permanent modification of hydrological/hydrogeological processes, water availability or water quality outside project tenure, with impacts to a water-dependent environmental value and/or change in beneficial use.

Beneficial use for surface water refers to the NSW WQOs.

Table 2-4 Qualitative Risk Assessment

Risk Assessment		Most credible Consequence Level				
		Insignificant	**Minor**	**Moderate**	**Major**	**Severe**
Likelihood	**Almost Certain**	Medium	High	High	Extreme	Extreme
	Likely	Medium	Medium	High	High	Extreme
	Possible	Low	Medium	Medium	High	High
	Unlikely	Low	Low	Medium	Medium	High
	Rare	Low	Low	Low	Medium	Medium

3 Relevant legislation, policy and guidelines

This chapter presents relevant regulations, legislation and policy governing management of groundwater and surface water pertinent to the proposal.

3.1 NSW framework

Table 3-1 presents the NSW legislation, policies, guidelines and statutory requirements associated with surface water and groundwater assessments along with the relevance of these frameworks with respect to the proposal.

Table 3-1 NSW legislation, policy, and guidelines

Document	Relevance
Fisheries Management Act 1994 (FM Act)	Key Fish Habitats (KFHs) are defined under the *Fisheries Management Act 1994.* The presence of KFHs are an indication of ecological value of the waterway. There are KFHs in proximity of the proposal.
NSW Aquifer Interference Policy (2012)	Aquifer interference projects (i.e. activities with the potential to interfere with groundwater aquifers) are required to assess their impact on groundwater-dependent ecosystems (GDEs) and culturally significant sites that are groundwater-dependent. There are GDEs present in proximity to the proposal and groundwater levels are high with in the area, as such, there is the potential for aquifer interception.
NSW State Groundwater Dependent Ecosystems Policy (2002)	Construction and operation of the proposal should account for the principles and processes expressed in this policy in protecting GDEs. There are GDEs present in proximity to the proposal.
NSW State Groundwater Quality Protection Policy (1998)	Construction and operation of the proposal should account for the principles and processes expressed in this policy in protecting groundwater quality. Groundwater levels are high with in the area as such groundwater may be impacted by the proposal.

Document	Relevance
NSW Water Quality Objectives (2006)	The NSW Water Quality Objectives (WQOs) are the agreed environmental values and long-term goals for NSW's surface waters. They set out: ▪ The community's values and uses for rivers, creeks, estuaries and lakes (e.g. aquatic foods, healthy aquatic ecosystems, industrial, irrigation, livestock water supply, water suitable for recreational activities like swimming and boating, and drinking water) ▪ A range of water quality indicators to help assess whether the current condition of a waterway supports those values and uses. The key WQOs and nominated environmental values relevant to the Georges River include: ▪ Protection of Aquatic Ecosystems: ecological condition of waterways and the riparian zone. Physical and chemical water quality stressors can cause degradation of aquatic ecosystems. For the purpose of this assessment, indicators include dissolved oxygen, metals, nutrients, pH, salinity and turbidity. ▪ Protection of Visual Amenity: aesthetic qualities of waters. For the purpose of this assessment, indicators include colour, odour and transparency. ▪ Protection of primary and secondary contact recreation: water quality for recreational activities, where primary contact recreation implies direct contact with the water via bodily immersion or submersion with a high potential for ingestion (e.g. swimming, diving and water skiing), and secondary contact recreation implies some direct contact with the water would be made but ingestion of water is unlikely (e.g. boating, fishing and wading). Bacteriological indicators are used to assess the suitability of water for recreation. The proposal is located within the Georges River catchment and lowland rivers and estuaries objectives are relevant to this proposal. The WQOs guideline values that have been selected for this study are presented in **Appendix A.**
NSW River Flow Objectives (2006)	The NSW River Flow Objectives are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses. The following river flow objectives have been set for 'waterway affected by urban development' within the Georges River catchment: ▪ Maintain natural flow variability ▪ Maintain natural rates of change in water levels ▪ Maintain wetland and floodplain inundation ▪ Minimise effects of weirs and other structures. Unlike WQOs (**Appendix A**), there a no quantitative thresholds set for the River Flow Objectives so assessment of impact would need to be completed on a qualitative basis.
Water Act 1912, *Water Management Act 2000* and *Water Management (General) Regulation 2018*	The proposal is considered an exempt controlled activity under the *Water Management Act 2000* as the works are being carried out by a public authority under clause 41 of the *Water Management (General) Regulation 2018.*

3.2 National framework

Table 3-2 presents Australian legislation, policies, guidelines and statutory requirements associated with surface water and groundwater assessments, along with the relevance of these frameworks with respect to the proposal.

Table 3-2 National legislation, policy, and guidelines

Document	Relevance
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2000)	The proposal has the potential to impact surface water quality, thus construction and operation of the proposal must account for the aims of the Australian National Water Quality Management Strategy (NWQMS) to achieve the sustainable use of Australia's and New Zealand's water resources by protecting and enhancing their quality. This has been superseded by ANZG 2018. However, certain guideline values are still relevant where ANZG 2018 have not been updated for certain analytes.
Guidelines for groundwater quality protection in Australia (2013)	The proposal has the potential to impact groundwater quality. These guidelines are designed to support the overall objective of the National Water Quality Management Strategy 2018 (NWQMS), focusing on protecting and enhancing groundwater quality to support the nominated environmental values and preventing groundwater contamination.
National Water Quality Management Strategy (2018)	The proposal has the potential to impact water quality within the Georges River catchment. As such, the proposal should integrate water quality management strategies (consistent with NWQMS) such that the environmental values of the sensitive receiving waterways are not adversely impacted.
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018)	The proposal has the potential to impact surface water quality, given the absence of site-specific guideline values, the ANZG's give directions to default guideline values (DGVs) for a range of stressors relevant to different community values, such as aquatic ecosystems, human health and primary industries.

4 Existing environment

4.1 Climate

4.1.1 Historical records

A review of data available through the Bureau of Meteorology (BoM) – Monthly Statistics: Climate Data Online indicates that the nearest BoM weather station with sufficient coverage of rainfall data is in Bankstown (Bankstown Airport AWS) NSW approximately 3 km from the overall proposal area (BoM, 2022).

Rainfall values for the local area have been extracted from the long-term record (1968-2020). Key rainfall statistics for each calendar month over this period are summarised in **Table 4-1** and presented in **Figure 4-1** alongside monthly potential evaporation totals.

Table 4-1 Monthly mean rainfall showing 10th and 90th percentiles from 1970-2022

Average	83.7	107.9	114.5	82.5	71.7	79.7	44.3	49.9	44.3	63.2	72.3	69	72.0	883.6
10th percentile	19.6	16.1	23.2	15.3	7.2	12.4	2.2	2.8	5.6	3.9	16.3	12.8	12.6	137.6

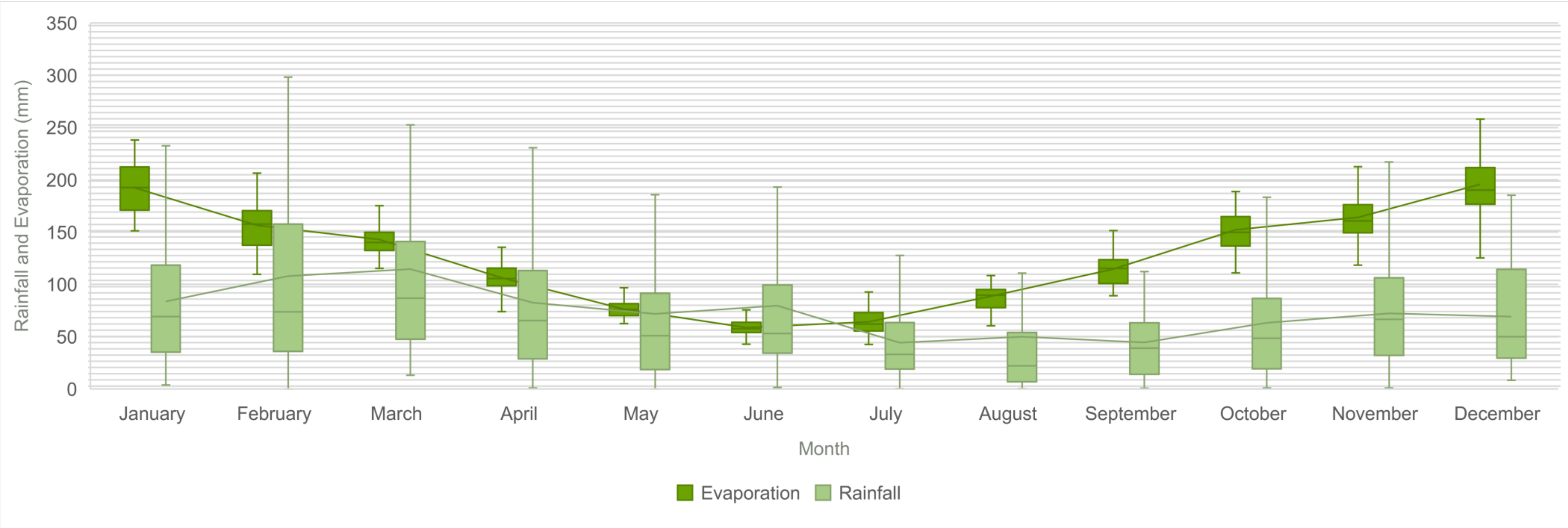


Figure 4-1 Range of total monthly rainfall and evaporation (1970-2022)

The available rainfall data shows that there has been a cyclic seasonal variation in total monthly rainfall from 1970-2022. These results show evidence of wetter (November – June) and drier (July – October) seasonality through comparison of monthly medians (**Table 4-1**). The variance in total monthly rainfall is higher during these wetter months, with July **-** September showing a smaller range of recorded values. Total monthly rainfall peaked during this 50-year period within the month of February, at 300 mm.

Potential evaporation results show strong seasonal trends and low variability, with higher rates occurring during the warmer summer months (October – March) as expected. Evaporation rates are lowest in June with a median of 55 mm, with the highest rates occurring in January, reporting a median of approximately 195 mm. This data also highlights that median monthly potential evaporation exceeds median monthly rainfall throughout the entire year, with the largest discrepancies occurring during the summer months of December and January.

Maximum and minimum monthly temperature ranges are presented in **Figure 4-2**. Analysis of climate records revealed the proposal area to have a temperate climate with warm and hot summers, with maximum temperatures averaging around 28˚C and minimum temperatures around 18˚C. Winters are cooler with average maximum temperatures around 18˚C and minimum temperatures averaging 6˚C.

Consecutive La Niña weather events and extreme rainfall exacerbated by climate change led to record widespread flooding along the east coast of Australia during 2021 and 2022. The severe storm events caused Henry Lawson Drive to experience major flooding throughout late March 2021 to early July 2022, particularly the northern portion of proposal area resulting in road closures.

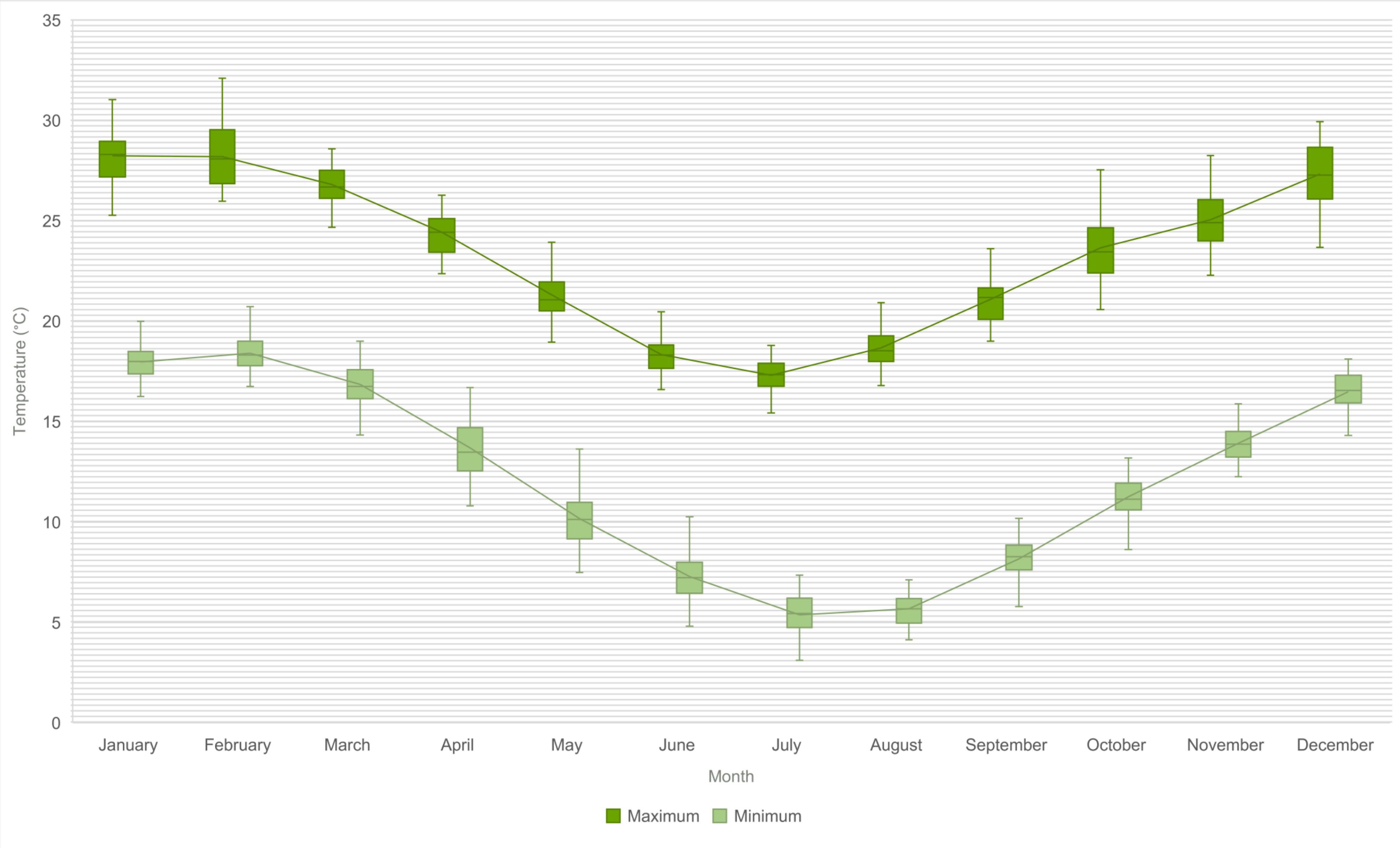


Figure 4-2 Minimum and maximum monthly temperatures (1970-2022)

4.1.2 Climate change

Consideration of potential climate change is a factor in assessing the impacts from this proposal, as it has the potential to influence the general environmental water balance as well as groundwater availability, soil and water salinity and water quality. Study results documented in ‘Climate change impacts on surface runoff and recharge to groundwater’ (Mark Littleboy et al. 2015) have been used in this working paper to assess expected local climatic changes in the proposal area.

NARCliM (the NSW and ACT Regional Climate Modelling project) predicted near future (2020-2039) and far future (2060-2079) changes to rainfall, runoff and recharge to groundwater (Littleboy et al., 2015). **Table 4-2** presents a summary of the statistical analysis for the Georges River Catchment.

Table 4-2 Per cent changes to multi-model mean annual rainfall, surface runoff and recharge

Catchment	Per cent change in near future (%) (2020-2039)			Per cent change in far future (%) (2060-2079)		
	Rainfall	Runoff	Recharge	Rainfall	Runoff	Recharge
Port Jackson and Georges River	+0.5	+5.5	-16.3	+8.7	+20	+13.2

Understanding of the physical processes that cause extreme rainfall, coupled with modelled projections, indicate with high confidence a future increase in the intensity of extreme rainfall events, although the magnitude of the increases cannot be confidently projected. The publication does not provide details regarding changes to flood-producing rainfall events other than to confirm that changes to rainfall intensity are predicted.

The ARR 2019 predicts a worst-case increase in rainfall intensity of nine per cent and 19.7% (20%) for the years 2050 and 2090, respectively.

Results from the ‘*'Practical Consideration of Climate Change' (2007)* publication showed a trend of increased rainfall intensities for the 40-year Average Recurrence Internal one-day rainfall event across NSW (**Table 4-3**).

Table 4-3 CSIRO indicative change in rainfall and evaporation one-day total (CSIRO, 2007)

Location	40 Year 1-day rainfall total projected change 2030	40 Year 1-day rainfall total projected change 2070	Evaporation projected change 2030	Evaporation projected change 2070
Sydney Metropolitan	-3% to +12%	-7% to +10%	+1% to +8%	+2% to +24%
NSW Average	-2% to +15%	-1% to +15%	+1% to +12%	+3% to +38%

These expected rainfall and evaporation changes support the NARCliM predictions (**Table 4-2**) as higher intensity storms will result in higher runoff volumes, whereas the increased evaporation rates will lead to reduced recharge, as suggested soon results.

The effect of these climate change predictions on hydrological behaviour will be important in considering the surface water and groundwater operational phase impacts for the proposal and could include:

- Runoff volume from the proposal area to receiving surface watercourses will increase, although the quantum of change is difficult to determine.
- The speed stormwater will reach these receiving watercourses is also likely to increase, due to lower interception, leading to a faster / ‘spiky’ hydrological response to rainfall (i.e. steeper ascending limb on the hydrograph).
- Rainfall events are expected to be more intense over time. Rainfall intensity that reaches the surface is expected to exceed the infiltration capacity of the soil or rock. This could generate more surface water runoff (also known as Hortonian Overland Flow). The higher the proportion of rainfall that becomes runoff

the less of the proportion of rainfall becomes groundwater recharge. Less groundwater recharge will lower groundwater levels, thus in the localised area in the near future, the rate of groundwater recharge is expected to be reduced. This could potentially disconnect streams that drew water from groundwater sources and cause the streams to switch from gaining to losing streams and could reduce inflows to the Georges and Nepean River, therefore reducing river levels. That paired with higher surface runoff rates will create a situation of greater variability in river water levels.

- Greater variability in river water levels will result from higher surface runoff rates and variable groundwater recharge rates.
- Possible higher tidal incursion range in the Georges Estuary due to the reduced force of downstream fluvial flows.

Temperature projections for Eastern Australia indicate higher average temperatures for the near future (2030) with the daily average expected to rise between 0.5 and 1.4°C above the average value recorded between 1986 and 2005. By late in the century (2090), for a high emission scenario (RCP8.5) the projected range of warming is 2.8 to 5.0 °C. Under an intermediate scenario (RCP4.5) the projected warming is 1.3 to 2.6 °C (Metropolitan Sydney, 2014). As average temperatures are predicted to rise in the future because of climate change, evaporation rates can be assumed to rise as well.

4.2 Topography

Topography of the proposal area and surrounding land is presented in **Figure 4-3**.

The proposal area for Stage 1B sits within a low-lying portion of the region, within the George's River floodplain. The proposal area ranges from 5 to 18 m above Australian Height Datum (AHD), with the highest points situated at the southern end of Henry Lawson Drive. The section of Henry Lawson Drive running easterly into Bullecourt Avenue has an average elevation of 6 m AHD, sloping west towards Georges River (0 m AHD). Elevation increases in a southerly direction towards South-Western Motorway, before it begins to decline again down to 5 m AHD nearby a surface water body on Bransgrove Road. The upper and lower limits of the proposal area sit upon a landscape that is highly weathered, with alluvial sediments forming level to very gently undulating plains, gently undulating low rises and alluvial terraces.

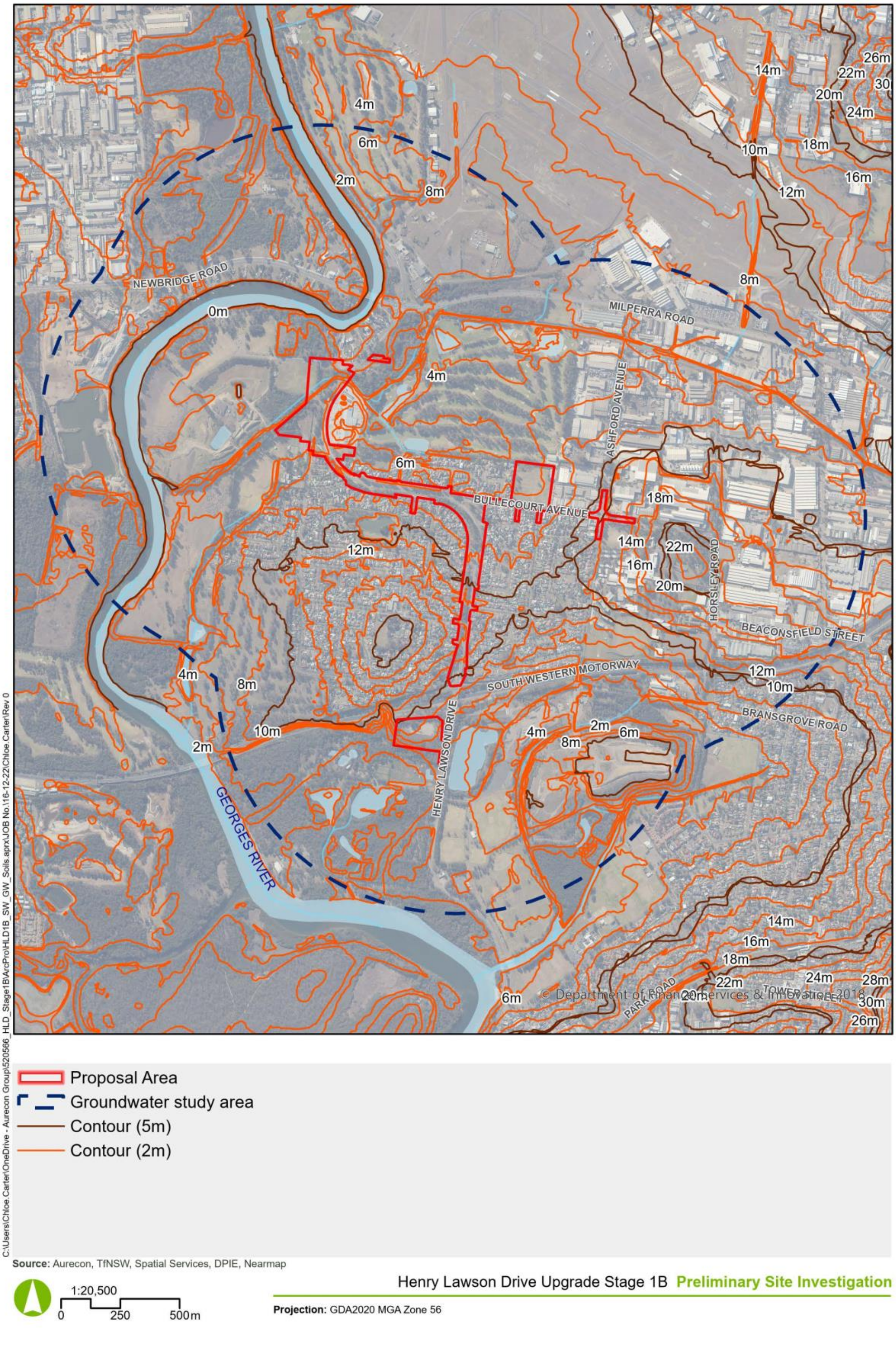


Figure 4-3 Topography

4.3 Catchment and surface water

4.3.1 Catchment overview

The overall proposal area is situated within the Georges River catchment, which spans 930 km^2 and covers a significant section of the Greater Metropolitan Region (Department of Planning, Industry and Environment 2018). Georges River extends about 60 km south-west of Sydney, with the waters in this catchment ultimately flowing east into Botany Bay. The Georges River catchment is one of the most urbanised and developed catchments in Australia, which has resulted in degraded water quality throughout most of the area. Land use varies across the catchment but includes protected areas such as drinking water catchments and conservation areas in the upper catchment (Department of Planning, Industry and Environment 2018). The Georges River catchment is presented in **Figure 4-4**.

4.3.2 Local water features

The Georges River (Strahler order 7 stream) is perennial and tidally influenced at the point adjacent to the proposal and flows south under estuarine/tidal conditions. The overall proposal area follows an already established roadway along a low-lying and flat floodplain of the Georges River.

The proposal is intersected by Milperra Drain (2^{nd} order stream) which flows from east to west along Milperra Road before running under Henry Lawson Drive and then cutting south-west into the Georges River. Milperra Drain at Henry Lawson Drive is natural and tidally affected, upstream it has recently undergone bank reconstruction with limestone banks by Council (adjacent to Milperra Road).

Scattered throughout the Bankstown Golf Course are approximately seven dams which from a desktop assessment appear to be connected to drains which are connected to Milperra Drain. Between Milperra Drain and Henry Lawson Drive there appears to be a string of ponds which are mapped as coastal wetlands.

There is another drain south-west of the proposal which flows north to south from near Piper Close and has three dams before discharging into Georges River. Newland Reserve Pond approximately 100m south of the proposal between the two bends of Henry Lawson Drive.

There are three large ponds and a smaller dam south of the proposal area. The pond south-eastern of the proposal would potentially take stormwater overland flow from Henry Lawson Drive.

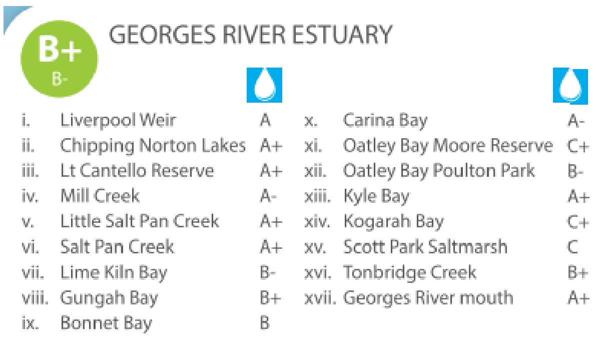
The majority of the Stage 1B footprint lies within the Milperra sub-catchment. In the southern extent, a small area lies within the Kelso Swamp (waterbodies in the south of the proposal area) sub-catchment. Local water features are presented in **Figure 4-4**.

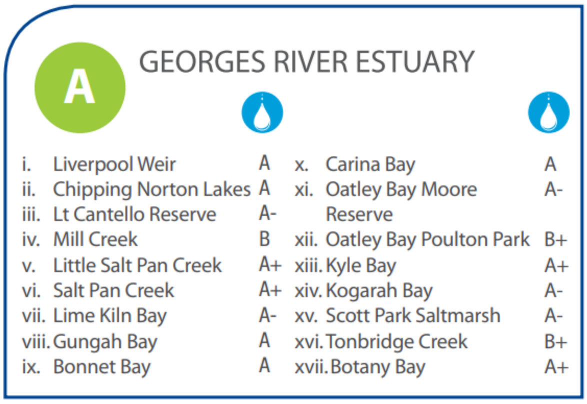
4.3.3 Water quality

WaterNSW and Georges River Keeper datasets were analysed to determine water quality within the Georges River catchment. The State of the Georges River 2020 (Georges River Keeper, 2020) provides an overview of the ecological state of the catchment as well as providing details on historical events that have impacted water health in this area. The river is in good ecological health within the upper catchment due to the prevalence of forested areas, resulting in more infiltration. In the central and more urbanised areas of this catchment, river health has been degraded, with the tidal influence having a positive impact in the lower catchment.

The proposal area sits within a significantly urbanised section of the Georges River Catchment, the Mid-Estuary Creek sub catchment, which has led to degraded river health (State of the Georges River, 2020). The main cause of this degradation is from significant volumes of stormwater that are delivered through runoff from urban areas in comparison with forested land, with sewage overflows and legacy pollutants also contributing (Georges River Keeper, 2020). Urban creeks are the main method of transport for stormwater runoff into the river, with impacts including eroded banks, altered channels, elevated pollutants, reduced biodiversity, and increased dominance of more tolerant aquatic species. Ongoing challenges in this region of the catchment include habitat loss, increased stormwater flows, sewage, litter, and runoff from urban areas.

The State of the Georges River (2020) provides an overview of the ecological health of each sub catchment, with grades assigned based on the condition of various environmental indicators. The proposal area sits within the Mid-Estuary Creek sub catchment, which was classified as having riparian vegetation, water quality and freshwater macroinvertebrates in poor condition. These indicators have received low ratings due to degraded riparian vegetation such as narrow strips of weedy vegetation along creek lines, polluted water and a low diversity of macroinvertebrates. Georges River Keeper complete fieldwork to inform river health grading. There are 17 estuary sites in the sampling network (Georges River Keeper, 2020). The captured data is used to grade conditions along the Georges River in terms of riparian vegetation, water quality and macroinvertebrate quality. The two most recently published report cards (Georges River Keeper, 2018) showed that the Georges River Estuary was overall allocated a B+ grade in 2018 Infographic 4-1 River Health Grades (adapted from Georges River Keeper, 2018)and an A grade in 2020 (or 'Good-Excellent' on a scale of A – Excellent to F – Poor).





(a) Georges River Estuary Section 2018 (b) Georges River Estuary Section 2020

Infographic 4-1 River Health Grades (adapted from Georges River Keeper, 2018)

The closest sampling site to the Study Area was Lt Cantello Reserve which was allocated an A+ in 2018 and an A- in 2020. These results may not be a true reflection on longer-term water quality conditions due to lower rainfall in the catchment in this period (Georges River Keeper, 2018). It is noted that stormwater generated flows in this urban catchment, with a population close to 1.5 million, transfers high pollutant loads into the river. Lower rainfall recorded during 2017-2018 mean that these pollutant loads were not washed into the river. Improved grades in the estuarine section indicates that tidal flushing leads to an improvement in water quality due to lower residence times, dilution of polluted stormwater and removal of polluted stormwater.

A search of the WaterNSW real-time database revealed no sites within a 5km radius that reported specific water quality data. Water quality was therefore retrieved from a Detailed Site Investigation (DSI) conducted by Aurecon in 2021 for the Henry Lawson Drive Stage 1A project, which is located north of the Stage 1B proposal (**Table 4-4**). The surface water samples were as follows:

- SW01: a drainage line north of the proposal, east of Henry Lawson Drive and at the south-west corner of Georges River Golf Course.
- SW02: in Milperra Drain upstream of the proposal and the north-east border of the Bankstown Golf Club, east of the proposal.
- SW03: in Milperra Drain, west of Henry Lawson Drive within the proposal area between Keys Parade and Auld Avenue.

Water Quality Objectives are outlined in **Appendix A**.

Table 4-4 Water quality data for major analytes at four locations near the proposal area (Aurecon, 2021)

Analyte	Units	Water Quality Guidelines	Sample ID		
			SW01	SW02	SW03
pH	-	**6.5 – 8.0**	7.38	7.76	7.66
Arsenic (III)	mg/L	**0.007**	0.004	< 0.001	< 0.001
Cadmium	mg/L	**0.0002**	< 0.0001	< 0.0001	< 0.0001
Chromium (III+VI)	mg/L	**0.0043**	< 0.001	< 0.001	< 0.001
Copper	mg/L	**0.0013**	0.006	0.004	0.002
Lead	mg/L	**0.0034**	< 0.001	< 0.001	< 0.001
Mercury	mg/L	**0.0004**	< 0.0001	< 0.0001	< 0.0001
PFOS	µg/L	**0.00023**	0.03	0.03	0.06
Nickel	mg/L	**0.07**	0.001	0.003	0.004
Zinc	mg/L	**0.008**	0.011	0.056	0.034

Key: = Within the water quality objective range; = Outside the water quality objective range

The majority of water quality parameters were within the water quality objective range at all sampling sites. Perflurorooctane Sulfonate (PFOS) and zinc, however, exceeded their water quality objectives at SW01, SW02 and SW03. No samples (except pH reading) were collected at SW04.

4.3.4 River styles

A river style can be described as a discrete river type, defined by its valley setting, bed material, planform, and geomorphic units. Classification of waterways into different river styles helps in producing a generic set of procedures, with tools for interpreting river behaviour, condition, and recovery potential. The predictive basis of this framework provides a solid foundation for decision-making when it comes to river management. Human activities have significantly impacted the inherent patterns and rates of river adjustment, altering overall behaviour. This is evident in the Georges River catchment, a heavily urbanised area, where runoff and pollution are impacting water quality and flow. The river style relevant to the stretch of Georges River alongside the proposal area is defined as a Laterally Unconfined Valley Setting, Continuous Terrace or cohesive floodplain, Low sinuosity, Planform Continuous, Fine Grained (abbreviated as LUV CC). The stream and vegetation condition in this region is classified as moderate. Stream condition, fragility and recovery potential are classified as 'moderate'.

No other waterbodies within the Study Area have been classified under the River Styles framework.

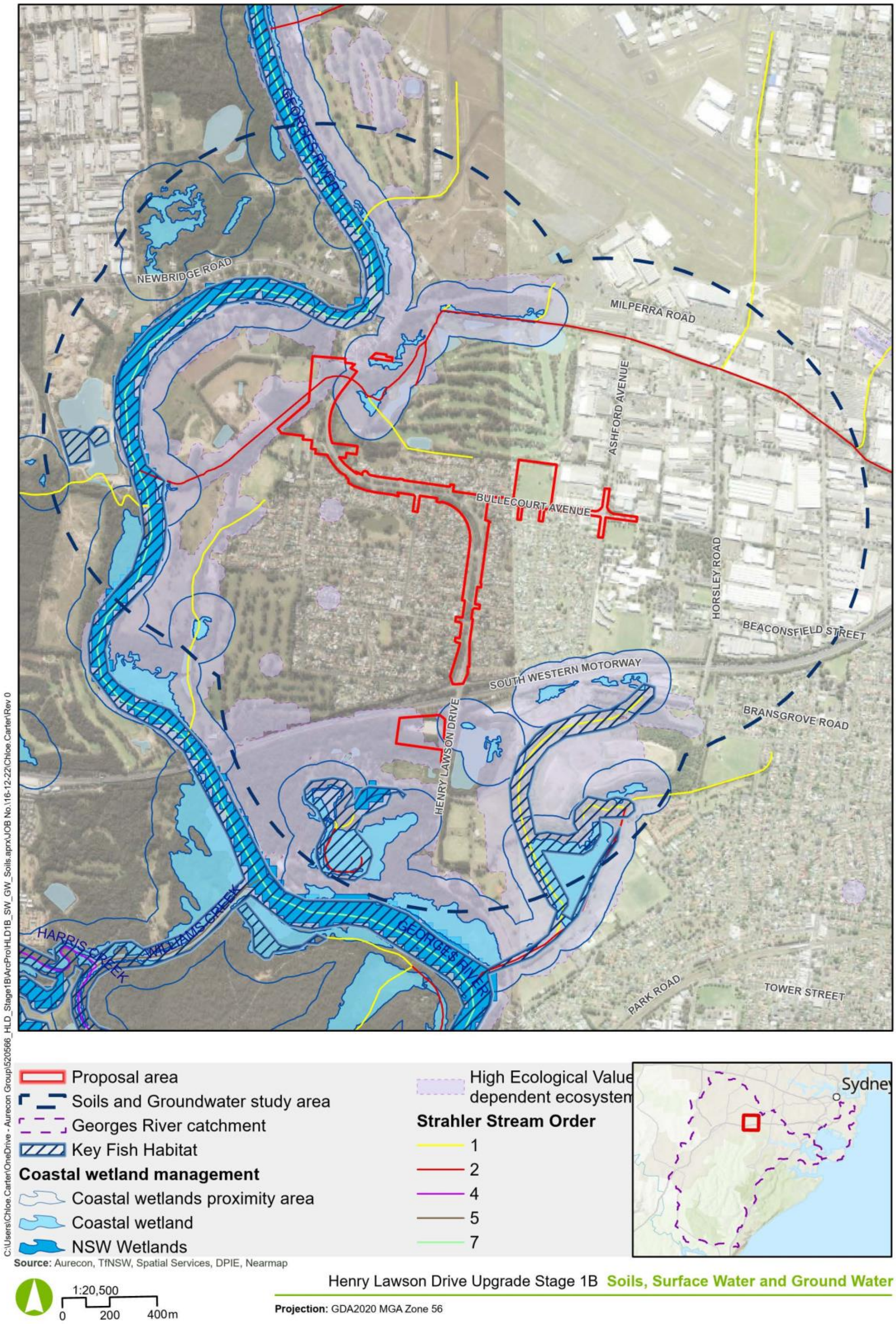


Figure 4-4 **Key surface water features**

4.4 Soils

4.4.1 Soil Landscapes

The proposal area stretches across two different soil landscapes. The central section of the planned upgrade is part of the Blacktown landscape, made up of gently undulating rises on Wianamatta Group shales (eSpade, 2022). The soils here consist of shallow to moderately deep hard setting mottled clay soils, red and brown Podzolic soils on crests grading to yellow Podzolic Soils on lower slopes and drainage culverts. A strong texture contrast exists between A and B horizons.

The northern and southern sections of the proposal area are part of the Richmond landscape, consisting of the Quaternary terraces of the Nepean and Georges rivers (eSpade, 2022). The soil landscape comprises poorly structured orange to red clay loams, clays, and sands. Texture may increase with depth and ironstone nodules may be present. Non-calcic Brown Soils, Red Earths and Red Podzolic Soils all occur here on terrace surfaces, with Earthy Sands found on terrace edges.

Soil landscapes present within the proposal area are shown in **Figure 4-5** and a summary of the Soil landscapes are presented in **Table 4-4**.

Table 4-4 Soil landscape summary

Soil Landscape	Common constraints (Landcom, 2004)	K-Factor (erodibility)	Erodibility and erosion hazard (eSpade)
Blacktown	Soils poorly drained with low fertility, localised high plasticity and expansive subsoils	0.038	Blacktown soil materials have moderate erodibility. The topsoils (bt1, bt2) are often hardsetting and they have high fine sand and silt content, but they also have high to moderate organic matter content. The subsoils (bt3, bt4) are very low in organic matter. Where they are also highly dispersible and occasionally sodic the erodibility is high. The erosion hazard for non-concentrated flows is slight to moderate but ranges from low to very high. Calculated soil loss during the first twelve months of urban development for topsoil and exposed subsoil tends to be low (7–11 t/ha). Soil erosion hazard for concentrated flows is moderate to high.
Richmond	High soil erosion hazard (particularly at terrace edge) and localised flooding hazards, localised salinity	0.059	The surface soils are moderately erodible. They have a high fine sand fraction and have low organic matter content. They are, however, not dispersible. The subsoils have very high erodibility due to very low organic matter and a high fine sand and silt content. They are also moderately dispersible. Due to low slopes and generally good vegetation cover the erosion hazard for non-concentrated flows on the Richmond soil landscape is low. During periods of drought or dry seasons this may increase in some areas. The calculated soil loss on the terrace surface in the first twelve months of urban development is low at 29 t/ha for topsoil and 49 t/ha for exposed subsoil. The erosion hazard for concentrated flows is moderate to high.

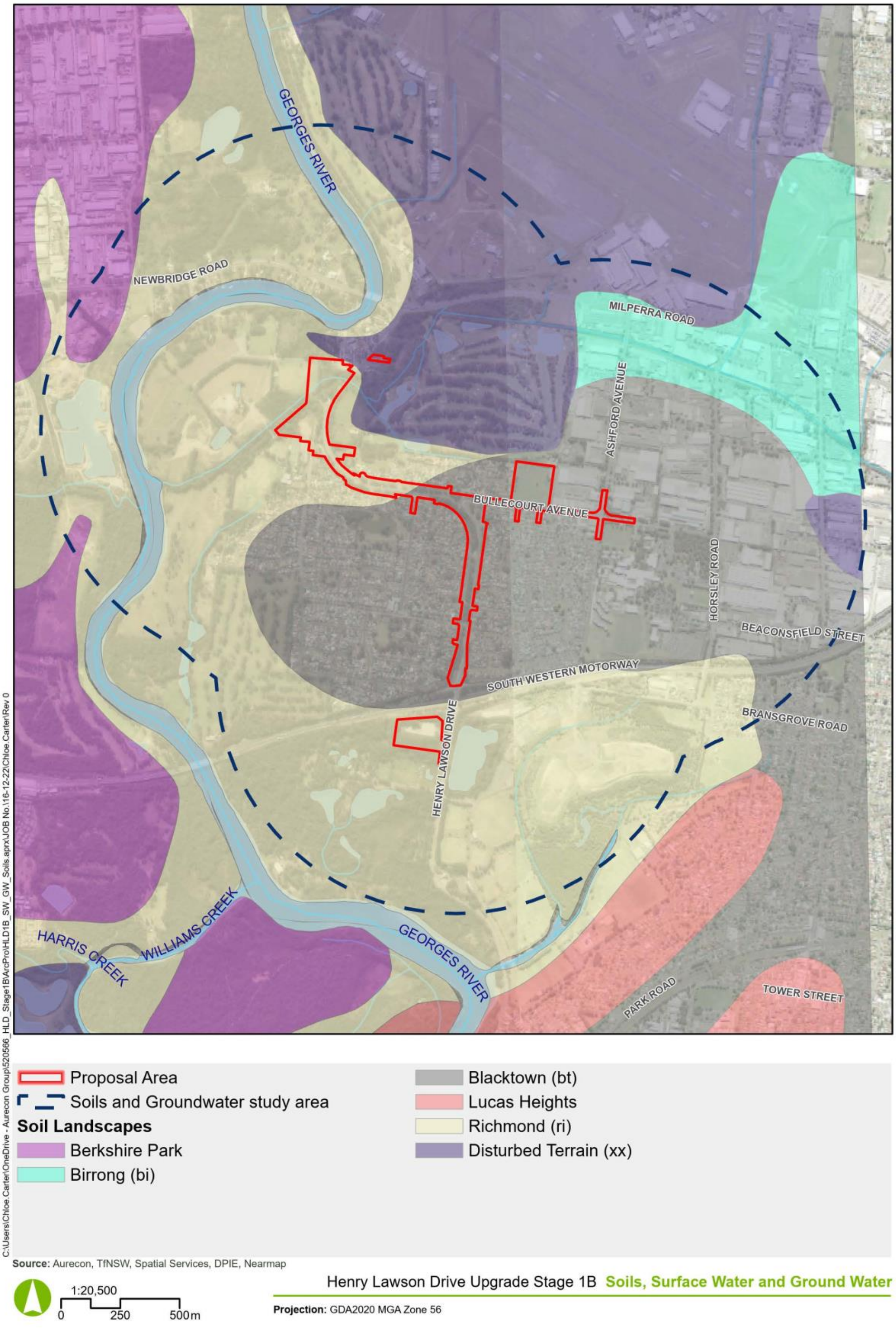


Figure 4-5 **Soil Landscapes**

4.4.2 Acid Sulphate Soils

Acid sulphate soils (ASS) are natural sediments that contain iron sulphides, formed from the process of sulphate reduction that often naturally occur in lakes, rivers, wetlands, and oceans (Australian Government, 2018). Acid sulphate soils are found most in coastal and estuarine wetlands, however, can also occur inland in waterways, wetlands, and drainage channels. ASS develop in waterlogged, saline, and anaerobic conditions. ASS is benign when left undisturbed in a waterlogged environment. When exposed to air, the iron sulphides in the soils react with atmospheric oxygen and water to produce sulphuric acid. Exposure to air occurs in response to a reduction in water levels within the hydromorphic zone of soils (e.g., during droughts and dredging operations).

The production of sulphuric acid can cause major cations and anions (such as Na^{+}, Mg^{2+}, Ca^{2+}, Cl^{-}, SO_4^{2-}), trace elements and metal ions (including Fe^{3+} and Al^{3+}) to be released and become mobile.

Inland ASS risk is determined by presence of waterways, wetlands and drainage channels and dryland salinity. The alignment is considered ‘high risk’ for inland ASS, given the presence of extensive floodplain soils and proximity to major waterway channels and wetlands (eSpade, 2022). A review of Geoscience Australia Portal revealed the risk of ASS within the proposal area. The northern and southern sections of Henry Lawson Drive were identified as being at high risk of ASS (High probability >3 m below ground surface), a small portion, south the high risk area, the road is classified as low risk (Low probability 1-3 m below ground surface) (eSpade, 2022). A map showing ASS risk for the proposal area can be seen in **Figure 4-6**.

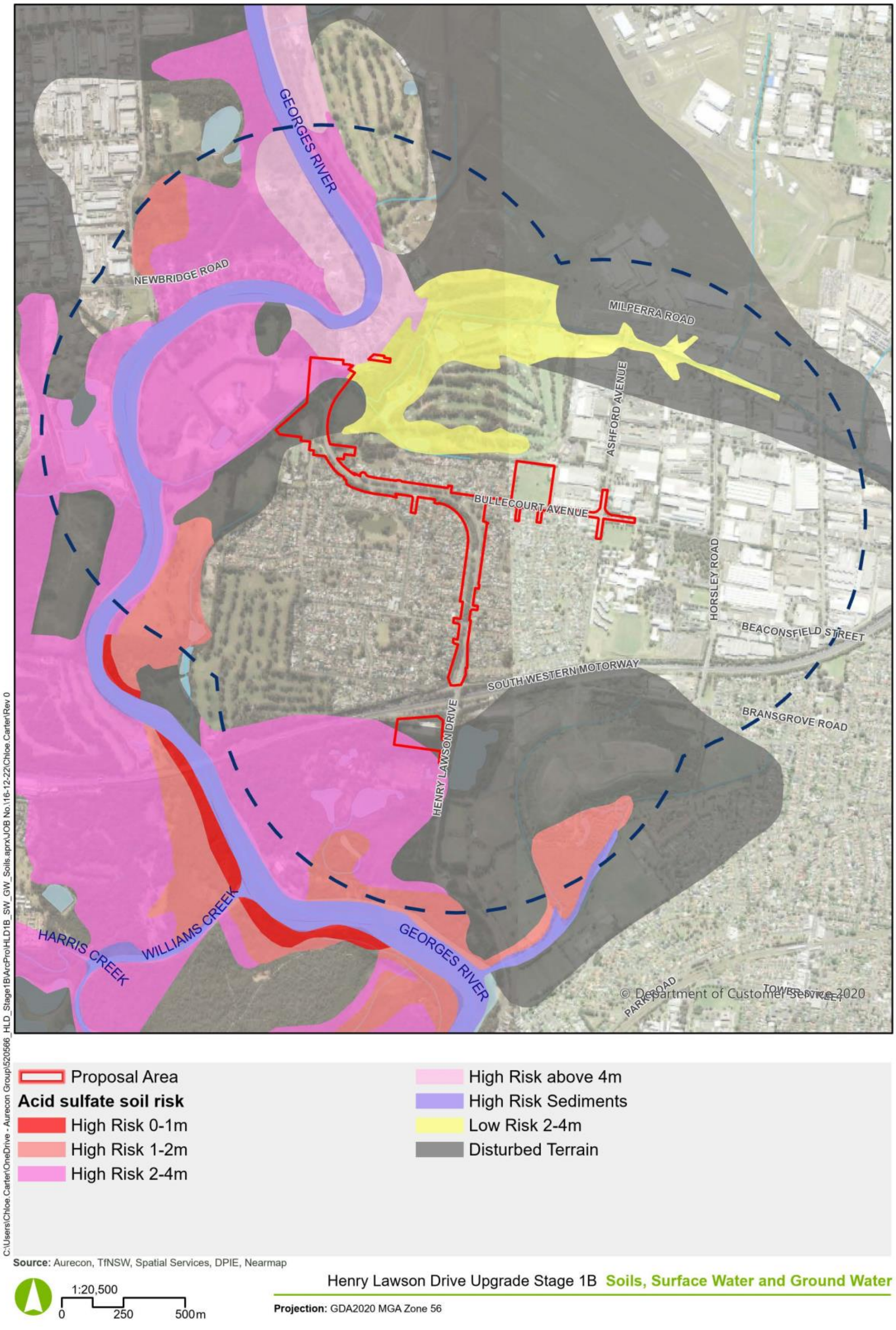


Figure 4-6 **Acid sulphate soils**

4.4.3 Salinity

Salinity refers to the concentration and mobility of salt in soil and natural waters. Salinity processes are driven by the interactions between water use characteristics of vegetation, physical soil properties and hydrogeological processes within a hydrogeological landscape. Sources of salt include retreating seas (salt remains in sediment), rain, wind and rocks (weathering) (DWER, 2022). Saline conditions can affect water movement, as well as the structure, microbial and plant diversity of soils. Impacts of salinity within the Sydney Metropolitan area have been worsening in areas underlain by Wianamatta shales (**Section 4.4.1**). Possible causes of salinity increases are:

- Alteration of natural drainage patterns by the construction of roads and channels
- Creation of wet zones of waterlogged soil by impeded drainage,
- Leakage of standing water bodies, lakes and services pipes,
- Exposure of susceptible soils,
- Irrigation, and
- A decrease in deep-rooted vegetation.

Analysis of the eSPADE salinity hazard mapping revealed the potential for saline soils within the proposal area. For most of the proposed zone, salt sites occur primarily on the edges of drainage lines and the potential for soil salinity is high. Frequent salt sites occur throughout this landscape within urban structures, with some larger sites also occurring along colluvial slopes and drainage lines. The combination of localised salt cycling and deeper groundwater rise produces high salt levels. High salt export is driven by groundwater discharge and runoff into streams, frequent widely distributed salt sites export high loads during rainfall events, while salty groundwater discharge maintains these high loads in periods of dry conditions. The water in this region is brackish with water quality impact recorded as high due to incoming tides on the Georges River. Significant features of this landscape include saline and sodic subsoil material and mainly colluvial change of slope salt sites. Salinity risk is presented in **Figure 4-7**.

Figure 4-7 **Salinity**

4.4.4 Hydrologic Soil Groups

Soils are classified into four hydrologic soil groups, depending on the soil's runoff potential. These four groups are A, B, C and D, with A's generally having the smallest runoff potential and D's the largest. Analysis of the SEED portal revealed that the entire proposal area is classified as containing Group C soils, which are those with slow infiltration rates. These soils are often sandy clay loams, consisting mainly of soils that have a layer impeding downward movement of water, posing a risk of waterlogging and acid sulphate soils. Soil structure within Group C soils is most commonly moderately fine to fine. Due to slow infiltration rates these soils have moderately high runoff potential when thoroughly wet, typically consisting of 20-40% clay and less than 50% sand. Physical characteristics of this soil group include a depth to a water impermeable layer of 50-100 cm and a saturated hydraulic conductivity of the least transmissive layer of ≤ 10.0 to > 1.0 μm/s.

As soils within this urbanised landscape are significantly disturbed, assumptions made based on natural soil properties may not be entirely accurate.

Hydrologic soil groups within the proposal area can be seen in **Figure 4-8**.

Figure 4-8 Hydrologic Soil Groups

4.5 Geology

A review of the Geoscience Australia Portal revealed the underlying geological landscape of the proposal area, shown in **Table 4-5**. The central section of the proposed upgrade for Henry Lawson Drive sits atop the Hawkesbury Sandstone, which forms the escarpments and ridges around Sydney Harbour. Regolith materials consist of both weathered shale and medium-grained quartz lithic sandstone. Clays accumulate down the colluvial slope, where heavy clays underlie the foot slopes and sandy alluvial material is present within the floodplain. Floodplains and drainage depressions are flat with incised channels.

The northern and southern sections of the proposal area are situated upon alluvial floodplain deposits from the Quaternary, Neogene, and Triassic periods. The landscape consists of alluvial plains and drainage lines, with slopes < 10%. Key lithologies of this hydrogeological landscape are:

- Recent alluvium – fine grained sand, silt, gravel, and clay,
- Neogene alluvium – clayey quartzose sand and clay,
- Bringelly Shale (Wianamatta Group) – shale, carbonaceous claystone, lithic sandstone and laminite, and
- Ashfield Shale (Wianamatta Group) – black to light grey shale and laminite.

Table 4-5 below summarises the major geological units that underpin the proposal area. **Figure 4-9** shows a geological map of the proposal area at 1:100,000 scale.

Table 4-5 Geological units

Period/s	Name	Area	Description
Triassic	Hawkesbury Sandstone	Centre of proposal area	Weathered shale, medium-grained quartz lithic sandstone
Quaternary, Triassic, and Neogene	Alluvial floodplain deposits	Upper and lower limits of proposal area	Clayey quartzose sand and clay, shale, carbonaceous claystone, lithic sandstone and laminite

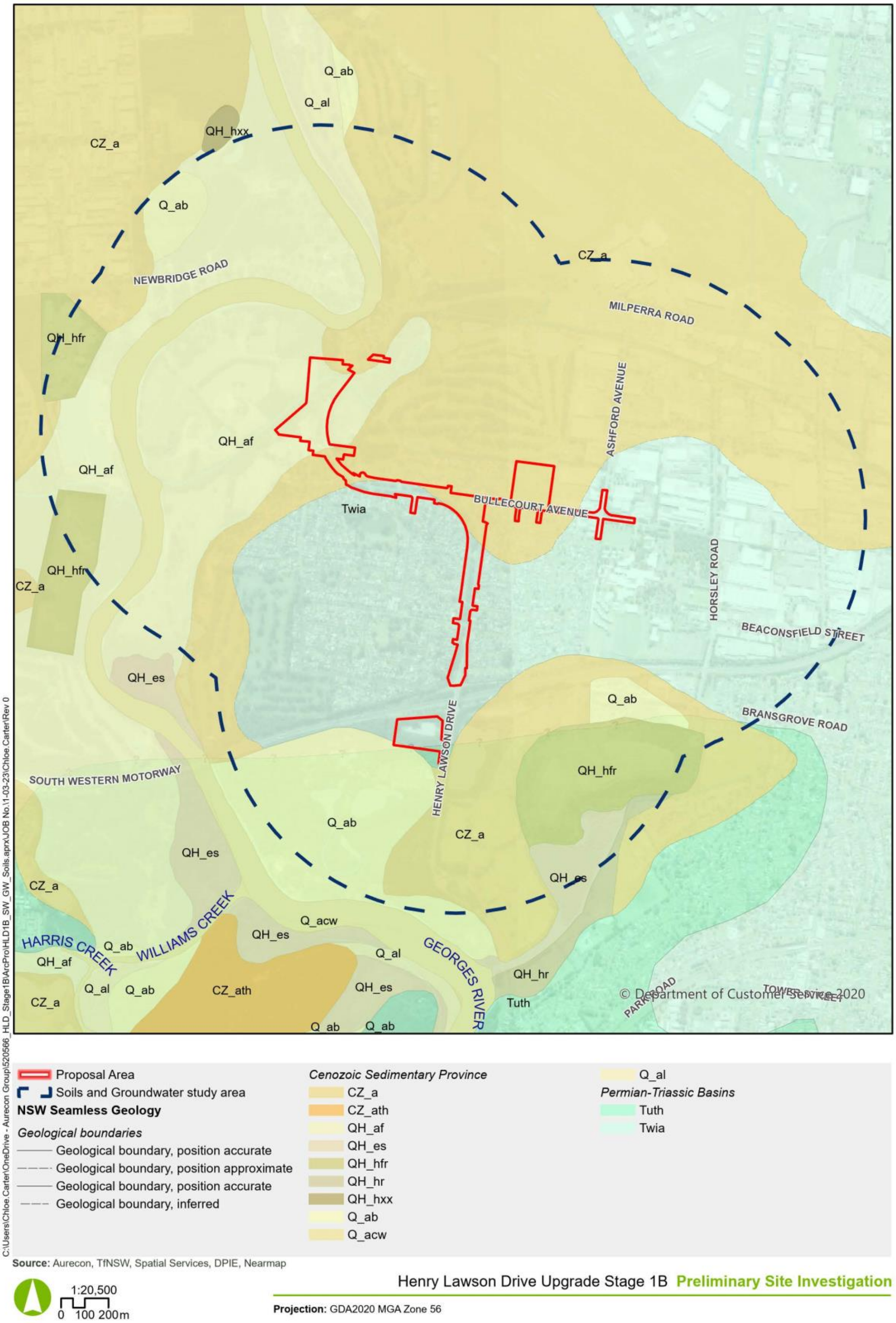


Figure 4-9 **Seamless geology**

4.6 Hydrogeology

4.6.1 Hydrogeological landscapes

Hydrogeological landscapes were distinguished using the eSPADE portal (NSW DPI). Most of the proposal area, specifically the central section of Henry Lawson Drive, falls within the Bankstown Hydrogeological Landscape (HGL). This landscape is characterised by low hills and rises on Triassic shale and sandstone. It is a region of moderate to high rainfall (>800mm) and is distinguished from other areas within the Sydney metro by its high prevalence of sodic and saline soils, particularly within drainage channels. This is believed to be caused by historical tidal influence from the Parramatta and Georges Rivers. This has resulted in high levels of salinisation throughout the area, with several frequent small patches of severely impacted land. Limitations and hazards related to this landscape include high salinity, highly erodible sub-soil, and streambank erosion. The saline conditions lead to EC spikes and increased salt loading during periods of high flow.

The northern section of the proposal area, as well as the south past M5 Motorway, fall within the Moorebank HGL. This landscape is characteristic of low-lying Quaternary, Neogene and Triassic alluvial floodplains of the Georges River and features flat extensive floodplains and alluvial plains. The disturbed and/or reclaimed lands close to the river are commonly waterlogged, containing ponded water and back swamps, creating the potential for acid sulfate soils. This HGL is distinguished from other areas within the Sydney Metro area by its very flat and low-lying alluvial plain, with ponding on the borders of the Georges and Parramatta Rivers. This HGL is distinguishable from the Bankstown HGL specifically as it is heavily influenced by ASS.

Hydrogeological landscapes of the proposal area are displayed in **Figure 4-10**.

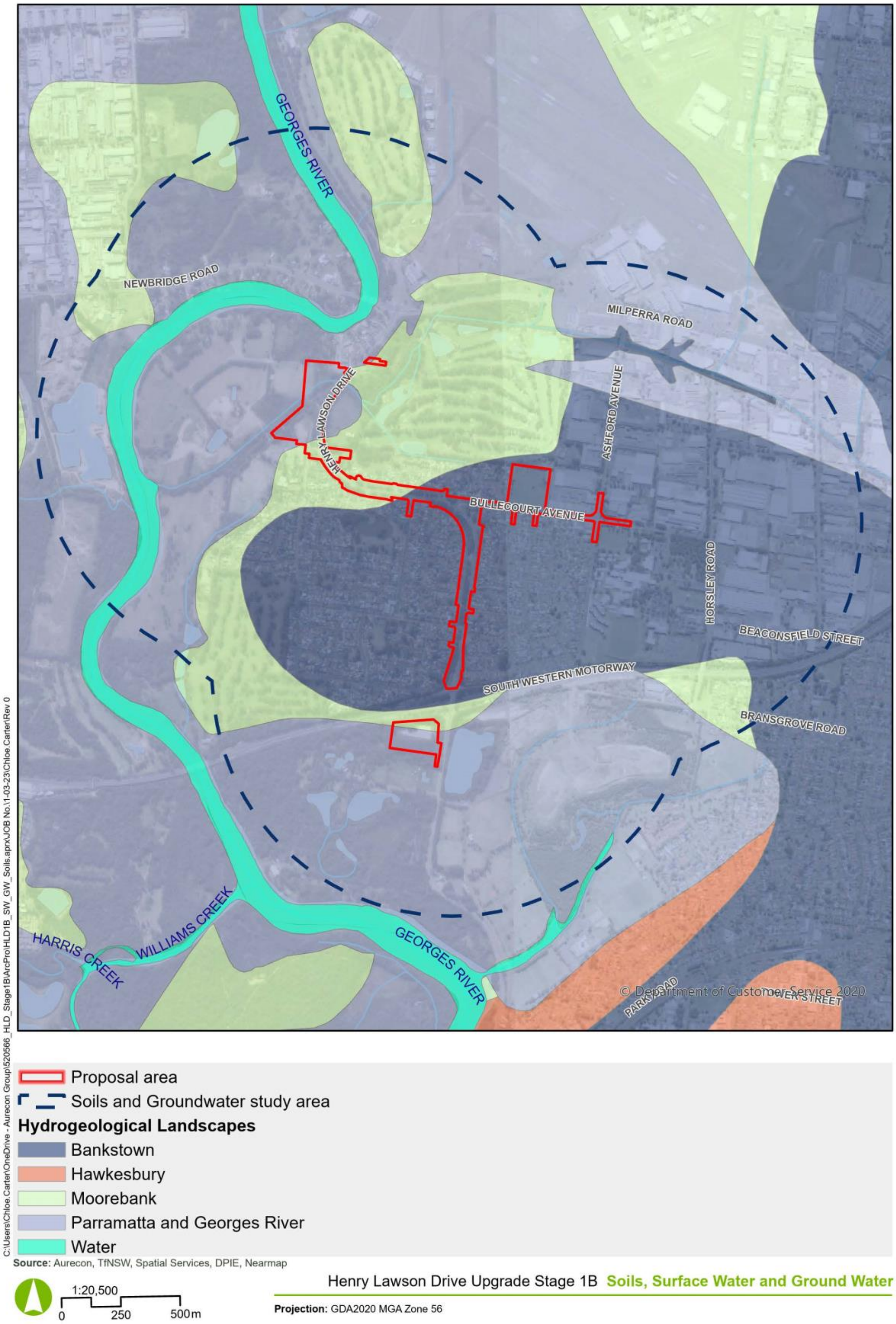


Figure 4-10 Hydrogeological Landscapes

4.6.2 Aquifers

Aquifers present in this region consist of both unconfined unconsolidated alluvial sediments and semi-confined fractured rock. Groundwater flow within the Bankstown HGL is driven by the primary porosity of the alluvial sediments and along the secondary porosity (structures) in the fractured bedrock. Water moves laterally through shale layers in this HGL, although vertical movement is possible where vertical fracturing occurs. Hydraulic conductivity and aquifer transmissivity are low to moderate with a gentle to moderate hydraulic gradient (<10 – 30%). The groundwater table is of intermediate depth (2 m-6 m) with flow lengths of less than 10km (short to intermediate).

Groundwater flow within the Moorebank HGL is driven by the primary porosity of the unconsolidated alluvial sediments. Hydraulic conductivity is moderate to high and aquifer transmissivity is moderate with a gentle to moderate hydraulic gradient (<10 – 30%). The groundwater table is of shallow to intermediate depth (0 m -8 m) with flow lengths of less than 5km (short).

4.6.3 Groundwater users

A search of the NGIS conducted on 20 May 2022 returned 31 registered bores within the groundwater study area. A summary of these bores is presented in **Appendix B** and are shown on Figure 4-11. Not all registered bores have a full suite of available information such as water level or water quality.

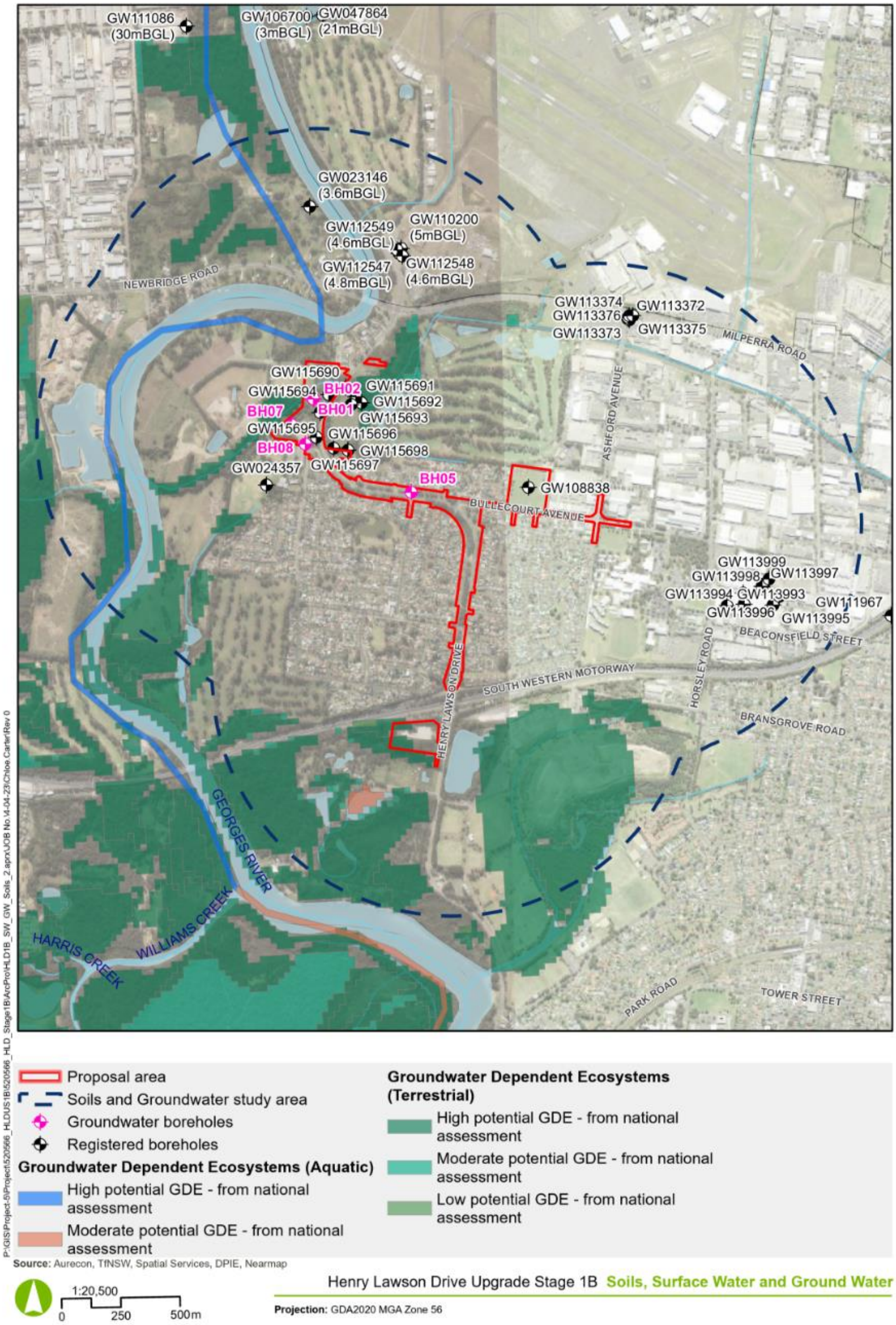


Figure 4-11 Groundwater users and GDEs

4.6.4 Groundwater monitoring wells

Geotechnical investigations were conducted as part of Henry Lawson Drive 1B. A number of boreholes were drilled and the groundwater depths are presented in **Table 4-6**.Error! Reference source not found. The locations are presented in Figure 4 – 12 and described below:

- BH01: South of entrance of footbridge west of Henry Lawson Drive and south of Auld Avenue
- BH02: South of middle of footbridge west of Henry Lawson Drive and south of Auld Avenue
- BH05: North side of Henry Lawson Drive at intersection of Amiens Avenue
- BH07: East side of Keys Parade (approximately 70m west of Henry Lawson Drive)
- BH08: North side of Raleigh Road (approximately 40m west of Henry Lawson Drive)

Table 4-6 Henry Lawson Drive 1B Geotechnical Investigation groundwater depths

Location	Date drilled	Screen material at level of standing water	Standing water level[1] (m below ground level)
BH01	20/09/2022	Sand, Silty Sand,	1.1
BH02	31/10/2022	Sand	1.6
BH03	18/08/2022	Sand	2.3
BH04	17/08/22	Sandy gravel	2.3
BH05	21/09/2022	Clay	7.6
BH06	05/08/22	Sand	2.3
BH07	18/11/2022	Sand	1.5
BH08	18/11/2022	N/D	Not encountered within 3.8m

[1] recorded at time of drilling

4.6.5 Groundwater quality

Groundwater within the Bankstown HGL is brackish to saline (1.6 – 4.8 dS/m), with salt cycling being a significant process in relation to water quality. Salt discharge into streams from the saline alluvium is significant. Water quality within the Moorebank HGL is fresher in comparison, ranging from fresh to marginal (< 0.8 – 1.6 dS/m). Groundwater becomes more saline in the deeper aquifers within the Wianamatta Group shales.

Table 4-7 Groundwater salinity from registered bores with available data (BoM, 2022)

Bore ID	Latitude	Longitude	Salinity (as presented in bore log)
GW023146	-33.9256	150.9764	Excellent[1]
GW024357	-33.9362	150.9742	501-1000 ppm
GW047864	-33.9184	150.9765	2100 (mg/L)

[1] Excellent was recorded at time of drilling by the driller and is assumed to mean fresh (as in non-saline) water

A Detailed Site Investigation (DSI) was conducted by Aurecon as part of Henry Lawson Drive Stage 1A. This report detailed groundwater quality at five different wells, from three sampling events. These events took place in November 2021, December 2021 and January 2022. **Table 4-8**, **Table 4-9** and **Table 4-10** summarises the groundwater quality for these sampling events across the five locations.

Table 4-8 Summary of Field Recorded Groundwater Physiochemical Parameters Event 1 (04/11/21)

Parameter	Comments
Dissolved Oxygen	Dissolved oxygen ranged between 0.66 and 9.21 ppm, indicating variable groundwater conditions ranging from anaerobic to aerobic.
Electrical Conductivity	Electrical conductivity (EC) ranged between 2119 µS/cm and 11,384 µS/cm, indicating brackish groundwater.
Oxidation/Reduction Potential	Redox potential ranged between -63.2 mV and 125.5 mV, indicating reducing and oxidising groundwater conditions.
pH	pH ranged between 6.47 pH units and 7.06 pH units, indicating neutral groundwater conditions.
Temperature	The temperature of groundwater ranged between 15.5 °C and 19.6 °C and is attributed to daily temperature conditions.

Table 4-9 Summary of Field Recorded Groundwater Physiochemical Parameters Event 2 (03/12/21)

Parameter	Comments
Dissolved Oxygen	Dissolved oxygen ranged between 0.95 and 2.78 ppm, indicating variable groundwater conditions ranging from anaerobic to slightly aerobic.
Electrical Conductivity	Electrical conductivity (EC) ranged between 2096 µS/cm and 9579 µS/cm, indicating brackish groundwater.
Oxidation/Reduction Potential	Redox potential ranged between -138.4 mV and 63.5 mV, indicating reducing and oxidising groundwater conditions.
pH	pH ranged between 6.42 pH units and 8.87 pH units, indicating neutral groundwater conditions.
Temperature	The temperature of groundwater ranged between 20.2 °C and 24.6 °C and is attributed to daily temperature conditions.

Table 4-10 Summary of Field Recorded Groundwater Physiochemical Parameters Event 3 (19/01/22)

Parameter	Comments
Dissolved Oxygen	Dissolved oxygen ranged between 1.1 and 2.4 ppm, indicating variable groundwater conditions ranging from anaerobic to aerobic.
Electrical Conductivity	Electrical conductivity (EC) ranged between 2428 µS/cm and 19975 µS/cm, indicating brackish to saline groundwater.
Oxidation/Reduction Potential	Redox potential ranged between -135.3 mV and 66 mV, indicating reducing and oxidising groundwater conditions.
pH	pH ranged between 6.42 pH units and 8.87 pH units, indicating neutral and basic groundwater conditions.
Temperature	The temperature of groundwater ranged between 18.6 °C and 20.5 °C and is attributed to daily temperature conditions.

Concentrations of all metals except mercury were detected in ground water samples. All detections that exceeded any adopted human health or ecological health investigation levels are tabulated below in **Table 4-11.**

Table 4-11 Groundwater Heavy Metal Exceedances

Sample ID	Event	Heavy Metal	Measurement (mg/L)	Investigation Criteria exceeded
BH01_GME01_041121	1	Nickel	0.012	NEPM 2013 Table 1C GILs, Fresh Waters
BH01_GME02_031221	2	Nickel	0.023	NEPM 2013 Table 1C GILs, Drinking Water
BH01_GME03_19122	3	Copper Nickel Zinc	0.004 0.011 0.018	NEPM 2013 Table 1C GILs, Fresh Waters (Copper). NEPM 2013 Table 1C GILs, Marine Waters (Nickel, Zinc).
BH05_GME01_041121	1	Zinc	0.038	NEPM 2013 Table 1C GILs, Marine Waters
BH05_GME02_031221	2	Nickel Zinc	0.145 0.054	NEPM 2013 Table 1C GILs, Drinking Water (Nickel). NEPM 2013 Table 1C GILs, Marine Waters (Zinc).
BH05_GME03_19122	3	Copper Nickel Zinc	0.006 0.115 0.030	NEPM 2013 Table 1C GILs, Fresh Waters (Copper). NEPM 2013 Table 1C GILs, Drinking Water (Nickel). NEPM 2013 Table 1C GILs, Marine Waters (Zinc).
BH07_GME01_041121	1	Zinc	0.043	NEPM 2013 Table 1C GILs, Marine Waters
BH07_GME02_031221	2	Copper Nickel Zinc	0.009 0.012 0.011	NEPM 2013 Table 1C GILs, Fresh Waters
BH07_GME03_ 19122	3	Copper Nickel	0.008 0.009	NEPM 2013 Table 1C GILs, Fresh Waters (Copper). NEPM 2013 Table 1C GILs, Marine Waters (Nickel).
BH10_GME01_041121	1	Copper Zinc	0.007 0.041	NEPM 2013 Table 1C GILs, Fresh Waters (Copper). NEPM 2013 Table 1C GILs, Marine Waters (Zinc).
BH10_GME02_031221	2	Copper Zinc	0.020 0.014	NEPM 2013 Table 1C GILs, Fresh Waters

A marginal detection of BTEX was noted in some samples (at BH01, BH03 and BH05). Groundwater samples did not exceed any adopted human health or ecological health investigation levels. Minor detections of TRH were detected in the samples (at BH01, BH05 and BH7). However, groundwater samples did not exceed any adopted human health or ecological health investigation levels.

The DSI conducted by Aurecon as part of Henry Lawson Drive Stage 1A in 2021, identified potential PFAS and/or PFOS contamination that may be present in the proposal area. The source of PFAS and PFOS contamination is likely from the historical use of aqueous film forming foam for firefighting purposes.

4.6.6 Groundwater levels

Groundwater levels throughout the proposal area are expected to be shallow as it is located within the alluvium and the proximity of the Georges River. Depth to the water table within the Bankstown HGL ranges from 2-6 m bgl, varying seasonally (lower in summer, higher in winter). Groundwater recharge rates within this landscape are classified as moderate,

Water table depths within the Moorebank HGL range from 0 – 8 m bgl, depending on the season (lower in summer, higher in winter). Groundwater recharge is reported to be moderate to high, with a gentle hydraulic gradient (< 10%).

Standing water levels from the registered bores within the groundwater study area are presented in **Table 4-12**. The levels shown were recorded at the bores date of installation as there are no telemetered bores within the groundwater study area for real time updates.

Table 4-12 Groundwater levels from registered bores with available data

Bore ID	Latitude	Longitude	Standing water level (m bgl)
GW023146	-33.9256	150.9764	3.60
GW047864	-33.9184	150.9765	21
GW106700	-33.9184	150.9772	3
GW110200	-33.9273	150.9806	5
GW111086	-33.9187	150.971	30
GW112547	-33.9275	150.9805	4.8
GW112548	-33.9274	150.9804	4.6
GW112549	-33.9276	150.9806	4.6

A DSI was conducted by Aurecon as part of Henry Lawson Drive Stage 1A. This report detailed groundwater elevation at five different wells, from three sampling events. These events took place in November 2021, December 2021 and January 2022. **Table 4-13** details the groundwater elevation for these sampling events across the five locations. These locations are:

- DD-BH01: Approximately 13m south of Milperra Drain on west side of Henry Lawson Drive
- DD-BH03: Approximately 45m north of Milperra Drain at corner of Henry Lawson Drive and Auld Avenue.
- DD-BH05: Adjacent to the drain on west side of Henry Lawson Drive, north of Tower Road.
- DD-BH07: South side of Milperra Road near the bend in Milperra Drain at recently upgraded road drainage rocky swale.
- DD-BH10 : Located on property bounded by Henry Lawson Drive, Tower Road and Starkie Drive.

Table 4-13 Minimum and maximum groundwater levels from the Stage 1A DSI (Aurecon, 2022).

Location	04/11/21	03/12/2021	19/01/2022	04/11/21	03/12/2021	19/01/2022
	m bTOC			m AHD		
DD-BH01	2.56	2.42	2.36	0.61	0.75	0.82
DD-BH03	3.87	3.72	3.58	0.49	0.64	0.78
DD-BH05	1.84	1.54	1.57	0.95	1.26	1.22
DD-BH07	2.09	1.88	1.85	1.26	1.57	1.51
DD-BH10	3.7	3.00	3.32	1.50	2.20	1.88

4.7 Surface water and groundwater interaction

The soil profile and hydrogeological landscapes of the proposal area were used to assess the level of interaction between surface water and groundwater. As subsoil in the Bankstown HGL has a low permeability than that of the Moorebank HGL, downward migration is restricted, potentially allowing the mobilisation and concentration of salts on the surface. This landscape also produces significant salt discharge into streams out of the sandy saline alluvium. Water moves slowly through this landscape due to a low gradient, thereby increasing salt accumulation from soils and bedrock.

Groundwater systems within the Moorebank HGL have a shallow to intermediate depth that varies seasonally between zero to eight metres. The systems are also local with short flow lengths in the lateral direction, that aligned with current stream channels and drainage depressions (DPE, 2016). Channels that contain surface water fluctuate with runoff events and are therefore not necessarily fed by groundwater baseflow. This makes them susceptible to surface intermittent flow and water ponding. During wetter periods. this landscape's restricted infiltration can produce local perching of water tables above clay lenses.

4.8 Sensitive receiving environments

4.8.1 Key fish habitats and threatened aquatic species

A review of the NSW Department of Primary Industries Fisheries mapping tool revealed that the proposal area is not located within any key fish habitats. The proposal area is located near key fish habitats such as Georges River and Voyager Point Wetland to the south of South-Western Motorway. The site is not situated near aquatic habitat holding any protected / threatened freshwater fish species. **Figure 4-4** summarises key fish habitats in the vicinity of the proposal area.

4.8.2 GDEs

Groundwater Dependent Ecosystems (GDEs) rely on groundwater for some or all their water requirements. Six types of Groundwater Dependent Ecosystems have been identified in Australia:

- Terrestrial vegetation that partial relies on the availability of shallow groundwater
- Wetlands such as paperbark swamp forests and mound springs
- River baseflow systems where groundwater discharge, provides significant baseflow component to the river
- Aquifer and cave ecosystems where life exists independent of sunlight
- Terrestrial fauna, both native and introduced species, that rely on groundwater as a source of drinking water
- Estuarine and near-shore marine systems, such as coastal mangroves, salt marshes and seagrass beds, which rely on the submarine discharge of groundwater.

A search of the BoM's Groundwater Dependent Ecosystem Atlas found that several GDE's are present within or near the study area. Areas of Subterranean GDE were not mapped within the proposal area.

The Department of Planning and Environment's Spatial Portal revealed that the areas with a high probability of containing GDE's were located to the south of South-Western Motorway and to the north adjacent to Bankstown Golf Club. The central residential section of the proposal area does not contain any Groundwater Dependent Ecosystems. The aquatic GDE's primarily occur along the riparian zone of the Georges River and are intersected by the planned works towards the north and south of the proposal area.

GDEs that exist within the proposal area are presented in Figure 4-11. It is expected that groundwater flows in a westerly direction towards the Georges River, with the GDE's identified in this investigation existing down-gradient of the proposed works.-

The following vegetation communities are considered GDE's within or immediately surrounding the proposal area:

- Coastal Freshwater Lagoon;
- Gordon Parker Reserve;
- Cumberland River-flat Forest; and
- Swamp Oak Floodplain Forest.

4.8.3 Wetlands

A review of the NSW State Environmental Planning Policy (Resilience and Hazards) 2021 and associated datasets revealed that there are no coastal wetlands located within the proposal area. However, planned works do pass through the coastal wetland proximity area to the far north and south of the site boundary. Coastal wetlands were identified along the riparian zone of the Georges River to the west of Henry Lawson Drive, as well as the upper limits of the proposal area where the Milperra Drain discharges into the Georges River.

Coastal wetlands are typically identifiable based on seven key types of vegetation:

- Salt marshes
- Mangroves
- Melaleuca forests
- Casuarina forests
- Sedgelands
- Brackish and Freshwater swamps
- Wet meadows

Wetlands found along the proposal alignment are presented in **Figure 4-4**. The only nationally important wetland nearby to the planned upgrades, as reported by Department of Agriculture, Water and the Environment, is Voyager Point Wetland situated south-west of South-Western Motorway.

5 Impact assessment

5.1 Potential construction impacts

An impact assessment for the construction phase of this proposal is outlined in this section. If not managed correctly, the following construction activities could potentially lead to adverse impacts to the surface water and groundwater environment.

The construction activities are presented in **Section 5.1.1** and the summary of impacts are presented in **Section 5.1.2**, presented in **Table 5-1**.

5.1.1 Construction activities

This section provides a summary of the construction activities which may potentially impact the soils, groundwater or surface water environment.

Ancillary facilities and stockpiles

To support construction, a range of ancillary facilities would be required. The facilities would include:

- Site offices, car parking, sheds, workshops and storage
- Areas for material delivery and storage, including Auld Avenue bridge structural elements
- Stormwater capture and treatment locations
- Stockpile locations for materials spoil and mulch.

Ancillary facilities would be temporary sites and structures and would be developed for the sole purpose of the construction of the proposal and be returned to pre-existing conditions or rehabilitated once construction is complete.

There are currently eight proposed ancillary facility locations for the proposal. Of the eight, five are considered low risk due to their distance from sensitive receptors. The remaining three locations are considered to be of a higher risk due to their close proximity to waterways/waterbodies or coastal wetlands and flooding risks:

- 439 Henry Lawson Drive Milperra 2214, adjacent to coastal wetland
- 2 Auld Avenue Milperra 2214, adjacent to Milperra Drain
- 101 Raleigh Road Milperra 2214, close to Milperra Drain

Proposed ancillary facilities are presented on **Figure 1-1.**

Concrete/asphalt activities

The proposal would require a large amount of concrete and asphalt. These would be transported to the site and stored temporarily at ancillary sites (as discussed in **Section 5.1.1**) during construction. The aspects of the proposal that would require concrete include:

- Shared paths and pedestrian footpaths
- Structures including kerbing and in-situ culverts
- Pavement for roads.

Dewatering and discharges

Groundwater is assumed to be shallow, especially within close proximity to the Georges River as discussed in **Section 4.6.6,** groundwater levels range from zero to eight metres below ground level across both Bankstown and Moorebank HGLs. As a result, areas identified as ‘cut’ in **Figure 1-1** will require excavation and shallow earthworks that may intersect the groundwater table. If dewatering is required, groundwater will be required to be removed, either by discharging to the environment or offsite disposal, depending on the nature and volume of the groundwater. Should dewatering activities produce larger volumes or the water quality is degraded, water licences and or dewatering management plans will be required.

Given the project's proximity to Bankstown Aerodome, dewatering works may encounter legacy contamination. Dewatering may draw groundwater contaminated with PFAS and/or PFOS from the airport site.

A Dewatering Assessment has been conducted by Aurecon to determine possible groundwater volumes to be dewatered and provide comments on possible groundwater licencing requirements.

Vegetation removal and earthworks

Vegetation removal would be required in areas to provide space for the proposal in areas of widening, construction of ancillary facilities and culvert construction across the Milperra Drain. The proposal would generally retain the existing road pavement and level, therefore minimal earthworks are required.

Some site levelling and cut and fill is to be employed for the roadworks. Excavation of drainage and underground utility trenches/ channels and foundations for overhead infrastructure is also anticipated, however the design of these and the construction methodology has not been confirmed at the time of writing this report.

Works of waterfront land

The proposal includes a culvert at Keys Parade that crosses the Milperra Drain. The construction methodology is to be finalised. These works would be deemed a controlled activity which TfNSW would be exempt from the requirement to obtain an approval. It is expected that the culvert construction would include:

- Vegetation removal
- Earthworks
- Concreting
- General construction activities.

The drainage design also includes a new outlet into the Milperra Drain at the northern end of the proposal along Henry Lawson Drive which works for this would be located on waterfront land.

Soil and erosion sediment control

The Erosion and Sedimentation Management Report (ESMR) prepared by SEEC outlines existing site conditions and recommends mitigation measure for soil erosion. The report outlines design considerations to minimise the impacts of sediment erosion on receiving waterways. The report also provides an assessment on the feasibility of constructing typical erosion and sediment control structures for HLD1B (SEEC, 2023). For more information, refer to the ESMR in **Appendix E**.

Major mitigation measures and controls proposed for HLD1B include:

- Up-gradient stormwater diversion to divert clean water from construction sites
- Temporary cross drainage to transfer clean water through and/or around site during construction
- Sedimentation traps and basin to manage runoff from site to sensitive receiving environments

5.1.2 Summary of potential construction impacts

Table 5-1 Summary of potential construction impacts for soils, surface water and groundwater

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation measures	Residual impacts
Vegetation removal and earthworks – soil erosion	Clearing the proposal area of vegetation and topsoil would increase the risk of soil erosion in all soil types. Excavations further increase the risk of erosion as it increases the surface area of soils and subsoils exposed to the elements. The soil landscapes for the proposal are Richmond and Blacktown (see **Section 4.4.1**) which have moderate erodibility and a maximum ranking of high water erosion hazards. This indicates that erosion is a likely impact, however the K values indicate that Richmond soils (0.059) are a higher risk of erosion than Blacktown (0.038) soils. As the soils in the proposal are classed as Group C soils (see **Section 4.4.4**), surface runoff is considered high when the soils are thoroughly wetted, thus it is likely top soils may be eroded by surface runoff during wet weather events. During wet weather events sediment-laden stormwater runoff could drain to both the Milperra Drain and the Georges River. The runoff may have elevated total dissolved solids (TDS), total suspended solids (TSS), nutrients (phosphorous and nitrogen) and a reduction in dissolved oxygen which could impact areas that are deemed Key Fish Habitats and identified Wetlands.	Surface water - quality Sensitive receptors: KFH, Wetlands, Aquatic GDE	Medium (Likely, moderate)	See mitigation measures for W1 Soil erosion and water pollution and W6 Stormwater discharges leading to pollution in **Table 6-1**	Low
Earthworks intercepting groundwater and waterlogged soils	Disturbance of potential acid sulphate soils may cause acid generation. Acid sulphate soils are natural sediments that contain iron sulphides, which can release acid when exposed to air through processes such as construction. As discussed in **Section 4.4.2**, there is a high potential for ASS in the northern area of the proposal between 2 -4 m bgl during culvert construction across Milperra Drain and general site levelling earthworks. The presence of ASS can accelerate corrosion due to the presence of acidic substances in the surrounding soil. Cracking of concrete structures can also be accelerated. ASS can also be treated with agricultural lime ($CaCO_3$) prior to construction/ compaction and reburial to neutralise acidity. Further discussion on ASS is presented Preliminary Site Investigation (Aurecon, 2022)	Groundwater - quality Sensitive receptors: Aquatic, Terrestrial GDEs, Groundwater Users Surface water - quality Sensitive receptors: KFH, Wetlands, Aquatic GDE)	High (Likely, moderate)	See mitigation measures for W8 Encountering ASS in Table 6-1.	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation measures	Residual impacts
Ancillary facilities and stockpiling	Materials stored within the ancillary facilities transported to waterways via wind or sediment-laden stormwater runoff may cause a reduction in water quality within Milperra Drain and the Georges River.	Surface water Sensitive receptors: KFH, Wetlands, Aquatic GDE	Medium (Possible, moderate)	See mitigation measures for W4 Water pollution due to stockpiles in **Table 6-1**.	Low
Ancillary facilities and stockpiling	The deposition of sediments from stockpiles and stored materials within the ancillary facility in nearby waterways may have geomorphological impacts on Milperra Drain.	Surface water Sensitive receptors: KFH, Wetlands, Aquatic GDE	Low (Unlikely, minor)	See mitigation measures for W4 Water pollution due to stockpiles in **Table 6-1**.	Low
Concrete/asphalt activities	Concrete transport and pouring operations can lead to soil and water pollution (increase in pH, TSS, TDS and minor levels of Aluminium, Iron and Magnesium oxides) as a result of cement laden runoff not being properly contained or being accidentally released to surface waters. Poor cement handling, storage and disposal practices can also contribute to these impacts.	Surface water Sensitive receptors: KFH, Wetlands, Aquatic GDE	Medium (Unlikely, moderate)	See mitigation measures for W5 Water pollution from accidental spills and W6 Stormwater discharges leading to pollution in **Table 6-1**.	Low
Discharges	During excavation works for culvert construction and site levelling, if the groundwater table is encountered, and dewatering is required, the water would have to be disposed of by either discharging to the environment or offsite disposal. If water is discharged to the environment, this may degrade surface water, depending on the quality of the groundwater.	Surface water and groundwater Sensitive receptors: KFH, Wetlands, Aquatic and Terrestrial GDE	Medium (Unlikely, moderate)	See mitigation measures for W8 Groundwater dewatering during excavation in **Table 6-1**.	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation measures	Residual impacts
Leak, spills and waste	Potentially harmful chemicals (eg. hydrocarbons, oil and grease, heavy metals) could accidentally be released to the surface water environment during construction spills, refuelling and inappropriate storage or handling. Leakage from construction worker facilities or wastewater collection points could runoff into soils and receiving waterways. This could potentially contaminate exposed soils or mobilise contaminated soils and liquids into local watercourses which could result in water quality impacts. They could leach into groundwater sources and contaminate the alluvial aquifer. Spillage of waste or construction materials during transportation could lead to macro pollutants including plastics, construction material, wastage being conveyed in surface runoff to nearby drainage pathways and downstream waterways. The hydrological soil type (refer to **Section 4.4.4**) suggests that seepage is minimal within the proposal area. Given the depth to groundwater and low permeability soils, impacts to groundwater quality are likely to be minor as a result of a minor spill. Measures to minimise the potential impacts associated with accidental leaks and spills during construction would be incorporated into a site-specific emergency spill plan, refer to **Section 5.1**.to **Section 6.2**.	Surface water and groundwater Sensitive receptors: KFH, Wetlands, Aquatic GDE	Medium (Unlikely, major)	See mitigation measures for W5 Water pollution from accidental spills in **Table 6-1**.	Low
Works on waterfront lands	The proposal ties in where Henry Lawson Drive crosses the Milperra Drain. Any construction activities including clearing, or earthworks can directly change the geomorphological condition of the Milperra Drain. There is a proposed outlet on the western side at this point and culvert will be constructed under Keys Parade to Auld Avenue. There is also a proposed stormwater outlet into Milperra Drain on the west side of the existing bridge (Henry Lawson Drive). Any work within the waterfront land of the Milperra Drain increases the risk of sediment and other construction materials being mobilised into the waterways, if uncontrolled. This could lead to water quality impacts within the stream and downstream. Construction within the banks of the waterways could cause geomorphological changes to the waterway if excavation is required at these locations within the bank.	Surface water and groundwater Sensitive receptors: KFH, Wetlands, Aquatic GDE	Medium (Possible, moderate)	See mitigation measures for W1 Soil and water pollution in **Table 6-1**	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation measures	Residual impacts
Dewatering	The WM Act 2000 defines aquifer interference activities (which would include construction dewatering) and what approval are required. Approval is required only for significant active dewatering (>3 ML/water year) or where GDEs are potentially impacted. Passive dewatering activities of groundwater ingress into excavations and bored piles by public authorities do not require any approvals or permits under the WM Act 2000. As groundwater is shallow throughout the proposal, especially closer to Georges River, there is potential for groundwater levels to rise due to higher than average rainfall conditions caused by short-term and long-term climate cycles. This could lead to potential saturation of planned excavations therefore excavation sites require dewatering. This should be monitored throughout the construction phase of works according to the Dewater Assessment, which has been undertaken separately by Aurecon, and include measures such as, (assumed to be off-site disposal): ▪ Site Environmental Coordinator or representative must contact the waste disposal contractor and receiving facility to determine the correct analytical suite and documentation required before water is transported. ▪ All liquid waste must be characterised with the documentation made available to both the waste disposal contractor and receiving facility ▪ All produced water must be collected and stored in a sealed, bunded or similar storage vessel ▪ Daily inspections of the stored water must be made and include the following items: – Date/ time and location of dewatering – Estimated inflow rate – pH – Turbidity – Signs of visible oil or fuel (hydrocarbon) sheen on the water – Any unusual odour colour slime or foamy scum Should other methods of disposal be selected such as trade waste disposal or discharge to receiving water (such as the Georges River) that additional approvals and monitoring/ management measures would be required.	Groundwater Sensitive receptors: Aquatic and Terrestrial GDEs	High (Likely, moderate)	See mitigation measures for W7 Groundwater dewatering during excavation in **Table 6-1**.	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation measures	Residual impacts
Disturbance of land salinity	Salts within the Parramatta/Georges River HGL are known to be highly mobile and pose a severe potential impact to buildings and structures within the proposal area. There is a high risk of excavated soils being saline, which may cause impacts where spoil material is exposed to surface waters and rain. However, it is noted that in the area, groundwater salinity is already high. Runoff from exposed soils could produce a highly saline waste stream that may have minor impacts should it migrate into the groundwater through recharge. Due to the minor amount of soil to be excavated (148m^3), these impacts are considered very low.	Groundwater Sensitive receptors: KFH, Aquatic and Terrestrial GDEs	Low (Rare, minor)	N/A	Low
Culvert construction	No works would result in groundwater flow obstruction or interference beyond the proposed culvert under the Auld Avenue and Keys Parade link road. The impacts will be highly localised as they affect a small specific extent and flow interference would be on the scale of 10-1m. As such, the potential for aquifer interference is considered low and potential impacts downstream or on other groundwater users would be negligible.	Groundwater Sensitive receptors: KFH, Aquatic and Terrestrial GDEs	Low (Rare, minor)	N/A	Low
Groundwater users	There are nine registered bores within 1 km of the proposal area, with the majoring being monitoring bores. The risk of aquifer interference and discharges to groundwater is deemed to be very low to low. As such the water table should not be affected by this proposal and the risk of changes to water availability to groundwater users is therefore also deemed to be very low –to low. The risks of ASS and contamination to groundwater are deemed to be moderate. Therefore taking a conservative approach, the risk to water quality and becoming unsuitable for groundwater users is also deemed to be moderate.	:	Moderate (Possible, moderate)	See mitigation measures for W8 Encountering ASS in Table 6-1.	Low
Water usage	Water demand for the overall proposal is only indicative at this stage, however given its nature and scale, the proposal would not be expected to be water intensive. Water use during construction would be minor and largely used for dust suppression and for the construction of the widened carriageway (eg. compaction). The water requirement would vary, dependent on material sources and methodologies applied by the construction contractor, and weather conditions. Sufficient potable water would be supplied for about 70 construction staff, and this is expected to be about 80kL per annum. One proposed ancillary site on Henry Lawson Drive, for site offices, is an existing building connected to the main water supply network. For other ancillary sites, potable water would be obtained from sources such as portable office water dispensers. All non-potable water would be sourced from construction sediment sumps, a standpipe (if one is located nearby), local sub-contractor watercarts or an alternative nearby source.		Low (Rare, minor)	N/A	Low

5.2 Potential operational impacts

5.2.1 Operational activities

Although most of the proposal's impacts are expected to occur during the construction phase, potential operational impacts and risks still need to be considered.

The main operation activities that may potentially negatively impact on surrounding soils, surface waters and groundwaters include:

- Increased of impervious surfaces with the construction of additional road footprint and shared pathway. Impervious surfaces prevent aquifer recharge and increase stormwater runoff volumes, thereby further facilitates sediment and contaminant transport into receiving waterways and groundwater. Key results of the MUSIC modelling are presented in **Table 5-3** with further detail presented in **Appendix D**.
- Scour and erosion to receiving waterways from additional drainage outlets and runoff.
- Spill and leaks of hydrocarbons, oils and grease and general litter from motorists, motor vehicle accidents and pedestrians.

Further details of operational impacts are outlined **i**n **Table 5-4**.

5.2.2 Operational water quality

Proposed environment

The catchment for Henry Lawson Drive 1B (HLD1B) is predominately impervious from the proposed road pavement, with a few areas of urban residential, road verges and adjacent parklands. There are predominately 3 major discharge outlets for the project.

From the intersection of Ruthven Ave and Henry Lawson Drive, the catchment slopes northward and falls north towards Henry Lawson Drive bridge and Milperra Drain. Milperra Drain is a tributary of Georges River. This drain flows generally flows westward, parallel to Keys Parade until it meets Georges River.

The second major discharge outlet is a major road sag located near intersection of Amiens Ave and Henry Lawson Drive. The catchment for this road sag extends from the crest at Ruthven Ave/Henry Lawson Drive intersection to Bullecourt Ave/Henry Lawson Drive intersection. The road sag is drained by an existing 900mm RCP which flows north towards Bankstown Golf Club. This ultimately discharges via headwall into a swale within Bankstown Golf Club and then into Milperra Drain which forms a tributary to Georges River as described above.

The third discharge outlet is at Bullecourt Ave/Henry Lawson Drive intersection. The catchment to this outlet starts from South Western Motorway towards Bullecourt Ave. The catchment is predominately road pavement with verges and a small parkland. This discharge is connected into the 900mm RCP described above then outlets into Milperra Drain.

Minor increases in flows are expected to each outlet due to increased impervious area. The pavement drainage consists of drainage pit and pipe spaced based on flow width requirements from Austroads guide to road design. The flood impact assessment will show flood impacts consequent to the proposed development.

The grading of the pipe will follow the road alignment. Some areas have been identified to have relatively flat longitudinal and cross-sectional grade and therefore continuous trench drains may be required for these areas.

As the site is low lying and flood affected, the performance of the drainage network is constrained by the tailwater level of the discharge points.

Potential impacts to water quality are likely during operation. Increased runoff and potential for erosion around controls could increase sediment and nutrient loads to the receiving waters, impacting water quality and protection of the ecological values. The water quality strategy is to limit the discharge of pollutants to meet the water quality objectives and maintain the environmental values for the Georges River Estuary and tributaries. The strategy for HLD1B is to limit the pollutant loads from the proposed corridor to no greater than those under present day conditions. Currently, the proposed stormwater treatment train is at the concept design stage and would be further developed during detailed design.

The proposal has a relatively confined corridor which poses a constraint for water quality treatment measures. The space and topography constraints limit the ability to provide water quality measures at its source. Similar to stage 1A, end-of-line treatments are therefore proposed to facilitate an ease of maintenance approach such that maintenance can be performed at a few end-of-line treatment locations. These measures are outlined in **Table 5-2** . Swales have been nominated near Link Road. Locations of the two gross pollutant traps (GPTs) have been nominated along Henry Lawson Drive north of Auld Avenue and east of Bullecourt Avenue respectively. The GPT locations are shown in **Figure 1-1 in Appendix D**.

Table 5-2 Summary of stormwater quality measures

Stormwater Quality Measure & Identifier	Stormwater Quality Arrangement			
	Bio-Retention Basin Surface Area (m^2)	Bio-Retention Basin Filter Area (m^2)	Vegetated Swale Length (m)	GPTs (number of devices)
Bioretention Basin	650	650	-	-
Ecoceptor GPT 01	-	-	-	1 x Ecoceptor Series 4000
Ecoceptor GPT 02	-	-	-	1 x Ecoceptor Series 4000
Proposed Swale	-	-	177	-
Proposed Swale	-	-	90	-

Post development water quality

A MUSIC model was developed to quantitatively assess the impact of the operation of HLD1B on stormwater quality. The HLD1B is not within the Sydney Drinking Water Catchment and therefore is not required to complete a Neutral or Beneficial Effects (NorBE) assessment under the Environmental Planning and Assessment Act 1979 (EP&A Act). As an aspirational target, however, the proposed stormwater treatment train aimed to achieve NorBE by reducing pollutant loads through implementation of a bioretention basin, two GPTs and vegetated swales along the proposed road design upgrade from sources (i.e. pre-treatment) including sealed roads, commercial areas, mixed use areas and forests.

Table 5-3 Proposed treatment train effectiveness

Pollutant type	Pre-development		Post-development		% Change	
	Sources	Residual Load	Sources	Residual Load	Sources	Residual Load
Total Suspended Solids (kg/yr)	10594	9963	14,859	8,454	40.3	-15.1
Total Phosphorus (kg/yr)	20	20	28	18	40.0	-10.0
Total Nitrogen (kg/yr)	119	120	151	117	26.9	-2.5
Gross Pollutants (kg/yr)	1243	1170	1661	941	33.6	-19.6

As presented in **Table 5-3**, the sum of all sources for all parameters, ranging from 26.9% to 40.3% increase. However, the residual load, i.e., pollutant load post-treatment train reduced when compared to existing conditions for all parameters, ranging from a 2.50% to 19.6% decrease. The proposed treatment train, therefore, is expected to achieve the stringent NorBE criteria.

A more detailed discussion of the MUSIC model is presented in **Appendix D**.

5.2.3 Summary of potential operational impacts

Table 5-4 Summary of potential operational impacts for soils, surface water and groundwater

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation measures	Residual impact
Vegetation removal / stormwater runoff	Removal of vegetation, stripping of topsoil and increase of impervious areas along the entire length of the proposal could potentially lead to erosion of soils. During wet weather events, increased stormwater volume of a potentially degraded quality could drain to Milperra Drain and the Georges River including areas that are deemed Key Fish Habitats and identified Wetlands.	Surface water Sensitive receptors: KFH, Wetlands, Aquatic GDE	Medium (Likely, moderate)	See mitigation measures for W9 Water pollution from stormwater in **Table 6-1**	Low
Leaks, spills, general litter and vehicle accidents	Heavy metals, hydrocarbons, oils and grease and other contaminants may leach into soils and enter waterways and groundwater from motor vehicles using the upgrade. Gross pollutants and general litter may arise from motor vehicles. The project would increase traffic and motor vehicle volume, therefore increased risk of motor vehicle accidents/collisions that may leak petrol, metal from cars and enter drainage lines and receiving waterways. This could potentially lead to contamination of exposed soils or mobilisation of contaminated soils and liquids into local watercourses which could result in water quality impacts. Littering of waste by motorists and pedestrians could potentially lead to gross pollutants including plastics, being conveyed in surface runoff to nearby drainage pathways and downstream waterways. There are a number of Terrestrial GDEs downstream of the proposal on the banks of School House Creek, these may also be impacted by surface water contamination and seepage to the groundwater system. The hydrological soil type (refer **Section 4.4.4**) suggests that seepage is minimal within the soils in the proposal area. Given the depth to groundwater and low permeability soils, impacts to groundwater quality are likely to be minor as a result of a spill.	Surface water Groundwater Sensitive receptors: KFH, Wetlands, Aquatic GDE	Medium (Possible, moderate)	See mitigation measures for W9 Water pollution from stormwater in **Table 6-1**	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation measures	Residual impact
Aquifer recharge	The proposal will increase areas with impermeable surfaces, thereby inhibiting overall recharge to underlying aquifers following rain events. Surface water runoff, stormwater and other associated drainage channels are not expected to interact with groundwater or aquifers across the proposal's alignment during operation. Due to the increase in the impermeable pavement for Henry Lawson Drive and Milperra Road, there is likely to be a minor reduction in the overall recharge rate to the underlying unconfined aquifers, as a result of the proposal being upgrades to existing road infrastructure rather than new road infrastructure. The overall reduction is unlikely to produce an effect that would constitute aquifer interference, with the aquifer interference framework, therefore the potential impacts are considered to be very low.	Groundwater – levels Sensitive receptors: Aquatic, Terrestrial GDEs, Groundwater Users	Low (Unlikely, minor)	N/A	Low
Stormwater discharges through outlets	Scour and erosion could potentially occur at the outlets. The increased stormwater runoff volume entering the drainage network could scour and erode receiving waterways, altering their geomorphology. However, as per drainage design, new outlets will be designed appropriately with scour protection, therefore scour and erosion unlikely to occur. The north of the proposal finishes at where Henry Lawson Drive crosses Milperra drain. There is a proposed outlet on the western side at this point and there is a bridge construction to connect Keys Parade to Auld Avenue. There is also a proposed stormwater outlet into Milperra Drain on the west side of the existing bridge (Henry Lawson Drive).	Surface water – erosion and geomorphology Sensitive receptors: KFH, Aquatic GDEs	Medium (Unlikely, moderate)	See mitigation measures for W9 Water pollution from stormwater in **Table 6-1**	Low

5.3 Cumulative impacts

Cumulative impacts have the potential to arise from the interaction of individual aspects of the site and the effects of the proposal with other projects in the local area. There are no to negligible impacts expected to arise from other projects.

Potential cumulative impacts from projects located in the vicinity are presented in **Table 5-5**.

Table 5-5 Summary of cumulative impacts

Project	Details	Interface	Potential Impacts	Cumulative Impact
Flower Power Complex (479 Henry Lawson Drive Milperra)	An existing complex for Flower Power, which is a garden centre, located in Milperra.	Flower Power Complex is situated on along the northern end of Henry Lawson Drive1B proposal. Construction of the complex was completed in 2021 and is currently operational.	Potential impacts to surface and groundwater quality could arise from poor storage of large quantities of fertilisers stored at centre. These are a potential source of nutrient loading if they were to enter waterways. Potential impacts are likely to be minimal as only operation activities from Flower Power Garden centre need to be considered.	No cumulative impacts are expected with adequate storage procedures practiced from Flower Power Complex.
Henry Lawson Drive Upgrade - Stage 1A	An upgrade of 1.3km length of Henry Lawson Drive between Keys Parade, Milperra to Tower Road, Bankstown. Also, includes additional upgrades to a 480m stretch along Milperra Road.	Henry Lawson Drive Stage 1A directly joins Stage 1B at Auld Avenue. Likely consecutive construction programs with Henry Lawson Drive Stage 1A expected to commence in early 2023 and take two years to complete.	Surface water quality impacts outlined in the REF arise from (NGH Environmental, 2021): ▪ Increased in-channel sediment accumulation resulting in smother of flora and fauna. ▪ Soil disturbance from excavation that increases soil runoff, therefore increases nutrient loading and acidic soils from ASS into waterways. Groundwater impacts outlined in REF with moderate to high impacts (Aurecon, 2021) ▪ Groundwater contamination mobilisation from earthworks. PFAS, hydrocarbon, VOCs and heavy metal contamination exist within groundwater at site.	No cumulative impacts are expected as erosion and sediment controls outlined in both REFs. These controls include: ▪ Site contamination plan ▪ Acid sulphate soils management plan ▪ Construction soil and water management plan

Project	Details	Interface	Potential Impacts	Cumulative Impact
Riverlands Subdivision (56 Prescott Parade, Milperra)	3 DAs have been submitted for the Riverlands Subdivision. These include subdivision of lot into 180 allotments, construction and extension of Keys Parade and bank stabilisation works along Georges River and remediation works on the Riverlands Golf Course site.	Located on north-western side of Henry Lawson Drive, along Auld Avenue. All DAs has been approved but construction timing has yet to be confirmed.	Bulk earthworks required for the subdivision will most likely intercept ASS or ASS and mobilise saline soils. These salts or contaminants could potentially leach into groundwater aquifers and degrade quality.	No cumulative impacts are expected with appropriate soil and water controls. The DA (DA-370/2020) for bank stabilisation works along Georges River foreshore and remediation and environmental rehabilitation works on the Riverland Golf course to further mitigate environmental impacts of the subdivision.
Anglicare Seniors Living Development (27 Bullecourt Avenue, Milperra)	The development works include demolition of existing shed, remediation work and construction of a seniors housing development including five buildings including a residential care facility, self-contained dwellings, community facilities, building identification signs, sealed road, basement and at-grade car parking and associated earthworks	The development application (DA-1213/2017) has been approved but the construction timing has not yet been confirmed. The site has been selected to install ancillary facilities during the construction of Henry Lawson Drive Upgrade Stage 1B proposal. Therefore, most likely consecutive construction programs.	The Council Assessment Report (City of Canterbury Bankstown Council, 2022) details the main environmental impacts to arise from vegetation removal and earthworks. They included exposing the asbestos impacted soils that were detected, acid sulphate soils detected on site. Petroleum tanks found on site, therefore mobilisation of legacy contamination– heavy metals, hydrocarbons are possible.	No cumulative impacts are expected as the Council Assessment Reports states the development will not result in any adverse environmental impacts. Mitigation measures include a Remedial Action Plan and ASSMP.
Gordon Parker Reserve amenities upgrade	The City of Canterbury Council building upgrade, roofing extension and upgrade to footpath of Gordon Parker Reserve amenities.	The Gordon Parker Reserve is located on northwest of the proposal area. Construction was completed in late 2022.	Operational impacts include: - increased foot traffic which may increase littering and pollution into waterways. - decrease in pervious areas which may affect aquifer recharge.	No cumulative impacts are expected given the small nature of works.

6 Management of impacts

6.1 Overview of mitigation measures

As the proposal has the potential to impact surface water and increase erosion risk during construction, a Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction. Due to the proposal's proximity to waterways, a construction water quality monitoring plan would be prepared and implemented as part of the SWMP. The plan will be prepared in accordance with the TfNSW Guideline for Construction Water Quality and EPA publication "Approved Methods for the Sampling and Analysis of Water Pollutants in NSW".

Due to the use of sediment basins during construction, a Construction Water Quality Discharge Assessment will be completed during detailed design in accordance with the EPA's Assessing and managing water pollution from road works and the Draft Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls (TfNSW 2020).

Construction generally reduces ground cover through vegetation removal and excavation, as such, a Preliminary Erosion and Sedimentation Assessment (PESA) was completed (**Appendix C**). Due potential high risk of the proposal an Erosion and Sedimentation Management Report (ESMR)has been prepared by SEEC in accordance with the RMS Erosion and Sedimentation Management Procedure PN 143P (**Appendix E**). Site specific preliminary Erosion and Sediment Control Plans (ESCPs) have been prepared and implemented as part of the ESMR (**Appendix E**).

Due to high levels of groundwater in the northern area of the proposal (closest to the Georges River), there is potential for excavation and construction to intercept groundwater, if this were to occur the Dewatering Assessment that was completed for the 80% design, should be reassessed prior to the construction phase.. The Dewatering Assessment has been conducted by Aurecon to determine possible groundwater volumes and its quality to be dewatered and provide comments on possible groundwater licencing requirements

As the proposal has the potential to intersect ASS in the northern part of the proposal area, an Acid Sulfate Soils Management Plan (ASSMP) would be produced to mitigate impacts of disturbed ASS.

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The road upgrade increases the impervious surfaces of the road, as such treatment is required to reduce the potential increase of contaminants and sediments from the road surface. A Water quality basin and other treatment process has been designed and modelled on MUSIC which is discussed in **Section 5.2.2**.

A summary of mitigation measures and impacts addressed are presented in **Table 6-1**.

6.2 Mitigation measures

Table 6-1 Summary of mitigation measures

ID	Impact	Mitigation measure	Responsibility	Timing
W1	Soil erosion and water pollution	A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction. The Soil and Water Management Plan (SWMP) will be reviewed by a soil conservationist on the TfNSW list of Registered Contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services. The SWMP will then be revised to address the outcomes of the review.	TfNSW/Contractor	Detailed design / pre-construction
		Where possible, permanent drainage structures will be installed as early as possible to facilitate effective separation of clean offsite and dirty onsite water.	Contractor	Construction
W2	Contamination of surface water	Regular visual water quality checks (include for turbid plumes and hydrocarbon spills or slicks) will be carried out when working in or near waterways. Construction water quality monitoring will be undertaken upstream and downstream of the REF proposal to ensure that controls and site practices are effective at maintaining current water quality conditions. Monitoring will be undertaken in accordance with the Guideline for Construction Water Quality Monitoring (RTA, undated).	Contractor	During construction

ID	Impact	Mitigation measure	Responsibility	Timing
W3	Soil erosion and water pollution	The preliminary Erosion and Sedimentation Management Plan (ESMR) and Erosion and Sedimentation Control Plans (ESCP) produced for the proposal (Appendix E to the REF) will be updated during the detailed design phase to refine the erosion and sedimentation controls for the proposal. Final ESCP will be developed by the construction contractor and would include the need to implement progressive ESCPs and the continual updating of these plans during construction.	TfNSW/Contractor	Detailed Design/construction
W4	Water pollution due to stockpiles	Stockpiles site locations would be confirmed during detailed design and where applicable, managed in accordance with Environmental Procedure Management of Wastes on Roads and Maritime Services Land (RMS, 2014) and the Stockpile Site Management Guideline (RMS, 2015). This would consider measures to manage cross contamination within a stockpile area. Further consideration of how to manage stockpiles, material laydown and chemical storage with respect to floodwaters would be undertaken by the construction contractor.	TfNSW/Contractor	Detailed design / pre-construction
W5	Water pollution from accidental spills	A site-specific emergency spill plan would be developed and include spill management measures in accordance with the Transport for NSW Code of Practice for Water Management (RTA, 1999) and relevant EPA guidelines. The plan would address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including TfNSW and EPA officers).	Contractor	pre-construction/
		An emergency spill kit will be kept on site at all times. Spill kits will be located at all ancillary facilities and main construction work areas. All staff would be made aware of the location of the spill kit and trained in its use.	Contractor	During construction

ID	Impact	Mitigation measure	Responsibility	Timing
		The refuelling and maintenance of plant and equipment will be undertaken in a designated sealed bunded area at ancillary facilities, where possible. Vehicle wash downs and concrete washouts will be carried out within designated sealed bunded areas at construction ancillary facilities or carried out off-site.	Contractor	During construction
W6	Stormwater discharges leading to pollution	A Construction Water Quality Discharge Assessment will be completed during detailed design in accordance with the EPA's Assessing and managing water pollution from road works and the Draft Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls (TfNSW 2020).	TfNSW	Detailed design
W7	Works on waterfront land	Works within Milperra Drain to construct the culvert will be undertaken with consideration to the design and construction considerations described in the Guidelines for instream works on waterfront land, Department of Primary Industries, Office of Water, July 2012, Guidelines for watercourse crossings on waterfront land, Department of Primary Industries, Office of Water, July 2012 and in accordance with relevant TfNSW specifications and guidelines.	TfNSW/Contractor	Detailed design / pre-construction

ID	Impact	Mitigation measure	Responsibility	Timing
W7	Groundwater dewatering during excavation	In the event that groundwater/ aquifer dewatering must occur to lower the groundwater table and reduce or prevent groundwater ingress into excavations, then potential impacts on GDEs must be quantitatively assessed prior to dewatering along with appropriate management measures and documented in a site dewatering management plan. Quantitative assessment must include assessment of the magnitude and duration of drawdown and whether impacts are likely to adversely affect the habitat conditions and ecological communities within the GDEs. Relevant approvals and permits must be obtained prior to groundwater/ aquifer dewatering.	Contractor	Pre-construction
W8	Encountering ASS	An Acid Sulphate Soil Management Plan (ASSMP) will be prepared and implemented to manage PASS or ASS exposed from excavations of soils between 2 and 4 metres, changes to groundwater levels and stockpiling. The ASSMP will be informed by the results of the Detailed Site Investigation that will include the identification of presence and extent of ASS/PASS, particularly around the culvert works over Milperra Drain.	Contractor	Detailed design / pre-construction
W9	Water pollution from Stormwater	Design stormwater system to reduce pollutant loads to waterway. Target pollution reduction to be based on information in **Section 5.2.2**.	TfNSW/	Concept design / detailed design

7 Conclusion

This report includes a desktop review of available information to identify the potential risks to soils and surface and groundwater resources and recommendations during the construction and operation of the proposal. Most of the impacts are expected to occur during the construction phase.

The main impacts of concerns during construction to soils, surface and groundwater sources include erosion and sedimentation impacts and contamination. Vegetation removal and earthworks may destabilise soils and erode exposed soils. With saline soils and ASS present within proposal area, runoff from construction sites could increase the acidity and salinity of nearby waterways or leach into groundwater aquifers. Other impacts to include contamination from accidental leaks and spill of hydrocarbons or grease.

During operation, the main impact will be the increased stormwater runoff from the increased impervious areas. Motor vehicles using the proposal will generate road dust that may contain heavy metals. Stormwater runoff will transport these road dusts into waterways, which may leach into groundwater sources. Additionally, greater volumes of runoff will introduce higher risks of scour and erosion at stormwater outlets, degrading the bank stability and cause erosion of soils.

To minimise impacts to surface water and groundwater, a range of measures would be implemented during the detailed design, construction and operational phases of the project such as the preparation of:

- Soil and Water Management Plan as part of the CEMP to mitigate soil erosion and water pollution during construction
- Acid Sulphate Soils Management Plan as part of the CEMP to address encountering and disturbing ASS during construction
- Erosion and Sediment Control Plan as part of the SWMP to minimise soil erosion and sediment transport to nearby waterways during wet weather events
- Dewatering Assessment to mitigate pollution from dewatered groundwater
- Site-specific emergency spill plans to address accidental spills and leaks of hydrocarbons,

Additionally, the construction methodologies would consider the following:

- Appropriately designed scour protection at new stormwater management points.
- End-of-line water quality treatment of stormwater runoff.
- Stockpile site locations, material laydown and chemical storage to prevent water pollution.

Overall, with the implementation of the proposed mitigation measures, the project is expected to have acceptable and minimal impacts on existing soil, surface water, groundwater resources and environmental values during both the construction and operation phases.

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Appendix A Selected Water Quality Objectives

Selected Water Quality Objectives

Indicator	Units	Aquatic Ecosystem Criteria		ANZ 2018 primary and secondary contact criteria	Selected Water Quality Objective
		ANZG 2018 DGVs (slightly disturbed ecosystems default trigger value for SE Australia Lowland Rivers)	Georges River (slightly disturbed ecosystems default trigger value for SE Australia Estuaries)		
Temperature	˚C	N/A	N/A	15-35	16-34
Total Phosphorus (TP)	mg/L	0.05	0.03	N/A	0.05
Total Nitrogen (TN)	mg/L	0.5	0.3	N/A	0.5
Turbidity	NTU	6-50	0.5 – 10	N/A	6-50
Salinity (electrical conductivity)	µS/cm	125 – 2,200	N/A	N/A	125 – 2,200
Dissolved Oxygen	% SAT	85 - 110	80 - 110	> 80	85 - 110
pH	-	6.5 – 8.0	7.0 – 8.5	5.0 – 9.0	6.5 – 8.0
Arsenic (III)	mg/L	0.024*	N/A	0.007	0.007
Cadmium	mg/L	0.0002*	0.0055**	0.0020	0.0002
Chr**omium (III)**	**mg/L**	**N/**A	0.**0274****	**N/A**	0.**0274**
Chromium (VI)	mg/L	0.0043*	0.0044**	0.0500	0.0043
Copper	mg/L	0.0013*	0.0013*	1.0000	0.0013
Iron	mg/L	N/A	N/A	0.3	0.3
Lead	mg/L	0.0034*	0.0044**	0.01	0.0034
Mercury (inorganic)	mg/L	0.0004*	0.0004**	0.0010	0.0004
Nickel	mg/L	0.07*	0.07**	0.02	0.07
Zinc	mg/L	0.008*	0.015**	3	0.008
PFOS	µg/L	0.00023*	0.00023**	0.0020¥	0.00023

*ANZ 2018 toxicant trigger value for freshwater (95% level of protection); **ANZ 2018 toxicant trigger value for marine (95% level of protection); ¥NHMRC 2019 Recreational water quality standard for sum of PFOS and PFHxS; N/A = Not available due to insufficient toxicity data

Appendix B Registered Bores

Registered Bores

BoreID	Drilled Depth	Status	Drilled Date	Latitude	Longitude	Type
GW113373	4	FUN	3/07/2007	-33.9301954	150.9909228	Monitoring
GW113186	8.3	FUN	26/08/2013	-33.9331524	151.0097626	Monitoring
GW023146		UNK	1/11/1965	-33.9256466	150.9764378	Water Supply
GW108838	240	USE	17/01/2006	-33.9364926	150.9861664	Monitoring
GW112549	6.5	FUN	12/04/2010	-33.9276013	150.9806212	Monitoring
GW113995	4	FUN	26/08/2013	-33.9411454	150.9972216	Monitoring
GW113375	5	FUN	4/07/2007	-33.9300422	150.9909264	Monitoring
GW111967	12	FUN	8/08/2012	-33.9416387	151.0026086	Monitoring
GW113374	5	FUN	4/07/2007	-33.9301044	150.9908709	Monitoring
GW113372	5	FUN	3/07/2007	-33.9301583	150.9908588	Monitoring
GW113999	7	FUN	26/08/2013	-33.9401509	150.997061	Monitoring
GW112548	7	FUN	12/04/2010	-33.9273632	150.9803996	Monitoring
GW113994	5.2	FUN	26/08/2013	-33.9410969	150.9959029	Monitoring
GW112547	8	FUN	12/04/2010	-33.9274998	150.9804829	Monitoring
GW106700	16	UNK	25/08/2004	-33.918376	150.9771992	Other
GW113998	4.5	FUN	26/08/2013	-33.9406725	150.9958696	Monitoring
GW047864	252	USE	1/12/1979	-33.9184083	150.9764694	Other
GW110200	8	UNK	15/06/2009	-33.9273111	150.9805833	Monitoring
GW109755	8.7	UNK	26/11/2002	-33.9162045	150.9691446	Monitoring
GW113376	5	FUN	4/07/2007	-33.9300358	150.9910888	Monitoring
GW113997	12.5	FUN	26/08/2013	-33.9404342	150.9967406	Monitoring
GW113993	4	FUN	26/08/2013	-33.9411383	150.995123	Monitoring
GW115695		FUN	2/05/2013	-33.9334887	150.9767285	Monitoring
GW115693		FUN	8/05/2013	-33.9332057	150.9781631	Monitoring
GW115694		FUN	8/05/2013	-33.9328101	150.977134	Monitoring
GW115690		FUN	8/05/2013	-33.9325436	150.9779299	Monitoring
GW115691		FUN	8/05/2013	-33.9329116	150.9783756	Monitoring
GW115697		FUN	2/07/2013	-33.9348508	150.9773129	Monitoring
GW115696		FUN	2/08/2013	-33.9344322	150.9765331	Monitoring
GW115692		FUN	8/05/2013	-33.93315	150.9786188	Monitoring

GW113996	4	FUN	26/08/2013	-33.9408257	150.9975212	Monitoring

Appendix C PESA

PESA

PN 143P Erosion and Sedimentation Management Procedure (RTA, 2008) requires all proposals be subject to a Preliminary Erosion and Sedimentation Assessment (PESA), following the procedure in Attachment 1a of that document. The PESA uses “triggers” that, if exceeded, classify a project as high risk.

For this project, two out of four triggers are exceeded, as detailed in the table below. As such, the project is considered potentially high risk, which triggers the requirement to engage a Soil Conservation Consultant and to prepare an ESMR.

Triggers	Yes/No	Comments
Does the complexity or size of the project result in it being inherently high risk as ongoing installation and maintenance of controls will require extensive coordinated resources?	No	Apart from traffic management, construction is not complex and does not involve any ground disturbing activities that are inherently high risk (from an erosion control perspective).
Assess the erosion hazard of each catchment area to be disturbed for the proposed project using attachment 1b (of PN143 P). Are any of the proposed construction areas defined as “High Erosion Hazard”?	No	Using the RUSLE, the overall site was assessed (calculations are presented below)
Are there known site constraints that limit the implementation of appropriate erosion and sedimentation control measures?	Yes	The proposal is located in an existing road corridor. Existing residential areas occur directly adjacent to the proposal. Limited space is identified for erosion and sedimentation controls. Services, traffic and staging constraints might limit the potential for erosion and sediment controls. Potentially high ground water tables might limit the ability to install sediment control traps. Part of the proposal lies on a floodplain. The risk of flooding can impact on the potential to install and maintain erosion and sediment controls such as sediment basins.
Are there identified sensitive receiving environments that will receive stormwater discharge from the construction project? Examples of sensitive environments include: • Listed wetland (Sepp14) • State and National Parks • Littoral Rainforest (SEPP26) • Drinking water catchments	Yes	The most northerly 100m of the proposal footprint lies within the Proximity Area for Coastal Wetlands and a mapped Coastal Wetland is approximately 60 m to the east of the proposal footprint at the Flower Power Garden Centre. Stormwater from the site would typically discharge westwards into Milperra Drain which flows into the Georges River Estuary after approximately 1 km.

An assessment of the erosion potential from areas that will be disturbed during the construction of the proposal was carried using the procedure set out in Appendix A of the Blue Book. The procedure involves the estimation of the soil loss from disturbed areas using the Revised Universal Soil Loss Equation (RUSLE), the formula for which is as follows:

A = R x K x LS x P x C

where, A = computed soil loss (tonnes/ha/year)

R = rainfall erosivity factor

K = soil erodibility factor

LS = slope length / gradient factor

P = erosion control practice factor

C = ground cover and management factor

The Table below contains a summary of the adopted values for the RUSLE calculations together with an estimate of the area of disturbance that would trigger the need for the installation of a sediment basin in accordance with the recommendations set out in the Blue Book.

Parameter	Value	Comment
R (rainfall erosivity factor)	1930	A rainfall erosivity factor of 1,930 was derived using the 2 year Average Recurrence Interval, 6 hour design storm intensity that was obtained from the Bureau of Meteorology website.
K (soil erodibility factor)	0.059	The mapping contained in the *Soil Landscapes of the Penrith 1:100,000* (Bannerman & Hazelton, 2010) shows that the proposal is located on land that is mapped as either Richmond Soil Landscape or the Blacktown Soil Landscape. Blacktown Soil Landscape has a recommended K value of 0.038 in Table 19 of Appendix C of Landcom, 2004 Richmond Soil Landscape has a recommended K value of 0.059 in Table 19 of Appendix C of Landcom, 2004 Richmond Soil Profile is adopted for the PESA.
LS (slope length / gradient factor)	0.53	Based on a slope of 3% and length of 80 m, which is the upper value of slope and length across the proposed areas of disturbance.
P (erosion control practice factor)	1.3	Assumed maximum value based on compacted and smooth surface conditions.
C (ground cover management factor)	1.0	Assumed maximum value based on worst case scenario with zero ground cover.
A (total calculated soil loss)	78tonnes/ha/yr	Representative soil loss for the proposal. All sub-catchments were analyzed and can be characterized as low erosion hazard.
Erosion Hazard	Very Low (Soil Loss Class 2)	Based on Table 4.2 of Landcom, 2004.

Appendix D MUSIC Modelling

MUSIC Modelling

To	**Transport for NSW**	From	**Aurecon**
Revision	**04**	Reference	**520566**
Date	**2023-02-13**	Pages (including this page)	**15**
Subject	**Henry Lawson Drive 1B - Water Quality Assessment**		

1 Introduction

Transport for NSW (TfNSW) has initiated the widening of Henry Lawson Drive between Auld Avenue and the South Western Motorway (M5). The project consists of upgrading approximately 1.8 kilometres (km) of Henry Lawson Drive. The work includes widening Henry Lawson Drive to two lanes in each direction with lane widths of 3.5 m and shared paths or footpaths along the proposal length. The proposed Henry Lawson Drive Stage 1B has a surface area of approximately 13.934 hectare as shown in Figure 1-1.

This memo serves to document the concept operational water quality MUSIC modelling strategy and results. The concept water quality strategy has been developed based on concept road design. The strategy is aimed at meeting the water quality objectives that have been established of limiting the discharge of pollutant loads from the proposed corridor to none greater than those under present day conditions. i.e., Neutral or Beneficial Effects (NorBE).

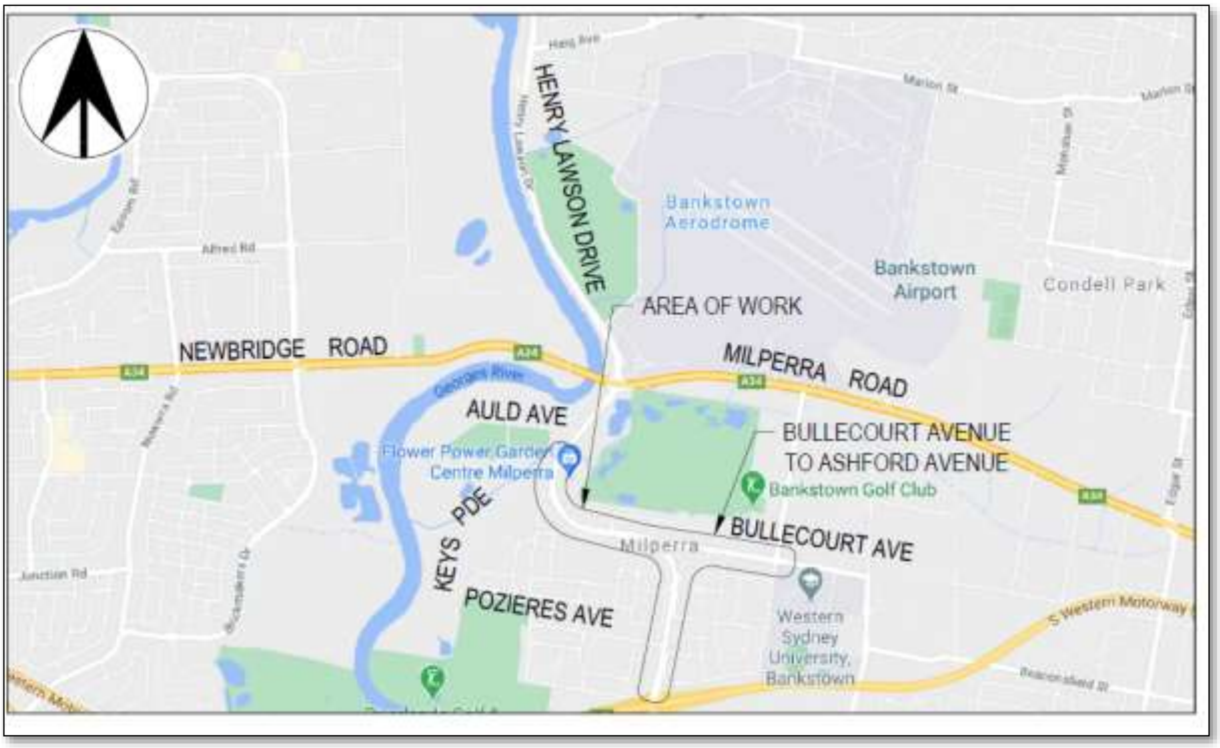


Figure 1-1 Proposed Road Layout

2 Background

Contaminants typically associated with road runoff include suspended solids, heavy metals, litter, nutrients such as nitrogen and phosphorus, oils, and greases. These contaminants build up on the road surface during dry weather and then get washed away during rainfall events. The proposed road widening has the potential to increase the amount of pollutants discharged into the receiving drainage network if appropriate mitigation measures are not incorporated into the design. The increase in pollutants is due to the increase in paved area combined with an increase in vehicle movements due to the upgrade requirements. This water quality study was completed using stormwater runoff modelling software (MUSIC) to demonstrate the extent to which the proposed road widening will impact water quality in the receiving waters.

The TfNSW water quality objectives are outlined below:

- Clause 3.1 of PS271 requires the development and design of a water management system that complies with RMS Water Policy 1997 which requires:
  - 85% retention of the average annual load - Total Suspended Solids (TSS),
  - 65% retention of the average annual load - Total Phosphorus (TP), and
  - 45% retention of the average annual load – Total Nitrogen (TN)

The ability to install water quality improvement measures to meet the best management practice guidelines is constrained by the prevailing topography, project corridor boundary, space required for maintenance access of the treatment measures and existing drainage network. These constraints limit the ability to provide runoff treatment to all areas of discharge. Under practical considerations, the project has been unable to achieve the water quality targets specified under RMS Water Policy 1997.

Notwithstanding the above constraints, the project therefore aims at minimum to provide a Neutral or Beneficial Effects (NorBE) for the residual water quality impact i.e. a no worsening impact from pre-development conditions.

3 Purpose

The purpose of this memorandum is to document the findings of an investigation into the requirements for controlling the impact of the operational phase Stage 1B of the proposed Henry Lawson Drive Upgrade project on water quality in the Georges River and Milperra Drain.

4 Inputs and assumptions

4.1 Available data and information

The following data was available and used to develop the MUSIC model:

- Proposed design TIN in 12D
- Existing surface TIN in 12D

- Proposed road design layout
- Existing road design layout
- Lidar survey
- QGIS pit & pipe data
- Proposed sub-catchment areas

4.2 Assumptions

- The proposed corridor is assumed to be a completely impervious surface (MUSIC source node to be "sealed road".
- The MUSIC modelling is a high-level assessment of stormwater quality based on available data;
- The proposed footpaths and residential areas along HLD1B are assumed to be "residential" areas as the MUSIC source node. Permeability ratios have been adopted based on google maps satellite views for each catchment pollutant source node.
- The proposed works on Bullecourt Ave involve asphalting works and retaining existing kerb and gutter. No drainage works are proposed on Bullecourt Ave. The land usage and development on Bullecourt Ave is not expected to impact operational water quality and therefore the area has been excluded from the MUSIC model.
- This HLD Stage 1B MUSIC assessment is independent of HLD Stage 1A MUSIC assessment however there are areas of interface between the two projects. The HLD1A detailed design MUSIC assessment is inclusive of the new HLD bridge crossing Milperra Drain catchment as well as Milperra Road Upgrade catchment. These catchments have been taken into consideration by HLD1A water quality assessment and therefore have been excluded from HLD1B's MUSIC assessment. The extent of HLD1B's MUSIC assessment is shown in Annexure A.

5 MUSIC model development

5.1.1 Modelling Strategy

A concept stormwater quality approach was developed to offset, to the maximum extent practicable within available site conditions, the increase in pollutant loading attributable to the proposed road upgrade. Offsetting the increase in pollutant loading would ensure that NorBE is achieved.

The modelling strategy first involves developing a music model that reflect the pollutant loads generated to the outlet location (Milperra Drain) under the present-day scenario. This process involves delineating the existing catchments that drains into the outlet location (Milperra Drain) over the area where the proposed development will be situated. The delineation of catchments and perviousness of catchments are determined from google satellite imagery. This will be termed the "Existing Model".

The Existing Model is then adjusted to reflect the post upgrade conditions to assess the impact of the proposed road works on the pollutants at the outlet location. The adjustment involves changing catchment boundaries, perviousness of catchments and drainage paths based on the proposed drainage plans. The rainfall, evapotranspiration, soil type, land use category and other parameters which are unaffected by the proposed developments, remains unchanged.

5.1.2 Rainfall data & Pollutant Generation

Rainfall records from Bankstown Station the period 1968 to 1992, 6 minutes were selected for use in the MUSIC models. Rainfall losses and pollutant concentrations in baseflow and stormwater flow were based on values recommended in the publication "Using MUSIC in Sydney's Drinking Water Catchment" (SCA, 2012). MUSIC X Version 1.1.0 was used to analyse the developed MUSIC X models. The rainfall data used are shown in Figure 5-1.

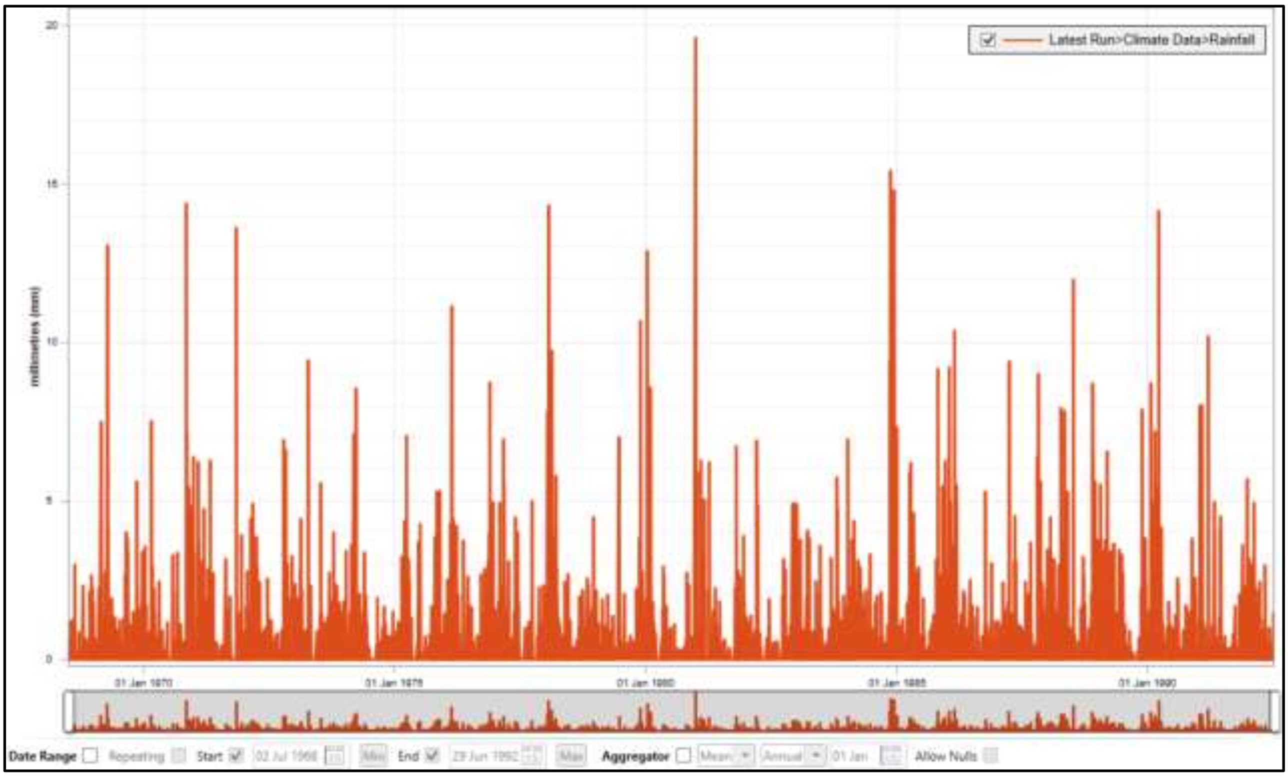
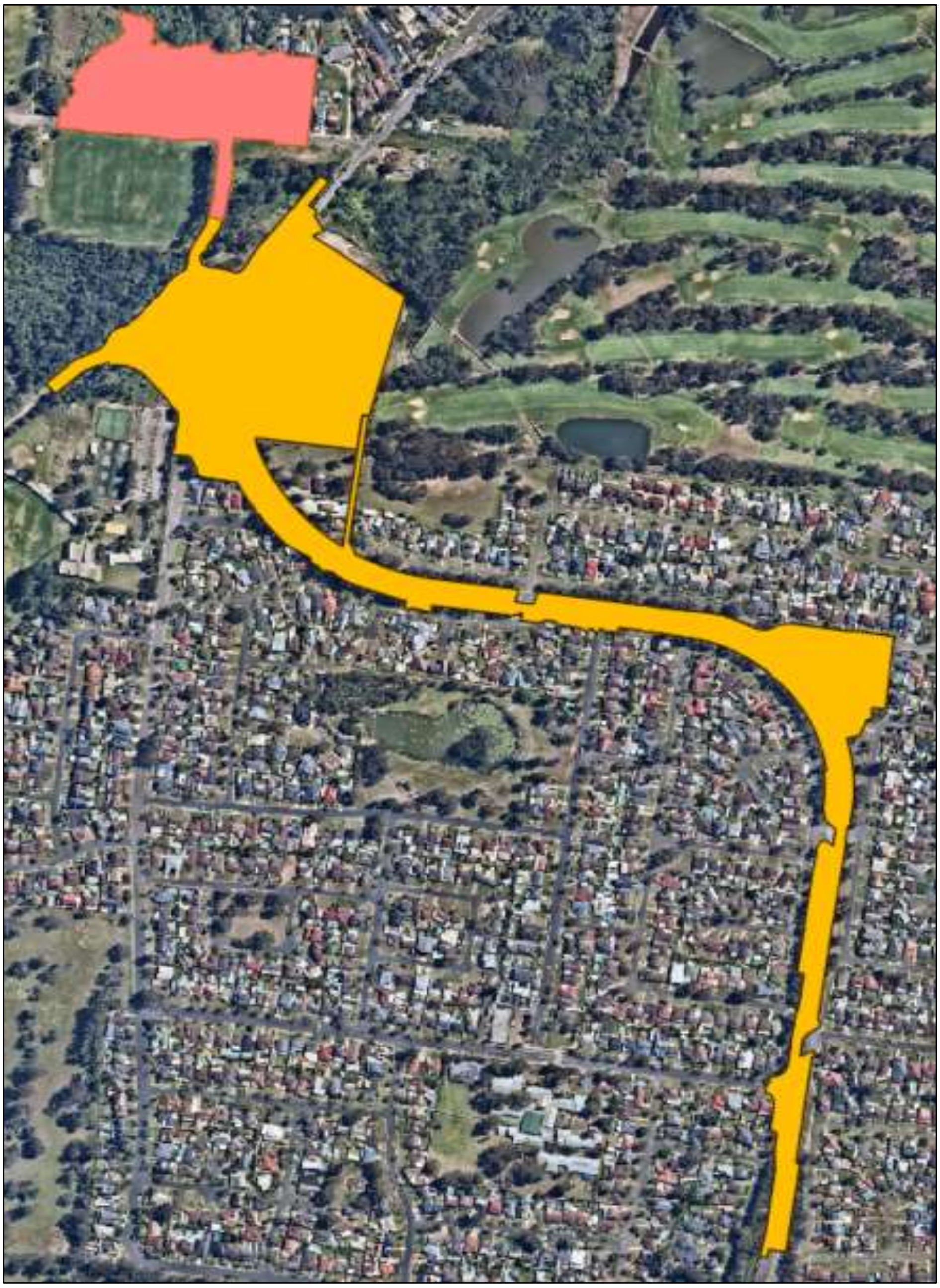


Figure 5-1 Rainfall data

5.1.3 Existing stormwater treatment measures

There is an existing "swale" on Link Road in Sub-catchment 5B (SC5B) and a series of open channels along HLD1B that serve the existing HLD1B and Local Roads. There are no known formalised stormwater management systems that provide formal water quality treatment, with the exception of the existing swale at Link Road noted above and existing grassed roadside conveyance open channels (which are expected to provide minimal water quality treatment benefits along Henry Lawson Drive Stage 1B). These channels are limited and are generally located on the northbound side of HLD1A between Ruthven Avenue and Auld Avenue. The existing stormwater catchments and land use type are shown in Figure 5-2 below.



LEGEND

Land use type

- Untreated Area
- Treated Area

Figure 5-2 Existing Stormwater Catchments and Land Use Type

5.1.4 Proposed stormwater treatment measures

Figure 5-3 shows the proposed stormwater catchments and land use type for Henry Lawson Drive Stage 1B (HLD1B) project and the proposed stormwater treatment measures within the site. Sub-catchments (SC) are separated based on land use category and based on areas to be treated and outlet location. The proposed stormwater treatment consists of 1 bioretention basin located in sub catchment 1B (SC1B), 2 Gross Pollutant Trap (GPT’s) devices, 177m long vegetated swales and 90m long vegetated swales. These treatment measures are similar to the measures proposed for HLD1A. The treatment measures for stage 1B have largely been based on HLD1A water quality strategy and feedback received from various stakeholders during Stage 1A consultation processes, including Canterbury Bankstown Council. i.e., Canterbury Bankstown Council recommended during Stage 1A consultation, that end of line treatments devices (such as GPTs) are preferred over multiple separated swale treatments as maintenance can be more readily provided at a single end of line location rather than separated over different areas.

The bioretention basin has a filter area of 650 m^2. The stormwater runoff generated from the HLD1B will be treated via bioretention basins, GPT’s devices as well as through vegetated swales before discharging into the existing pipe network or existing watercourses. A portion of the HLD1B area will not be treated (as shown in blue, green, magenta, yellow, brown and pink) as stormwater runoff within this area will be discharged directly into the existing pipe network or existing watercourses. A proportion of the HLD1B (SC1A) runoff will be discharged directly into the bioretention basin.

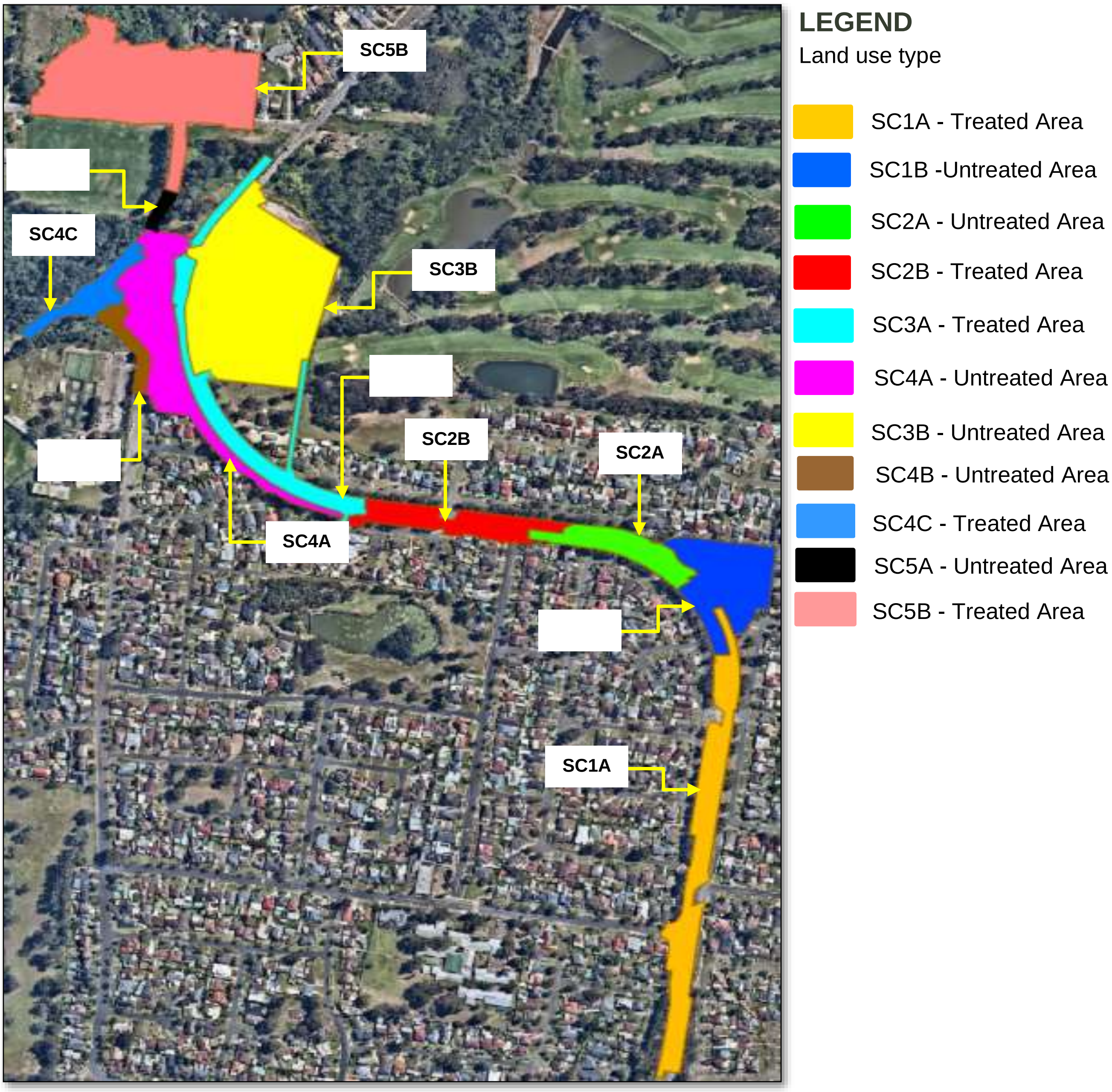


Figure 5-3 Proposed Stormwater Catchments and Land Use Type

5.1.5 Model diagram and parameters

Figure 5-4 shows the schematic diagram of the pre-development MUSIC model. The pre-development scenario consists of an impervious area of 3.061 hectare and a pervious area of 10.873 hectare. The pollution sources are from the urban - sealed roads, commercial areas, mixed areas and forests. In terms of treatment measures there is only one swale that treats a small part of the site.

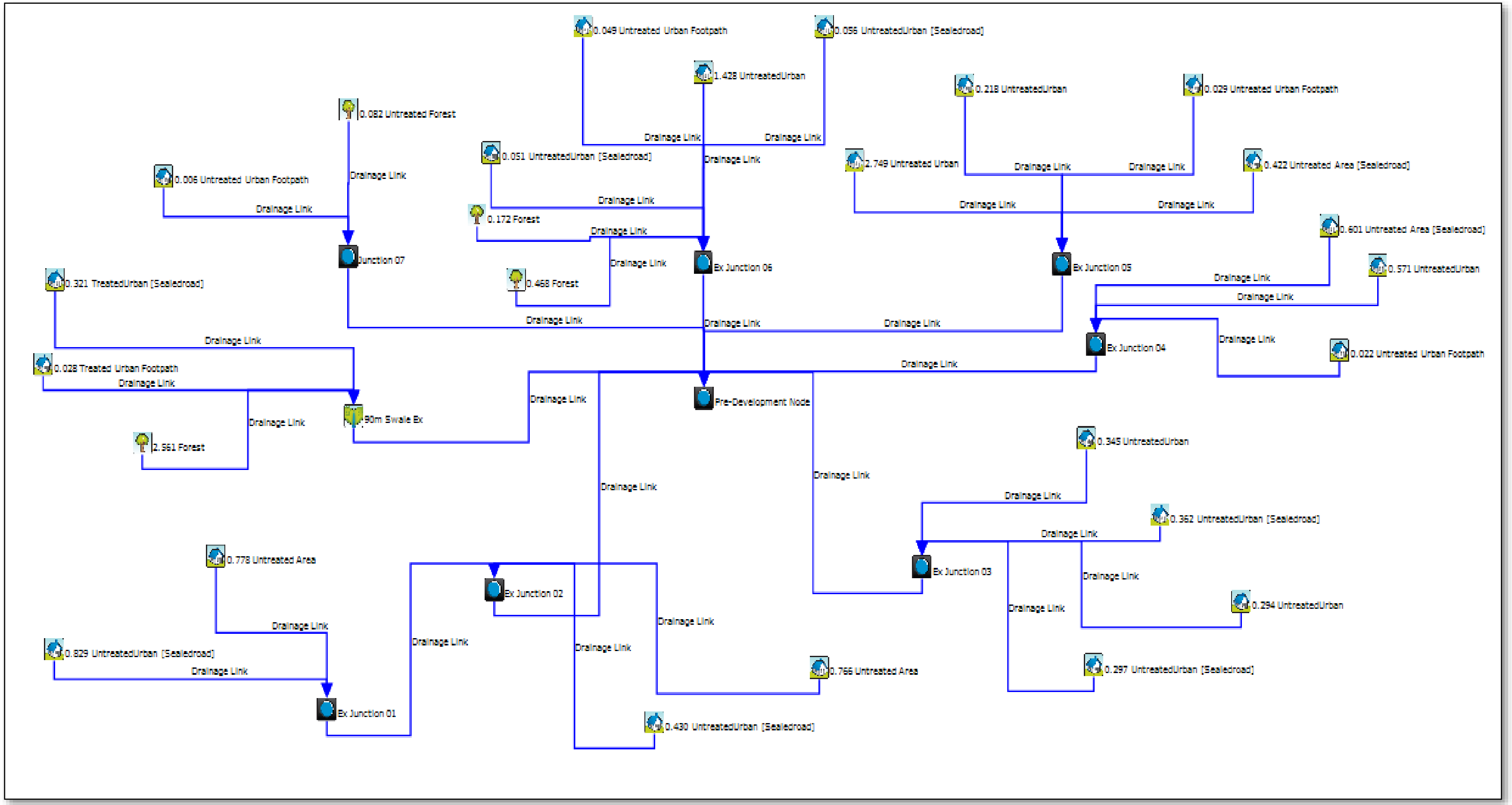


Figure 5-4 MUSIC schematic diagram of the existing design treatment train on HLD1B

Figure 5-5 shows the schematic diagram of the post-development MUSIC model. The post-development scenario consists of an impervious area of 8.263 hectare and a pervious area of 5.672 hectare. The pollution sources are from various urban areas - sealed roads, commercial areas, mixed-use areas, and forests. The treatment measures consist of one bioretention, two (2) GPTs, and two (2) swales. All the above treatment measures treat approximately 6.886ha of the site.

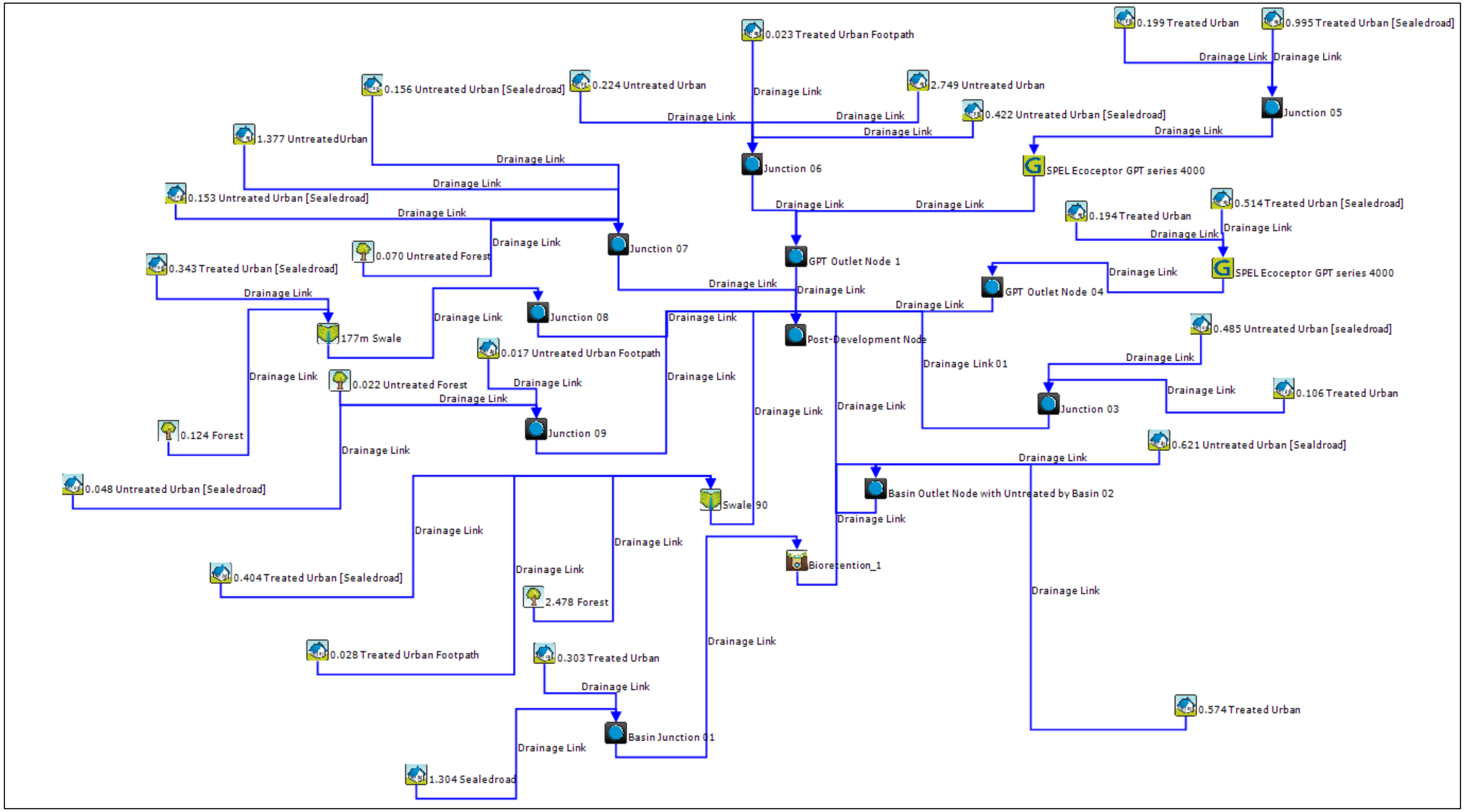


Figure 5-5 MUSIC schematic diagram of the proposed design treatment train on HLD1B

Figure 5-6 shows the parameters of the MUSIC model used for the bioretention basin. The bioretention node have been sized according to eWater guidelines and bioretention basin has a filter area of 650m², and a filter depth of 0.4 m.

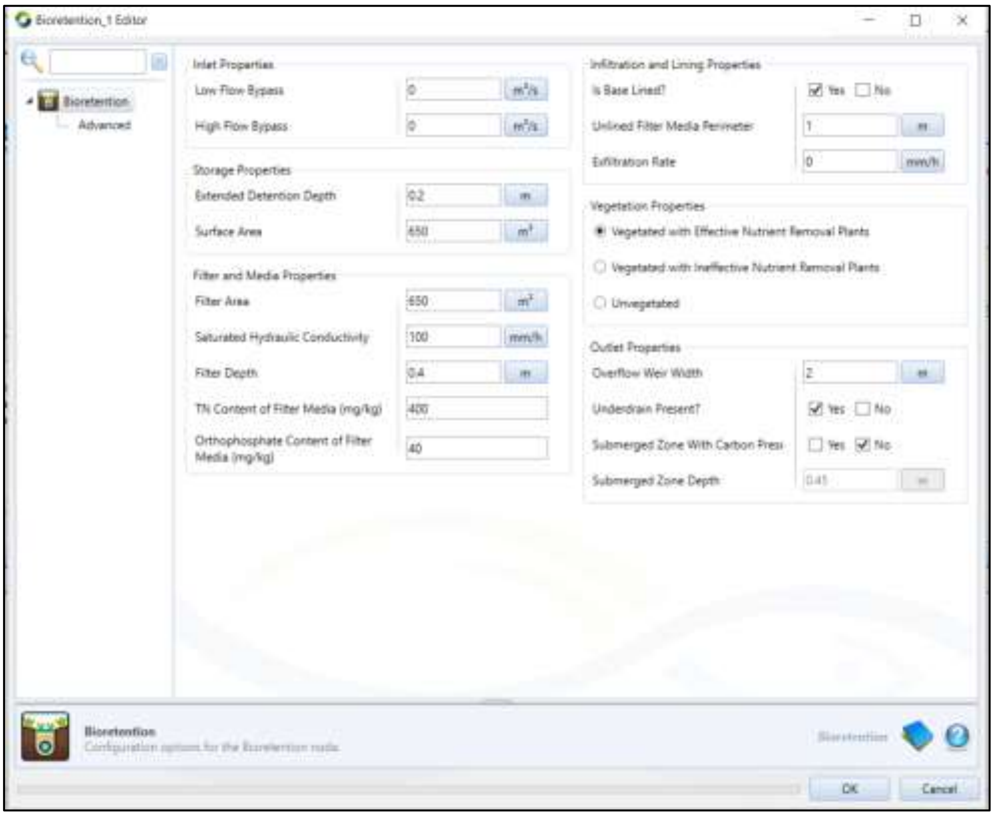


Figure 5-6 MUSIC model parameters used in bioretention basin

Figure 5-7 shows the MUSIC model parameters used for the two (2) x Ecoceptor GPT devices. The flows and parameters were adopted using the SPEL MUSIC Node Standard.

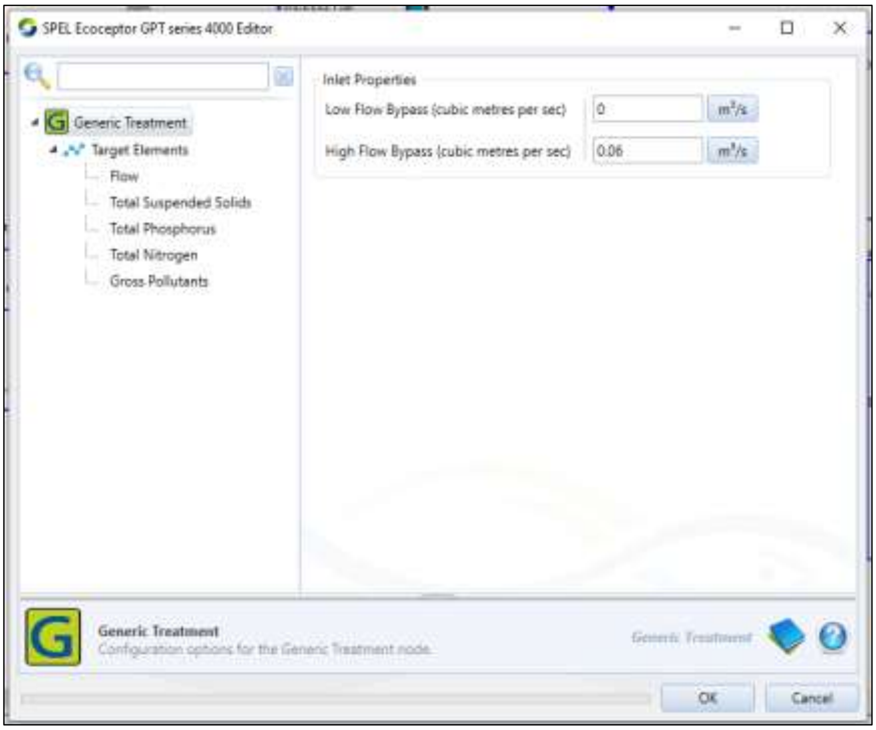


Figure 5-7 MUSIC model parameters for Ecoceptor GPT

Figure 5-8 shows the parameters of the MUSIC model used to treat stormwater in sub-catchment 4C (SC4C). The swale was designed based on the catchment area that contributing into the swale. The height of the vegetation was adopted to be 0.2m and no bypass flows or exfiltration rates were allowed because no losses are expected in the swale.

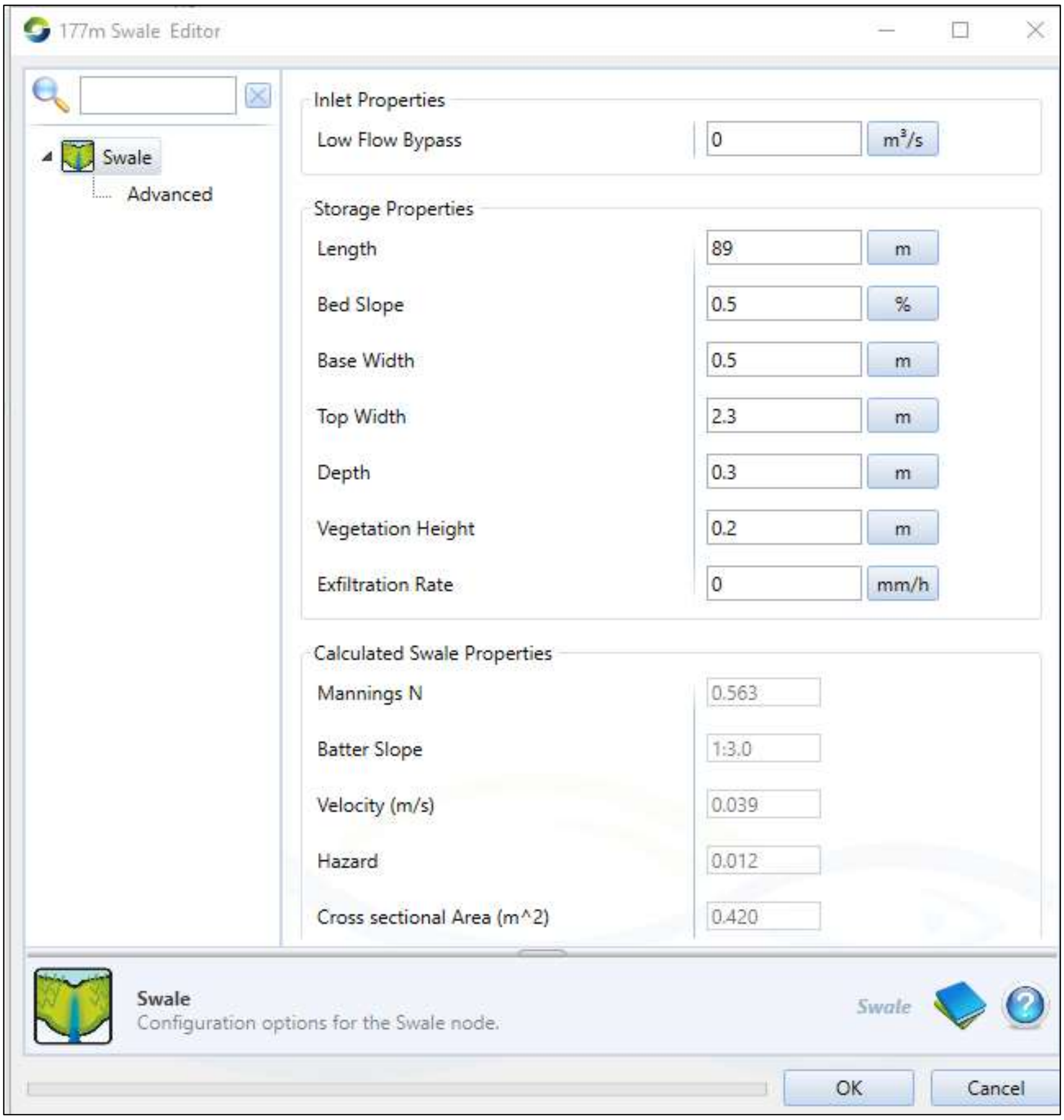


Figure 5-8 MUSIC model parameters used in vegetated swale

Figure 5-9 shows the parameters of the MUSIC model used to treat stormwater in sub-catchment 5B (SC5B). The swale was designed based on the catchment area contributing to the swale. The height of the vegetation was adopted to be 0.25m and no bypass flows or exfiltration rates were allowed because no losses are expected in the swale.

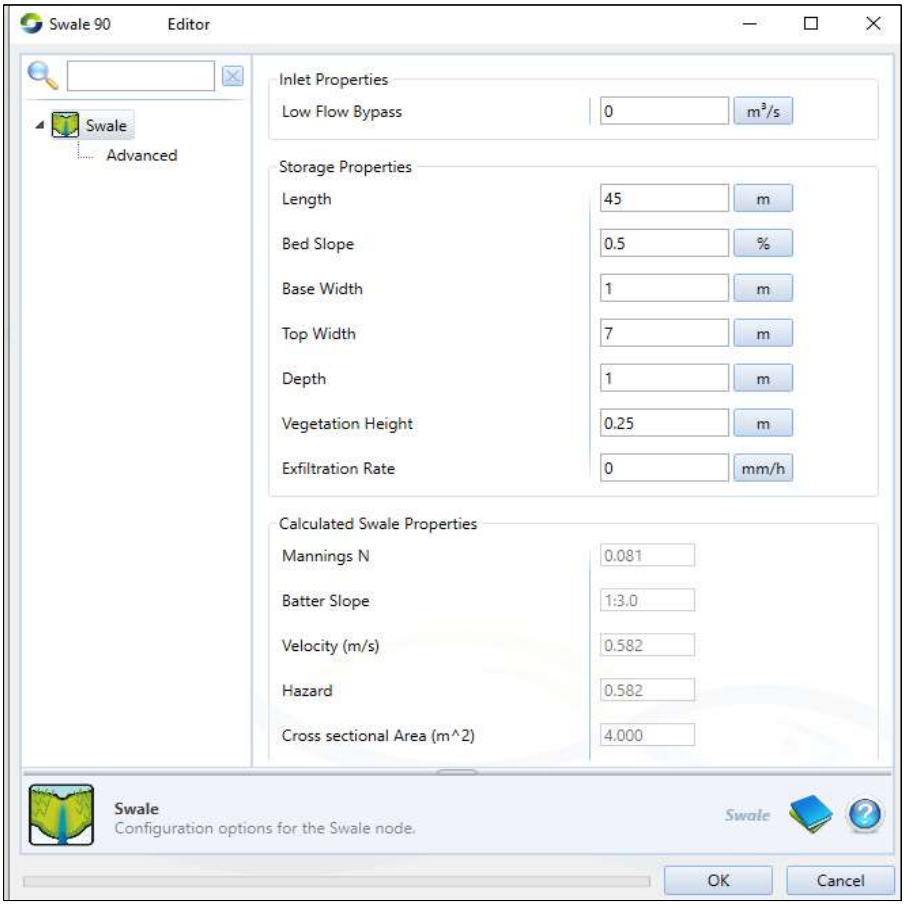


Figure 5-9 MUSIC model parameters used in vegetated swale

6 MUSIC modelling results

Table 6-1 shows the results of the MUSIC models for:

1. Pre-development,
2. Post-development conditions (without treatment),
3. Post-development results with the proposed mitigation water quality strategy model for the site.

Table 6-1 shows results without mitigation measures, the average annual weight of gross pollutant TSS, TP, and TN, would increase resulting in a negative impact on water quality by TSS 40%, TP 38%, TN 27% and gross pollutants 34%, for the project as a whole. Figure 6-1 shows the location of proposed stormwater quality measures along the HLD1B. Table 6-1 shows that with the inclusion of the aforementioned stormwater quality measures, a reduction to the average annual weight of gross pollutants, TSS, and TP compared to present day conditions is expected for the project site. NorBE is therefore achieved for the stage 1B project. Without treatment, the post-development conditions would result in a worsening of water quality in all 4 types of pollutant: TSS, TP, TN and GP. Table 6-2 shows the summary of stormwater quality mitigation devices proposed in the treatment strategy.

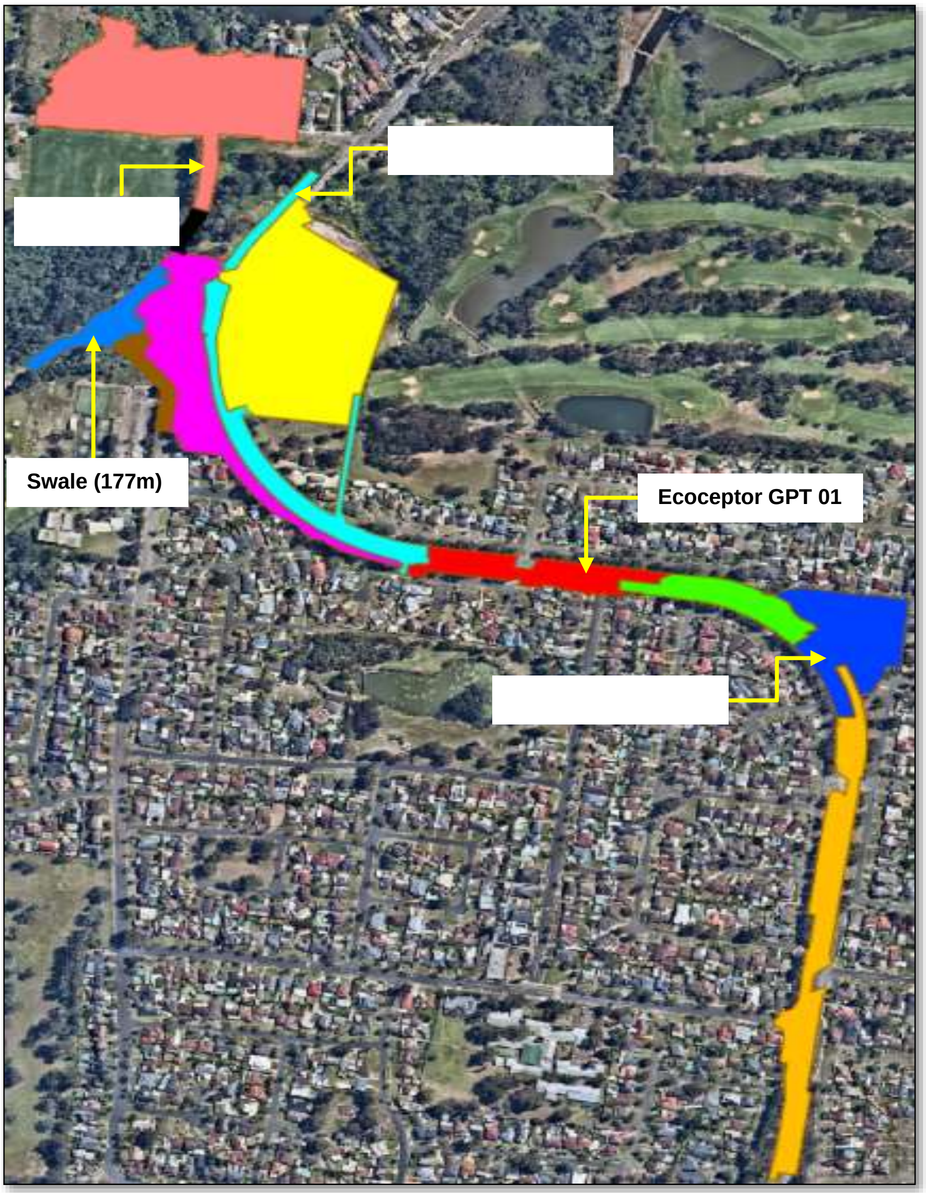


Figure 6-1 Location of stormwater quality measures

Table 6-1 Summary of treatment train effectiveness on HLD1B

Pollutant type	Pre-development		Post-development	
	Sources	Residual Load	Sources	Residual Load
Total Suspended Solids (kg/yr)	10594	9963	14859	8454
Total Phosphorus (kg/yr)	20	20	28	18
Total Nitrogen (kg/yr)	119	120	151	117
Gross Pollutants (kg/yr)	1243	1170	1661	941

Table 6-2 Summary of stormwater quality measures

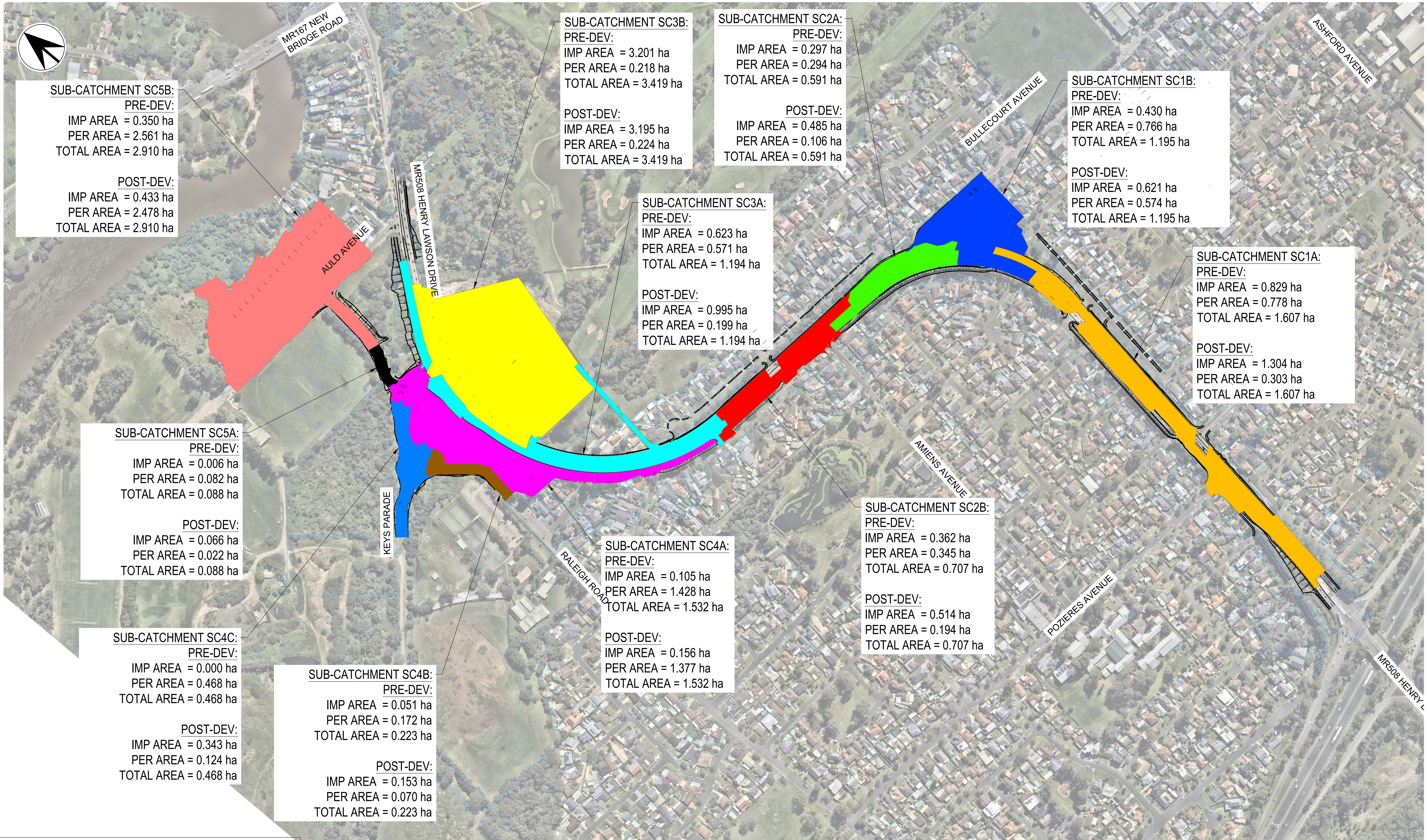
Water Quality Strategy Model	Stormwater Quality Measure & Identifier	Stormwater Quality Arrangement			
		Bio-Retention Basin Surface Area (m^2)	Bio-Retention Basin Filter Area (m^2)	Vegetated Swale Length (m)	GPTs (no. of devices)
Proposed Mitigation MUSIC Model	Bioretention Basin	650	650	-	-
	Ecoceptor GPT 01	-	-	-	1 x Ecoceptor Series 4000
	Ecoceptor GPT 02	-	-	-	1 x Ecoceptor Series 4000
	Proposed Swale	-	-	177	-
	Proposed Swale	-	-	90	-

7 Conclusion

A MUSIC model was developed for the proposed concept road widening works for Henry Lawson Drive Stage 1B to measure the impact of the project on operational water quality. The assessment presented in this memorandum has demonstrated the pre-development and post- development operational water quality results. The results indicated that the Georges River water quality requirements for achieving NorBE were met. The proposed treatment train consist of a Bioretention basin, Gross Pollutant Traps (GPT's), and vegetated swales along the proposed road design upgrade. For consistency purposes, the water quality treatment measures proposed in this memorandum were selected based on HLD1A which incorporated feedback from various stakeholders including Canterbury Bankstown Council.

There are limited opportunities to implement a range of treatment measures due to project boundary and spatial & topographical constraints. The results are based on concept drainage and road design geometry. Further refinement is required in detailed design stages.

8 Annexure A – Catchment Layout



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FOR REVIEW AND COMMENT

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PLOT DATE & TIME: 10/2/2023 3:54:03 pm

REFERENCES:

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	FOR INFORMATION			

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SCALE: 1:2500

1:2500 @ A1 0 20 40 60 80 100 120 m

DESIGN LOT CODE: -

CLIENT: NSW GOVERNMENT Transport for NSW

PREPARED FOR:
INFRASTRUCTURE AND PLACE DEVELOPMENT
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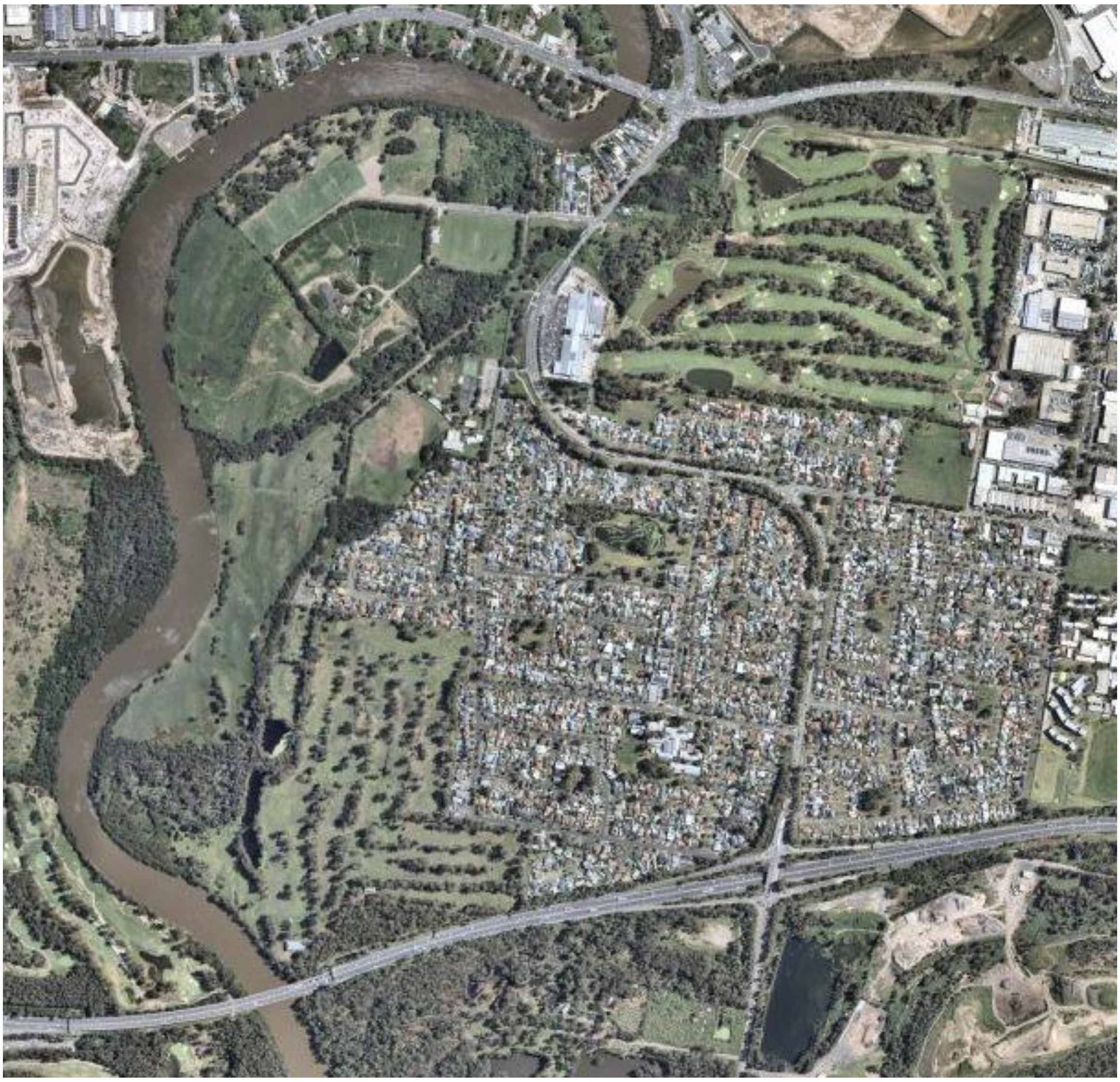
CANTERBURY - BANKSTOWN CITY COUNCIL
MR508 HENRY LAWSON DRIVE
HENRY LAWSON DRIVE BETWEEN SOUTH WESTERN MOTORWAY AND AULD AVE
STORMWATER DRAINAGE
CATCHMENT LAYOUT

DRAWING SET No: DS2021/000426 | PART: 1 | SHEET: 01 OF 01
STATUS: 80% CONCEPT DESIGN - SUBMISSION | BRIDGE No: - | ©
DRG No. | REV - | VER - | EDMS No. - | AMD No. -

Appendix E ESMR

SEEC



Erosion and Sediment Management Report

Henry Lawson Drive Upgrade; Stage 1B

Prepared for:

Aurecon and Transport for NSW

26 April 2023

Strategic Environmental & Engineering Consulting

SEEC

Strategic Environmental and Engineering Consulting

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Document Certification

This report has been developed based on agreed requirements as understood by SEEC at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects.

Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

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26 April 2023

Version Register

Version	Date	Author	Reviewer	Notes	Other
A	06/12/22	AT	AM	Draft ESMR - Rev A issued for review	
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C	28/02/23	AT/AM	AM/LO	Updated to 80% design	
D	26/04/23	AT/AM	AM/LO	Minor updates to address comments	

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1 INTRODUCTION

1.1 Proposal Identification

Transport for NSW (Transport) proposes to upgrade a 1.8-kilometre section of Henry Lawson Drive between Auld Avenue, Milperra and the approach to the M5 Motorway (known as the Henry Lawson Drive Upgrade Stage 1B) (the proposal). This includes road widening to increase traffic capacity and improve travel time as well as upgrades of key intersections to enhance capability and driver safety.

This report supports the environmental assessment (Review of Environmental Factors, REF; Aurecon, 2023) and concept design for the proposal.

1.2 Proposal Location and Key Features

The boundary of the proposal is shown in Figure 1. Key features of the proposal would include:

- Widening Henry Lawson Drive from two to four lanes between Auld Avenue, Milperra and the M5 Motorway, Milperra with a raised central median.
- Upgrading the Henry Lawson Drive / Bullecourt Avenue signalised intersection, including:
  - An additional right-turn lane from Henry Lawson Drive (northbound) to Bullecourt Avenue (two right-turn lanes total)
  - An additional right-turn lane from Bullecourt Avenue to Henry Lawson Drive (northbound) (two right-turn lanes total)
  - Converting the existing dedicated left-turn lane from Bullecourt Avenue to Henry Lawson Drive (southbound) into a dedicated left-turn slip lane
  - Maintaining the dedicated left-turn lane from Henry Lawson Drive (southbound) to Bullecourt Avenue
- Upgrading the Henry Lawson Drive / Pozieres Avenue signalised intersection, including:
  - A new dedicated right-turn lane from Henry Lawson Drive (southbound) to Pozieres Avenue
  - A new dedicated left-turn lane from Henry Lawson Drive (northbound) to Pozieres Avenue and relocation of the existing bus stop north of the intersection
- Providing a new two-lane local link road between Auld Avenue and Keys Parade (about 160 metres), crossing over Milperra Drain, providing access to / from southbound lanes of Henry Lawson Drive and Auld Avenue, and removing up to eight parking spaces on Auld Avenue to accommodate the link road

- Extending Raleigh Road about 120 metres to connect with Keys Parade at a roundabout, and removing the direct connection between Raleigh Road and Henry Lawson Drive
- Converting the Henry Lawson Drive intersections to be left-in left-out only, at:
  - Ruthven Avenue
  - Whittle Avenue
  - Amiens Avenue
  - Ganmain Crescent
  - Fromelles Avenue
  - Hermies Avenue
- Modifying the Bullecourt Avenue / Ashford Avenue intersection to better accommodate heavy vehicle movements
- Constructing a three-metre-wide shared path:
  - On the western side of Henry Lawson Drive between Pozieres Avenue and Keys Parade
  - Along Keys Parade, the new Auld Avenue local link road and the extended section of Raleigh Road
- Reconstruction of some existing shared paths within the proposal area
- Constructing a new footpath within the proposal area:
  - On the eastern side of Henry Lawson Drive between the Flower Power and Ingram Avenue
  - Along the northern side of Ingram Avenue
  - Along the eastern side of Fromelles Avenue
- Installing new drainage infrastructure and water quality controls within the proposal area, including:
  - An upgraded longitudinal and transverse drainage pits and pipes network along Henry Lawson Drive
  - A bioretention basin between Henry Lawson Drive, Bullecourt Avenue and Fleurbaix Avenue and maintenance access to this basin
  - Swales along Henry Lawson Drive and Keys Parade and installation of Gross Pollutant Traps
- Construction activities and ancillary work, including:
  - Relocation of utilities (including electrical, gas, water and telecommunications)
  - Civil earthworks, drainage work, water quality controls and tie-in work to adjoining sections of Henry Lawson Drive and local roads

- Final roadworks including pavement, kerb and gutters, signs, road furniture, landscaping, lighting and line marking
- New traffic signals and intelligent transport systems including, but not limited to, closed-circuit television
- Establishment of temporary ancillary facilities to support construction, including compound sites, site offices, stockpile and laydown locations, temporary access tracks and water quality devices

The proposal lies on mostly flat or very gently inclined terrain, including flood-prone lands within close proximity to the Georges River. Such conditions, in conjunction with space constraints, requirements regarding traffic management, and existing services can limit the potential for installing the erosion and sediment control structures that are typically employed during road construction.

1.3 Purpose of This Report

This Erosion and Sedimentation Management Report (ESMR) has been prepared for Aurecon and TfNSW by Strategic Environmental and Engineering Consulting (SEEC).

The purpose of this report is to determine how the construction of the proposal might impact on soils and surface water, and to determine appropriate mitigation or management measures where impacts are identified.

This ESMR has been prepared following the procedure described in Section 4.1 of TfNSW PN143P Erosion and Sedimentation Management Procedure.

The expanded purpose of this document as described in TfNSW Procedure PN143P is:

- To develop concept designs for major erosion and sedimentation control measures. Major control measures will include:
  - Up-gradient stormwater diversion to ensure clean water does not enter the construction site.
  - Temporary cross drainage to transfer clean water through and/or around the site through all construction phases,
  - Sedimentation basins, as required, designed in accordance with the sizing criteria in DECC (2008) (Blue Book Volume 2D) (e.g. 80th/85th percentile 5-day rainfall event capture for non-sensitive/sensitive receiving environments – consideration may be given to designing larger sedimentation basins to manage runoff to particularly sensitive receiving environments or for particularly high risk activities).
- To assess constraints (risks) to the installation and operation of major controls through all construction phases.

- To eliminate risks where possible.
- To design preliminary compensatory measures where risks cannot be eliminated.
- To report the findings in an Erosion and Sedimentation Management Report (ESMR).

1.4 Structure of This Report

This report includes the following sections:

- Section 2 provides background regarding document preparation against Transport procedural guidelines;
- Section 3 provides an assessment of the potential constraints and opportunities relevant to soil and surface water management and construction-phase erosion and sediment control;
- Section 4 identifies design considerations for erosion and sediment control measures;
- Section 5 provides an assessment of potential impacts, and summarises a series of recommendations to manage or mitigate potential impacts relating to construction-phase erosion and sediment control.

Section 5 is accompanied by a Concept Erosion and Sediment Control Plan (ESCP) which is included as Appendix 1. The Concept ESCP shows conceptually the setup of key erosion and sediment control measures.

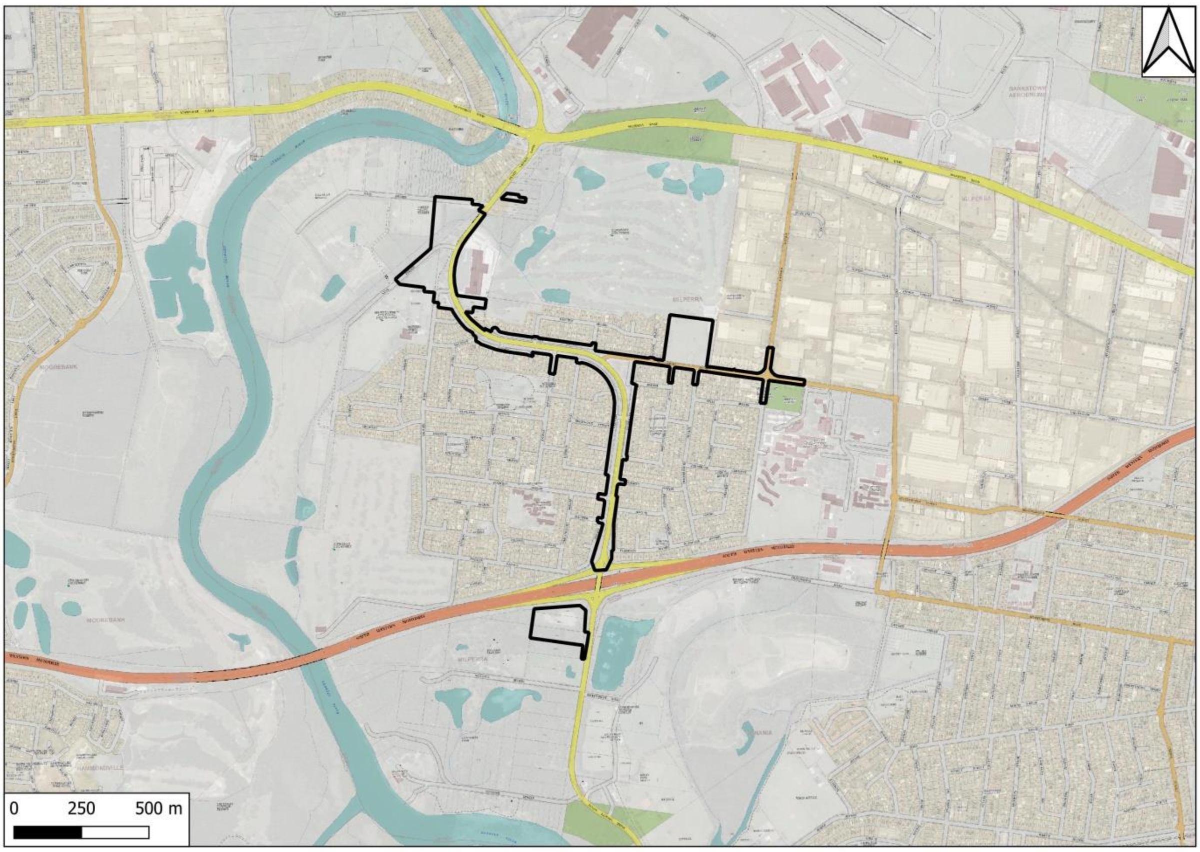


Figure 1 – Locality plan and proposal footprint.

2 DOCUMENTATION, REVIEW AND LIAISON

2.1 Design Documentation

A Concept ESCP prepared by SEEC accompanies this ESMR and is included in Appendix 1. It shows the setup of key erosion and sediment control measures for construction around the proposal.

2.2 Review of Existing Design

As part of preparing this ESMR, SEEC conducted a review of:

- The concept design prepared by Aurecon (2023), to determine if any inherent design issues might impact on the effective constructability and implementation of erosion and sediment controls;
- The proposal boundaries and land available during construction to determine if space constraints are likely to impact on the effective implementation and establishment of erosion and sediment controls;

- Likely broad-scale traffic and construction staging, to determine how these aspects might influence the constructability of structures such as sediment basins, and the management of clean offsite water and dirty onsite water at each stage;
- How access from the existing road network might impact on erosion and sediment control; and
- The site topography, soils, the receiving environment and local setting, to determine if these aspects influence or are impacted by the proposal, and how they might affect the effective implementation of erosion and sediment controls.

Constraints identified in this process have been taken into account in preparing the Concept ESCP (Appendix 1) and comments regarding this are included in Section 5 of this report.

2.3 Site Investigation

A site investigation was conducted by Alyssa Thomson from SEEC in November 2022 to identify and confirm soil and topographical conditions and how they might influence erosion and sediment control during construction.

2.4 Preliminary Erosion and Sedimentation Assessment (PESA)

TfNSW procedure PN 143P (RTA, 2008) requires all projects be subject to a Preliminary Erosion and Sedimentation Assessment (PESA), following the procedure in Attachment 1a of that document. The PESA uses "triggers" that, if exceeded, classify a project as high risk.

For this proposal, two out of four triggers are exceeded, as detailed in Table 2-1, below. As such, the proposal is considered potentially high risk, which triggers the requirement to engage a Soil Conservation Consultant and to prepare an ESMR.

Table 2-1: PESA for the proposal

Triggers	Yes/No	Comments to support decision
1. Does the complexity or size of the project result in it being inherently high risk as ongoing installation and maintenance of controls will require extensive coordinated resources?	No	Apart from traffic management, construction is not complex and does not involve any ground disturbing activities that are inherently high risk (from an erosion control perspective).
2. Assess the erosion hazard of each catchment to be disturbed for the proposed project using Attachment 1b (of RTA, 2008). Are any of the proposed construction areas defined as "High Erosion Hazard"?	No	R-factor is 1930 (See Section 3.1) and slopes are up to 3%. As such, based on the soil loss class, the erosion hazard is considered low for this proposal.

3. Are there known site constraints that limit the implementation of appropriate erosion and sedimentation control measures?	Yes	The proposal is located in an existing road corridor. Existing residential areas occur directly adjacent to the proposal. Limited space is identified for erosion and sedimentation controls. Services, traffic and staging constraints might limit the potential for erosion and sediment controls. Potentially high ground water tables might limit the ability to install sediment control traps. Part of the proposal lies on a floodplain. The risk of flooding can impact on the potential to install and maintain erosion and sediment controls such as sediment basins.
4. Are there identified sensitive receiving environments that will receive stormwater discharge from the construction project?	Yes	The most northerly 100m of the proposal footprint lies within the Proximity Area for Coastal Wetlands and a mapped Coastal Wetland is approximately 60 m to the east of the proposal footprint at the Flower Power Garden Centre. Stormwater from the site would typically discharge westwards into Milperra Drain which flows into the Georges River Estuary after approximately 1 km.

2.5 Environmental Design and Compliance Checklist

Table 2-2 details the requirements for this ESMR as described in Section 2.3.2 of TfNSW PS311 Specification (Environmental Design and Compliance) and where each is addressed.

Table 2-2 : TfNSW Specification PS311 Compliance Checklist

Item reference	ESMR requirement	Location where this is addressed in this ESMR
2.3.2 (i)	Identify road corridor and surrounding catchments.	Section 3.5 and Concept ESCP (Appendix 1)
2.3.2 (ii)	Identify road construction boundary catchments and their associated erosion hazard.	Concept ESCP (Appendix 1)
2.3.2 (iii)	Identification of site constraints that limit the implementation of appropriate erosion and sediment control measures.	Section 3, Section 5.1 and Concept ESCP (Appendix 1)
2.3.2 (iv)	Identification of any sensitive receiving environments that will receive stormwater discharge from the construction project, their environmental values and ANZECC Guidelines (2018) and NSW water quality objectives, including but not limited to: (a) lands protected under environmental planning instruments such as State Environmental Planning Policy (Coastal Management); and (b) land reserved or protected under national parks legislation such as Marine Parks, National Park estates or State Forests.	Section 3.5 and 3.10
2.3.2 (v)	Major erosion and sediment control measures, including but not limited to: (a) Up-gradient stormwater diversion to ensure clean water does not enter the construction site; (b) Temporary cross drainage to transfer clean water through and/or around the site through all construction phases; (c) Sedimentation basins, as required, designed in accordance with the sizing criteria in Blue Book Vol 2D.	Section 3.14, Section 4, Section 5, Concept ESCP (Appendix 1)
2.3.2 (vi)	Water flow paths and direction for the construction area and adjacent property i.e. off site and on site water flow	Concept ESCP (Appendix 1)
2.3.2 (vii)	Calculation of work area and soil loss for each road catchment (Refer Department of Housing's Publication Managing Urban Stormwater - Soils and Construction).	Concept ESCP (Appendix 1) Section 3.14 Section 4.1
2.3.2 (viii)	Basin calculation for each road catchment that exceeds the soil loss equation in accordance with the Department of Housing's Publication Managing Urban Stormwater - Soils and Construction	N/A
2.3.2 (ix)	Construction basin location and measures to direct on site runoff into the basin	N/A
2.3.2 (x)	A risk assessment of the effective installation, operation or maintenance of major controls, including but not limited to: (a) Timing of installation of the major controls, with reference to the	Section 5.3 and Concept ESCP (Appendix 1)

	construction staging of the project, including traffic and earthworks staging; (b) Availability of land to install major controls, with reference to any property acquisition requirements or environmental restrictions on environmentally sensitive area.	
2.3.2 (xi)	Measures to mitigate or eliminate identified risks, through design changes, construction methodology and additional land acquisition and/or leasing. Where risks cannot be eliminated, mitigation measures for managing the specific sub-catchment must be designed and documented in a summary table.	Section 5.3, specifically Table 5-2.
2.3.2 (xii)	Prepare plans for the ESMR for major activities or stages such as clearing and grubbing, and earthworks.	Concept ESCP (Appendix 1)

2.6 Design Standards and Guidelines

Erosion and sediment controls in this ESMR (and the accompanying Concept ESCP) have been designed in accordance with:

- The NSW Government publication "Managing Urban Stormwater – Soils and Construction", Volume 1, 4th Edition (Landcom, 2004) – "the Blue Book Volume 1",
- "Managing Urban Stormwater – Soils and Construction", Volume 2D, Main Road Construction (DECC, 2008) – "the Blue Book Volume 2D", and
- The Review of Environmental Factors (REF) (Aurecon, 2023).

In addition, TfNSW's Design Guide has also been used to inform the design of erosion and sediment controls in this ESMR and the accompanying Concept ESCP in Appendix 1.

3 ASSESSMENT OF CONSTRAINTS AND OPPORTUNITIES

3.1 Climate

Bureau of Meteorology (BoM) rainfall statistics for nearby Bankstown Airport AWS are contained in Table 3-1.

Table 3-1 – Monthly rainfall for Bankstown Airport AWS (BoM station 066137).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann-ual
Rainfall (mm)	93.2	110.3	115	82.3	64.3	77.6	49.1	49.4	44.5	62.1	76.3	67.3	868
Mean no of days with rain >1mm	8.1	8.2	8.9	6.6	6.6	6.8	5.4	4.6	5.4	6.9	8.0	7.1	82.6

The Bureau of Meteorology reports the 2-year, 6-hour rainfall event as 9.23 mm/hr for the site. This translates to a Revised Universal Soil Loss Equation (RUSLE) R-Factor of 1,930 which is low-moderate. This value contrasts with R-factor mapping in Appendix B of Landcom (2004), where the R-factor for this area is mapped at around 2,900. Given that the Bureau of Meteorology data is more recent, an R-factor of 1,930 has been adopted for all erosion hazard calculations (refer to Section 3.14).

3.2 Topography

Site topography is fairly consistent across the alignment of the proposal. Slopes are mostly very gentle (less than 3%) and include some low-lying, flood-prone lands.

Although slopes across the site are very gentle, topography is still considered to be a constraint for this proposal as flat, low lying, flood-prone lands can limit the feasibility for implementing typical erosion and sediment control measures and constructing structures such as sediment control basins, sumps or traps.

The recommendations in Section 5 include proposed management and mitigation measures for topography-related constraints. Also refer to the accompanying Concept ESCP (Appendix 1).

3.3 Soils - General

Soil Landscape Mapping for the Penrith 1:100,000 mapsheet shows the proposal lies on two different soil types (Blacktown and Richmond Soil Landscapes).

Figure 2 shows the soil landscapes (sourced from NSW Office of Environment and Heritage eSpade portal) with the route of the proposal. A site investigation by SEEC staff confirmed the accuracy of the soil landscape mapping.

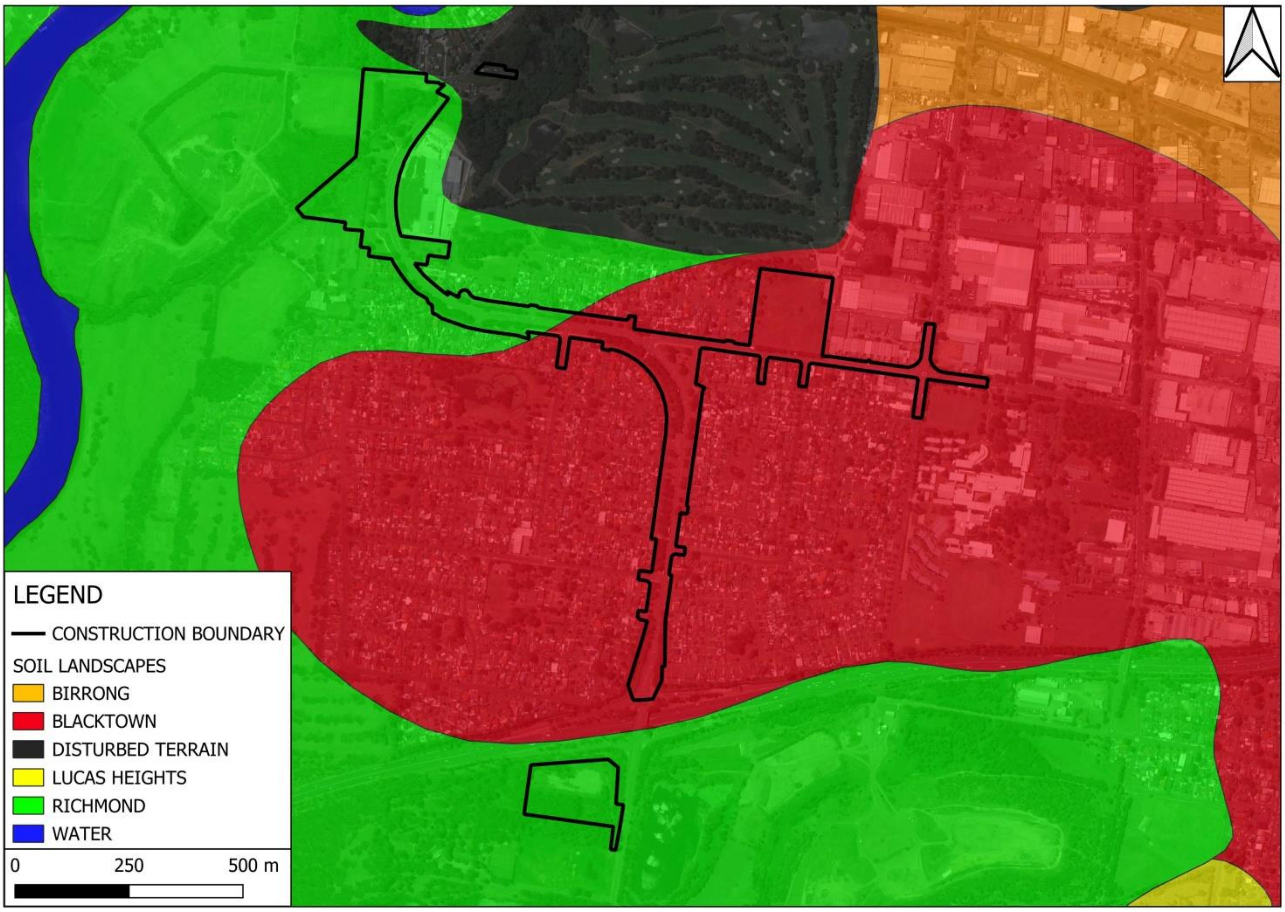


Figure 2 – Soil landscape mapping (NSW Government eSpade portal, accessed 2023) around the footprint of the proposal.

Table 3-2 contains a summary of soil landscape descriptions, key features and potential constraints that might influence erosion and sediment control during construction.

Table 3-2– Soil landscape summary (from NSW Government eSpade portal and Landcom, 2004).

Soil landscape name	Approximate occurrence along the proposal route	Soil landscape description	Dominant K-factor	Key landscape constraints for erosion and sediment control
Blacktown	60%	Gently undulating rises with local relief 10-30m with slopes generally greater than 5% but occasionally up to 10%. Soils are derived from the Wianamatta Group with shallow to moderately deep hardsetting mottled texture contrast soils, Red and Brown Podzolic Soils on crests grading to Yellow Brown Podzolic Soils on lower slopes and in drainage lines.	0.038	Soil erosion hazard varies from low to high Dispersible soils Moderately erodible soils with localised areas of highly erodibility Localised salinity Poorly drained soils Low to moderate soil fertility Localised high plasticity and expansive subsoils
Richmond	40%	Mostly flat terrace tops with terrace edges providing low relief up to 10m. Slopes are typically less than 1%. Soils are alluvial in nature with poorly structured orange to red clay loams, clays and sands. Texture may increase with depth. Greater profile development (deep acidic Non-Calcic Brown Soils and Red Podzolic Soils) occur on terrace surfaces with Earthy Sands on terrace edges.	0.059	High soil erosion hazard (particularly at terrace edges) Localised flood hazard Localised salinity Localised seasonal waterlogging Low to very low soil fertility Low water holding capacity

The K-factor of 0.059 is recommended for erosion hazard calculations based on the typical soil data presented in eSpade (NSW Government, 2022) and Landcom, 2004 for the Richmond Soil Landscape. The Blacktown Soil Landscape lists a K-factor of 0.038. However, since soils may be moved across the project and many areas have already been disturbed/developed the worst case K-factor for Richmond has been adopted for the entire proposal.

Soils of the Blacktown Soil Landscape are classed as dispersible (also based on the typical soil data presented in eSpade (NSW Government, 2022) and Landcom, 2004). Soils of the Richmond Soil Landscape are not noted as being dispersible. However, since soils on the Blacktown Soil Landscpae are classed dispersible, all soil materials should be considered as potentially dispersible.

Soils were identified as having potentially high soil erosion hazard and poor drainage.

Soils for both the Blacktown and Richmond Soil Landscapes are prone to localised salinity (refer to Section 3.5) and have low fertility, which can be a significant constraint for revegetation following construction unless properly ameliorated.

The recommendations in Section 5 include proposed management and mitigation measures for soils-related constraints.

3.4 Acid Sulfate Soils

Acid Sulfate Soil Risk Mapping (DLWC, 1997) identified some minor locations at the northern end of the proposal where it crosses lands with Potential Acid Sulfate Soils (PASS) (Figure 3).

The majority of the proposed route is not marked as being impacted by PASS. However, a minor location at the northern end of the proposal just south of Auld Avenue has been identified as having a high probability of encountering PASS at depths 1-3m below ground level and the very northern tip of the proposal along Henry Lawson Drive is identified as having a low probability of encountering PASS at depths 1-3m below ground level. There is another minor section adjoining Keys Parade and Raleigh Road that has been identified as disturbed terrain.

The recommendations in Section 5 include proposed management and mitigation measures for constraints relating to management of PASS during construction.

Figure 3 – Acid Sulfate Soil Risk Map (DLWC, 1997) with the footprint of the proposal.

3.5 Salinity

Mapping of the salinity potential in Western Sydney (DPIE, 2002) shows the soils along the alignment have a moderate potential for salinity (Figure 4).

Areas classified as moderate risk for salinity are unlikely to show significant expressions of salinity (e.g. vegetation decline, excessive erosion, salt damage to built structures). However, excessive groundwater recharge in areas of moderate risk can cause or exacerbate surface expressions of salinity in high risk areas.

The construction of the project is unlikely to increase the amount of groundwater infiltration and so the risk of the proposal being impacted by salinity, or impacting upon salinity is considered low.

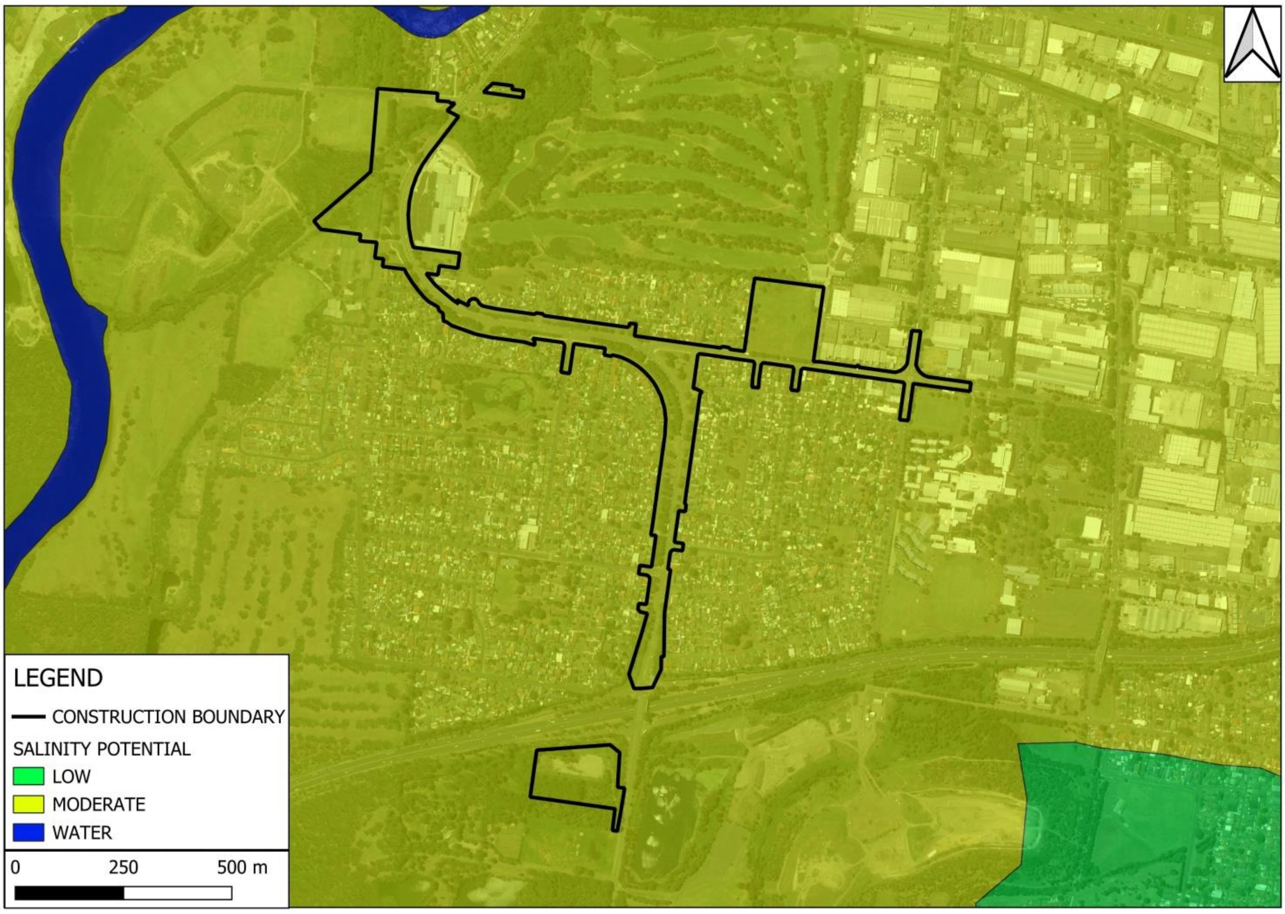


Figure 4 – Salinity potential around the proposal footprint (DPIE, 2002).

3.6 Catchments and Receiving Waters

The proposal lies wholly within the catchment of the Georges River, which is located to the north and west of the proposal. A minor tributary of the Georges River, named Milperra Drain is located just south of Auld Avenue and crosses the alignment at the northern end of the proposal.

Georges River estuaries are located both up and downstream of the proposal and Coastal Wetlands are located to the north and south west of the proposal along Georges River.

The waterways listed above have all been modified and impacted over the last two centuries by agriculture and/or urbanisation. Past and current impacts on water quality in the Georges River include sediment loading, contaminated leachate (including sewage) and polluted urban runoff. Therefore, any proposal-related water quality impacts would be unlikely to have a significant impact on water quality.

The recommendations in Section 5 include proposed management and mitigation measures for constraints relating to management of stormwater quality during construction.

3.7 Flooding

The northern end of the site is located in close proximity to the Georges River and immediately adjacent to the unnamed drainage line just south of Auld Avenue. It has been identified that there is the potential for the most northern section of the main alignment and most of the Keys Parade connection works to be impacted by flooding. The Concept ESCP in Appendix 1 shows the extent of the flooding for the 10 yearr ARI flood event (based on flood information provided by Aurecon).

Flooding can impact on the ability to install and/or operate erosion and sediment controls. The Blue Book (Landcom, 2004) suggests that special erosion and sediment control measures should apply to any works below the 2-year average recurrence interval (ARI) flood level. This includes:

- Sediment controls should be placed above the 2-year ARI flood level (e.g. basins, sediment fences etc).
- Requirements to stabilise lands using temporary ground cover whenever rain is falling or imminent.
- Scheduling works for lower-risk times of year, based on historical rainfall figures.

The recommendations in Section 5 include proposed management and mitigation measures for constraints relating to management of flooding during construction.

3.8 Groundwater

According to the Geotechnical Factual Report (Transport for NSW, 2022), elevated groundwater tables within 1m of the current ground level have been identified sporadically within the proposal site. These elevated water tables occur within alluvial sediments across floodplains associated with the Georges River and its tributaries. Groundwater levels are noted as being relatively stable, with only minor fluctuations associated with rainfall.

The presence of high groundwater tables can impact on erosion and sediment control during construction with regard to foundation earthworks, trenching for drainage and services and sediment basin location. Groundwater in the form of perched water tables or springs can generate both vertical and lateral destabilising forces including high pressures below embankment foundations, softening of the subgrade and seepage erosion of cut faces.

Accordingly, the risk of elevated groundwater tables has been taken into account when positioning structures such as sediment basins and traps and when making recommendations regarding rehabilitation. This is reflected on the Concept ESCPs (Appendix 1) and recommendations have been included in Section 5.

3.9 Existing and Future Drainage

The proposal involves widening and reconfiguration of Henry Lawson Drive and local road connections to Keys Parade and Bullecourt Avenue. The current drainage along these roads is mostly via formalised stormwater drainage (kerb and gutter with pits and pipes) as well as sheet flow via roadside verges in some areas.

During construction, there is a risk of offsite (clean) and onsite (dirty) water mixing at various locations due to the overlap between the existing road network and the proposed works, and the need to maintain live traffic through the work area.

The topography of the site, space constraints and the traffic loads mean that diverting traffic off the current road alignment during construction is not practical.

Wherever possible, permanent cross-drainage (i.e. culverts) will need to be replaced or extended as early as possible to facilitate effective separation of offsite (clean) and onsite (dirty) water. The existing stormwater drainage system will be maintained and also used where possible to separate offsite (clean) and onsite (dirty) water. In addition, temporary cross-drainage may to facilitate effective drainage control during construction. Recommendations regarding this are included in Section 5 and on the accompanying Concept ESCP (Appendix 1).

3.10 Ecology

Under the TfNSW Biodiversity Guidelines (2011) and Biodiversity Assessment Guidelines (2022), avoiding or minimising ecological impacts is recommended. This has been considered in the selection and positioning of erosion and sediment control measures, especially those that typically involve disturbing land outside the earthworks footprint during construction (e.g. major sediment control structures).

The Concept ESCP in Appendix 1 show the conceptual positioning of construction-phase sediment control devices. In locating these structures, local ecology has been considered.

3.11 Existing Services

Existing services and utilities will be a significant constraint for the proposal. The type and size of erosion and sediment control structures must be considerate of existing services, and this has been taken into account in developing the Concept ESCP in Appendix 1, with comments included in Section 5.

3.12 Land Availability

Land availability is a common constraint for major road projects during construction, especially for:

- Establishing stockpiles; and
- Constructing major sediment control structures.

As previously noted, topographical and ecological constraints limit the potential for siting sediment traps/sumps and, as a result, land availability presents a significant constraint for the construction of sediment control structures.

The accompanying Concept ESCP (Appendix 1) identifies the proposed locations for sediment control devices and offsite (clean) and onsite (dirty) water drainage control devices, along with recommendations for alternative management where sediment control structures cannot reasonably be constructed (where applicable).

Further, Section 5 includes recommendations regarding alternative management and mitigation measures where land availability constrains the potential to install sediment control structures (where applicable).

3.13 Design and Construction Constraints

3.13.1 Tie-Ins and Interface

The proposal includes modifying and widening the existing roadway footprint. Live traffic flow would need to be maintained during construction, although temporary short-term lane closures, traffic switches, and reduced lane widths are assumed to be necessary.

Separating clean and dirty water and providing adequate sediment controls will be difficult due to the restricted working areas and progressive nature of the works. This has been taken into account when preparing the Concept ESCP (Appendix 1) and in the recommendations contained in Section 5 of this ESMR.

3.13.2 Sediment Tracking onto Surrounding Roads

The proposal includes construction interactions with existing live traffic on Henry Lawson Drive, Milperra Road and other local roads. As such, there is a risk of sediment tracking onto existing sealed live roadways from construction areas.

Refer to Section 5 for an assessment of the potential to manage sediment tracking during construction, along with recommendations for any identified constraints.

3.14 Erosion Hazard

An evaluation of the erosion hazard was made using the approach in Chapter 4 of the Blue Book (Landcom, 2004). This process involves calculating the predicted annual average soil loss using the Revised Universal Soil Loss Equation (RUSLE) as follows:

$$A = R \times K \times LS \times P \times C$$

Table 3-3 details the above equation and the values used in assessing erosion hazard.

Table 3-3 – RUSLE definitions and assumptions

Parameter	Definition	Typical values for the alignment	Maximum values for the southern ancillary area (southern side of M5 Motorway)
		Slopes up to 2.5%	Slopes up to 5%
A	Total calculated soil loss (t/ha/yr)	78 t/ha/yr.	176 t/ha/yr.
R	Rainfall erosivity factor (refer to Section 3.1)	1930	1930
K	Soil erodibility factor (Refer to Section 3.3)	0.059	0.059
LS	Slope length and gradient factor	2.5% and 80m (LS of 0.53)	5% max. and 80m (LS of 1.19)
P	Conservation practice factor	Maximum of 1.3 assumed	Maximum of 1.3 assumed
C	Ground cover factor	Maximum of 1.0 assumed	Maximum of 1.0 assumed
Erosion hazard (from Landcom, 2004)		Very low	Moderate
Catchment size trigger for sediment basins		2.6 ha	1.15ha

Included in Table 3-3 is an assessment of the construction catchment size that would trigger the need for constructing a sediment basin for that catchment, in compliance with Landcom (2004) and DECC (2008).

4 DESIGN STANDARD FOR EROSION AND SEDIMENT CONTROL

4.1 Sediment Basins

4.1.1 Erosion Hazard Triggers for Sediment Basins

The Blue Book (Landcom, 2004 and DECC, 2008) notes that a sediment basin should be included in catchments where the erosion hazard exceeds 150 m^3/year (200 tonnes/year) of soil loss. It is standard practice that each affected catchment on a road construction project be assessed against this requirement.

Following on from the erosion hazard assessment in Section 3.14 and the calculations in Table 3-3, an assessment of all catchments (existing catchments and future catchments once earthworks are complete) has been undertaken (refer to Section 4.1.2). It was identified that sediment basin(s) will not be required during construction for the main alignment works. However, a sediment basin/s will be required for the ancillary area that is located on the southern side of the M5 Motorway.

For the main alignment works alternative sediment control devices such as sediment sumps, mulch bunds, rock filter dams, sediment fences or similar should be used in conjunction with erosion control measures. This is discussed further in Section 5 (specifically in Table 5-2) and is noted on the Concept ESCP in Appendix 1.

4.1.2 Sub-Catchment Assessment for Sediment Basins

Each sub-catchment to be disturbed for this proposal was assessed using the procedure detailed in Section 3.14 to determine which, if any, sub-catchments trigger the requirement for a sediment basin to comply with the NSW Blue Book (Landcom, 2004 and DECC, 2008). Table 4-1 details the assessment for each sub-catchment. Note that the R, K, LS, P and C factors are consistent with Table 3-3.

Table 4-1 – Assessment of each sub-catchment using the RUSLE process (from Landcom, 2004 and DECC, 2008).

Sub-catchment	Chainage/ location	Approximate area (ha) of disturbance	Slope (%)	Erosion hazard (t/ha/yr)	Sub-catchment erosion (t/yr)	Is a sediment basin required?*
CA1	30 to 260 Northbound side	0.75	1.5	44	33	No
CA2	20 to 560 Northbound side	0.9	2.5	78	70	No
CA3	560 to 970 Northbound side	1.2	1.5	44	52	No
CA4	970 to 1160 Northbound side	0.6	1.5	44	26	No

CA5	1160 to 1440 Northbound side	0.9	1.5	44	39	No
CA6	1440 to 1600 Northbound side and Keys Parade and Ancillary Area	2.7	2	60	163	No
CA6A	1600 to 1720 Northbound side	0.4	1.5	44	17	No
CA7	20 to 170 Link Road	0.4	1.5	44	17	No
CA8	800 to 1060 Henry Lawson Drive and 0 to 130 Bullecourt Avenue	0.55	1.5	44	24	No
CA9	Bullecourt Avenue 560 – 740 and Ashford Avenue 0 - 160	0.9	1.5	44	39	No
CA10	Ancillary Area in-between Henry Lawson Drive and Bullecourt Avenue	0.6	1.5	44	26	No
CA11	Ancillary Area on Henry Lawson Drive next to Pet Stock	0.24	3	96	23	No
CA12	Ancillary Area on corner of Raleigh Road and Henry Lawson Drive	0.41	2	60	25	No
CA13	Ancillary Area North of Auld Avenue on Henry Lawson Drive	0.1	5	176	18	No
CA14	Ancillary Area on Henry Lawson Drive North of Auld Avenue	0.18	5	176	32	No
CA15	Ancillary Area Bullecourt Avenue	2.8	2	60	167	No
CA16	Ancillary Area South of M5 Motorway	1.6	5	176	281	Yes

* A basin is required if the sub-catchment erosion hazard exceeds 150 m^3/yr (200 t/yr).

Included in Table 4-1 is an assessment of whether the erosion hazard in each sub-catchment exceeds the threshold for triggering the need to construct a sediment basin for that sub-catchment, in accordance with Landcom (2004) and DECC (2008). None of the sub-catchments exceeds the threshold to trigger the requirement for a sediment basin except the Ancillary Area south of the M5 Motorway (Catchment CA16).

4.1.3 Sediment Basin Design Criteria

The construction-phase sediment basin(s) has been sized based on the following criteria (Landcom, 2004):

- Design rainfall depth: 32.2 mm (5-day, 85th percentile for Liverpool) for all areas;
- Basins designed for Type F/D (fine or dispersible) sediment;
- Volumetric runoff coefficient (Cv): 0.64 (Hydrologic Group C, assuming compacted subgrades) for all areas.

The size of the basin(s) is included in the Concept ESCPs in Appendix 1.

Outlet structures are to be provided from all sediment basins and sediment traps to spread out flows, encourage dissipation and minimise erosion. Permanent outlet structures (where applicable) should ideally be constructed early to help achieve this.

Given that the sediment basin and sediment traps shown on the Concept ESCPs in Appendix 1 all sit within the proposal area boundary, separate fencing is not likely to be necessary (because construction sites are not publicly accessible). However, the safety aspects of each sediment basin would need to be assessed on a case-by-case basis at the time of construction.

4.2 Onsite and Offsite Water Separation

Temporary drainage will be required in some locations to ensure that:

- Offsite (‘clean’) water is bypassed through or around work areas and away from sediment control structures; and
- Onsite (‘dirty’) water is diverted to sediment control structures.

The locations for temporary drainage are detailed on the Concept ESCP (Appendix 1).

As much as possible, cross-formation culverts will be installed or extended early to assist with separating onsite (dirty) and offsite (clean) water during construction. In some locations temporary cross-drainage will be required to achieve adequate separation due to the prevailing topography and design of the road. Those locations are marked on the Concept ESCP (Appendix 1).

4.3 Construction-Phase De-watering

It is assumed that an Environment Protection Licence (EPL) would not be required for this proposal, so the requirements for water quality and quantity in any discharges would default to typical TfNSW and Blue Book (Landcom, 2004) recommendations to comply with Section 120 of the NSW Protection of the Environment Operations Act (POEO Act, 1997). The Blue Book (Landcom, 2004) suggests that water discharged from construction sites should not contain more than 50mg/L of suspended sediment.

5 PROPOSED EROSION AND SEDIMENT CONTROL MEASURES

5.1 Assessment of Applicability of Erosion and Sediment Controls

In preparing the Concept ESCP drawings (Appendix 1), a review was conducted of the road design to determine if the inherent design would impact on effective implementation of erosion and sediment control during construction. A number of constraints were identified that limit the establishment of erosion and sediment control devices in a number of locations.

Table 5-1 provides details of the principles of erosion and sediment control typically adopted on major road projects, along with an assessment of whether each can be effectively implemented on this proposal.

Where constraints to the effective implementation of typical erosion and sediment controls are identified in Table 5-1, details of proposed mitigation and/or management measures for each are contained in Table 5-2 and also on the Concept ESCP in Appendix 1.

Note that the Concept ESCP in Appendix 1 is based on the 80% Concept Design.

Table 5-1 – Assessment of Typical Erosion and Sediment Control Measures

Erosion and Sediment Control Principle	No.	Assessment of applicability of typical Blue Book controls for this proposal	Details or Comments
Assess constraints and opportunities for erosion and sediment control during the planning/design phase.	1	This report includes an assessment of constraints and opportunities for erosion and sediment control.	N/A
Plan early for erosion and sediment control.	2a	This report and the accompanying Concept ESCPs (Appendix 1) demonstrate early planning.	N/A
	2b	Progressive ESCPs would be prepared during construction showing the location of controls for each stage of work. This is a typical requirement in TfNSW QA G38 specification.	Ensure that TfNSW QA G38 specification includes a requirement for progressive ESCPs. This is noted in Table 5.2.
	2c	The requirement to keep an up-to-date register of ESCPs during construction is typically included in TfNSW QA G38 specification.	Ensure that TfNSW QA G38 specification includes a requirement for a register of progressive ESCPs to be kept up to date. This is noted in Table 5.2.
	2d	Erosion and sediment controls should be installed early in the construction process, generally as part of clearing and grubbing works.	Standard practice. No specific additional requirements for this proposal. No significant limitations identified to early installation of major erosion and sediment controls as part of clearing and grubbing works.
Minimise the extent and duration of disturbance.	3a	As part of the REF process, project limits were established that take into account biodiversity constraints. No further assessment is necessary for erosion and sediment control purposes.	N/A
	3b	Position erosion and sediment controls to minimise the need for additional clearing.	The Concept ESCPs (Appendix 1) nominate a suite of erosion and sediment controls that require no additional clearing. No further action required.

Erosion and Sediment Control Principle	No.	Assessment of applicability of typical Blue Book controls for this proposal	Details or Comments
Manage soils, including conserving topsoil for later reuse in rehabilitation.	4a	In most locations topsoils have low fertility and have been impacted by previous land use practices, which could impact the success of rehabilitation.	Topsoils should be tested and ameliorated and/or fertilized as required. Refer to Table 5.2 for recommendations regarding management of soils with low fertility.
	4b	Highly erodible soils occur in areas mapped as Richmond Soil Landscape (Section 3.3 above).	This has been taken into account in the erosion hazard assessment (Section 3.14 and Section 4.1.2) when assessing the requirement (or otherwise) for sediment basins.
	4c	Soils have low plant-available waterholding capacity. This could limit the success of revegetation unless effectively addressed.	Soils should either be ameliorated to address their low water holding capacity, or the watering frequency adjusted to take this into account following landscaping. Refer to Table 5.2 for recommendations.
	4d	Soils are generally acidic, which could impact the success of rehabilitation.	Soils should be tested, ameliorated and treated as required. Refer to Table 5.2 for details regarding management of acidic soils and low fertility.
	4e	Soils have moderate salinity potential.	The construction of the proposal is unlikely to be affected by salinity or to impact on local salinity. No proposal-specific recommendations required.
	4f	Stockpiling is not recommended in areas below the 10yr ARI flood level and therefore, will be restricted in these areas.	Typical G38 and Blue Book requirements for stockpiling will generally apply in areas where feasible. However, refer to Table 5-2 and the Concept ESCPs within Appendix 1 for recommendations regarding restrictions and management measures for stockpiling in/near flood prone lands.
Control water flow on, through and off the site.	5a	Temporary drainage will be required to achieve adequate separation of clean offsite water and dirty onsite water, or to ensure dirty onsite water is directed to sediment trapping devices.	The Concept ESCPs in Appendix 1 note locations for temporary drainage. This is typical practice during road construction.

Erosion and Sediment Control Principle	No.	Assessment of applicability of typical Blue Book controls for this proposal	Details or Comments
	5b	Cross-alignment permanent pipes and culverts are typically constructed early, thereby allowing cross-alignment passage of clean offsite water. Temporary drainage might be required during construction, but this is considered standard practice.	The Concept ESCPs in Appendix 1 note where cross-alignment culverts should be constructed early.
	5c	Where existing pipe culverts will be extended, these works should to be scheduled for dry weather, with provision made to establish temporary ground cover or temporary diversions to allow for the passage of clean offsite water through/around the culvert construction area in the event of significant rainfall.	Typical details (sourced from Roads and Maritime, 2011) for this have been included in Section 5.2. Locations are shown within the Concept ESCPs in Appendix 1.
	5d	Upslope catchments cannot be diverted around the works in some locations due to topography. In these locations erosion and sediment control measures will be designed to accommodate the upslope clean water catchment. However, note that upslope clean water catchments are very minor and will not affect onsite controls significantly.	The Concept ESCPs in Appendix 1 have been designed to take this into account and include all necessary details to address it.
	5e	Part of the site lies within flood prone lands and works may be impacted by flooding from the adjacent river and the unnamed drainage line south of Auld Avenue. High groundwater tables also occur in some areas across the site particularly within flood prone areas. Sediment basins are not required for the main alignment works so the potential for elevated ground water tables is not considered a significant constraint for erosion and sediment control. However, elevated groundwater tables could lead to groundwater ingress into trenches and excavations for new services or stormwater infrastructure. Dewatering of groundwater inflows will most likely be required during construction.	The Concept ESCPs in Appendix 1 note the necessary precautions and management measures to address flooding issues. Dewatering of groundwater inflows into trenches and excavations will most likely be required during construction. This is a potential site management and pollution risk and will require appropriate planning. These are noted in Table 5.2.

Erosion and Sediment Control Principle	No.	Assessment of applicability of typical Blue Book controls for this proposal	Details or Comments
	5f	Temporary waterway crossings are to be stable and must minimise impacts to the waterway. They should be designed and constructed in accordance with Blue Book standard details.	Standard practice. No specific additional requirements for this proposal.
Minimise erosion as much as possible.	6a	Stockpiles require stabilisation to minimise the risk of erosion. There are no restrictions to this being implemented on this proposal.	Standard practice. No specific additional requirements for this proposal.
	6b	Dust control is required to minimise dust impacts to the environment and to nearby receivers. This is typically carried out using water carts.	Standard practice. No specific additional requirements for this proposal.
	6c	Fine, erodible soils may be particularly prone to erosion especially near waterways. Erosion and sediment control measures should be considerate of this.	The Concept ESCPs in Appendix 1 include enhanced erosion controls to reduce potential impacts from erodible soils. This is also noted in Table 5.2.
	6d	Flooding may increase the risk of erosion throughout the site. Enhanced erosion control measures should be included to address this.	The Concept ESCPs in Appendix 1 include enhanced erosion controls to reduce the potential for higher rates of erosion associated with potential flooding. This is also noted in Table 5.2.
	6e	Slope breaks are typically required at 80m intervals on long, disturbed slopes prior to rainfall to reduce the rate of erosion.	Standard practice. No specific additional requirements for this proposal.
Maximise sediment retention onsite.	7a	Rumble grids (or similar) are typically used at site gates to minimise the risk of sediment tracking onto surrounding roads. There are no significant constraints to this being implemented on this proposal.	Standard practice. No specific additional requirements for this proposal.

Erosion and Sediment Control Principle	No.	Assessment of applicability of typical Blue Book controls for this proposal	Details or Comments
	7b	Typically, sediment basins are to be used in any catchment where the erosion risk exceeds 150 m^3/year (equivalent to 200 tonnes/year). All catchments have been assessed for the assumed stages of construction, and no sediment basins are required for the main alignment works to comply with NSW Blue Book (Landcom, 2004 and DECC, 2008). However, a sediment basin is required for the ancillary area on the southern side of the M5 Motorway.	Alternative sediment controls for the main alignment works and details of the sediment basin for the ancillary area are included on the Concept ESCPs in Appendix 1.
	7c	The installation and management of sediment control measures can be difficult where space is limited, where multiple traffic switches will occur, in areas of very flat topography, in areas prone to flooding and in areas of elevated groundwater.	Suitable sediment controls measures and additional erosion control measures (where necessary) have been determined considering the various constraints. These are included within the Concept ESCPs within Appendix 1.
Rehabilitate disturbed lands progressively, ensuring rehabilitation is effective to reduce the erosion hazard.	8a	In most locations topsoils have low fertility and have been impacted by previous land use practices, which could impact the success of rehabilitation.	Topsoils should be tested and ameliorated and/or fertilized as required. Refer to Table 5.2 for recommendations regarding management of soils with low fertility.
	8b	Soils have low plant-available waterholding capacity. This could limit the success of revegetation unless effectively addressed.	Soils should either be ameliorated to address their low water holding capacity, or the watering frequency adjusted to take this into account following landscaping. Refer to Table 5.2 for recommendations.
	8c	Soils are generally acidic, which could impact the success of rehabilitation.	Soils should be tested, ameliorated and treated as required. Refer to Table 5.2 for recommendations regarding management of acidic soils and low fertility.
	8d	Soils have moderate salinity potential.	The construction of the proposal is unlikely to be affected by salinity or to impact on local salinity. No proposal-specific recommendations.

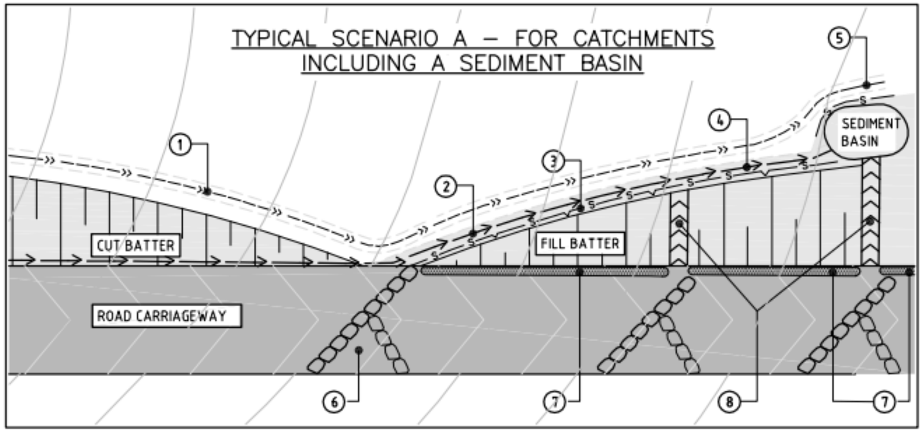
Erosion and Sediment Control Principle	No.	Assessment of applicability of typical Blue Book controls for this proposal	Details or Comments
Conduct regular inspections of the site to identify potential problems and allow for rectification or repair.	9	The requirement for documented inspections is typically included in TfNSW QA G36 and G38 specifications.	Standard practice. No specific additional requirements for this proposal.
Maintain all erosion and sediment controls, including cleaning out sediment traps, until the upslope catchments are effectively rehabilitated.	10	The requirement to maintain and/or clean out erosion and sediment controls until the upslope catchments are rehabilitated is typically included in TfNSW QA G36 and G38 specifications.	Standard practice. No specific additional requirements for this proposal.

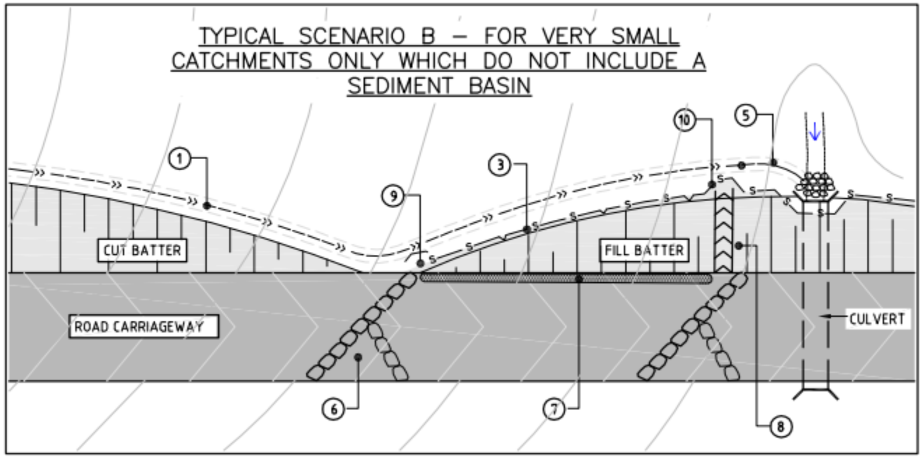
5.2 Typical Details for Erosion and Sediment Control

See following pages for typical details. These details show the typical setup for erosion and sediment control on major road projects such as this. The Concept ESCPs (Appendix 1) are based on these typical details.

These typical details are contained in a TfNSW Technical Guideline 11.068 (Roads and Maritime, 2011) so will be used to help inform the preparation of Progressive ESCPs during construction.

CUT / FILL BATTER WATER MANAGEMENT





LEGEND

- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ROCK STABILISED OUTLET/INLET (SD 5-8)
- CUT / FILL BATTER
- DIVERSION BERM (SD 5-5)
- CREEK / PIPE FLOW ROUTE
- SPILLWAY
- SEDIMENT FENCE (SD 6-8)

CONSTRUCTION NOTES

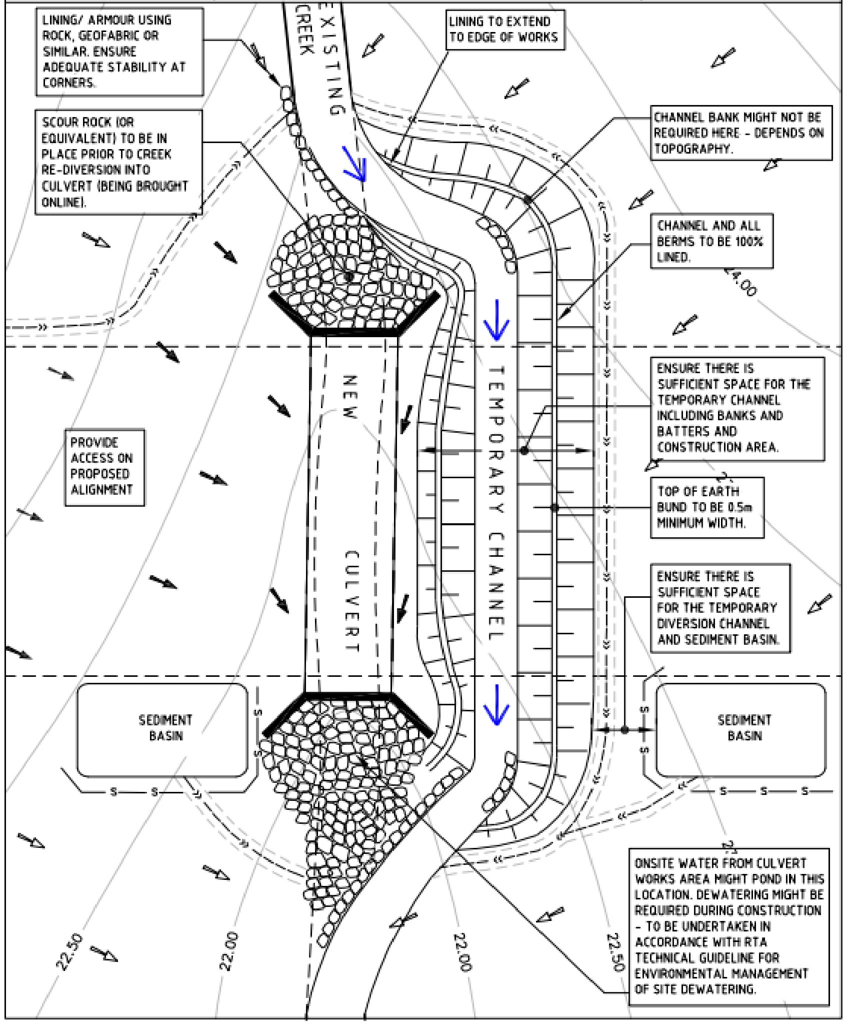
THE FOLLOWING WORKS ARE TO BE UNDERTAKEN AS SHOWN ON THE RELEVANT DIAGRAMS

1. Lined permanent diversion drains to be used as 'offsite' water drains during construction. Must convey water all the way to a watercourse or depression and onto a stabilised outlet point.
2. Provide sufficient room between toe of fill and 'offsite' water drain for management of 'onsite' water. 'Onsite' water diversion (temporary drain) - to drain to sediment basin.
3. Sediment fence at toe of batter. Include returns at 20m intervals.
4. 'Onsite' water diversion (temporary drain) - to drain to sediment basin.
5. Ensure 'offsite' water drain extends all the way to drainage line and onto a stabilised outlet point.
6. Use earth bank or sandbags to divert runoff at cut / fill line to onsite drain or sediment trap. Do not mix with 'offsite' water in cut-off drain. Use arrowhead shape if water is being shed from both sides of formation. It is only required at end of day or when rain is imminent.
7. Earth or sandbag windrow for directing water into drop-down flume. To be installed at end of day or when rain is imminent.
8. Lined drop-down chute to carry 'onsite' water to basin or trap. Only required when rain is imminent.
9. Install sediment trap at cut/fill line if runoff is not flowing to a basin.
10. Install sediment trap at base of drop-down flume if runoff is not flowing to a basin. This can simply be formed as a section of the sediment fence with returns both sides.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

NEW ONLINE CULVERT
(PREFERABLY AS "EARLY WORKS")



SWMP – ONLINE CULVERT CONSTRUCTION AND CREEK STABILISATION WORKS

NEW ONLINE CULVERT – CONSTRUCTION NOTES

THESE STEPS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW.

Stage 1: Temporary Channel Construction
- Establish diversion drains for offsite water.
- Construct and line the temporary channel including rock armouring at the existing creek and temporary channel junctions.
- Construct and line temporary earth bunds.
- Divert creek flows into this channel. Work downstream to upstream.

Stage 2: Culvert Construction Works
- Construct the new culvert including the stabilised culvert inlet and outlets.
- Stabilise the culvert construction works area once culvert construction works are complete.

Stage 3: Final diversion and Rehabilitation Works
- Divert creek flows into new culvert.
- Temporary channel and bunds to be decommissioned without allowing sediment downstream to creek and the disturbed area stabilised.
- Diversion drains for offsite water can be redirected to inlet of new culvert on upstream site or can be removed and rehabilitated.

OTHER NOTES

1. This design assumes that culvert construction is part of the 'early works' for the site.
2. Temporary channel to be sized and lined as per the requirements in Table 6.1 (DECC, 2008) and Table 5.2 (Landcom, 2004).
3. Ideally schedule works to periods when rainfall erosivity is low (Refer to Table 4.3 – Landcom, 2004)
4. Only undertake in-stream works (e.g. placement of rock) during periods of zero or very low flow and only when the 24 hour weather forecast suggests a significant rain event is not likely.
5. Ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils within in-stream locations if an unexpected rain or flow event occurs.
6. No culvert works are to occur until creek flows are successfully diverted into the stabilised temporary channel.
7. Culverts are to be completed before being allowed to convey flows. This includes all inlet and outlet protection, wingwalls etc.
8. Stabilisation, as defined by the Blue Book, means achieving:
   - For concentrated flows– At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability).
   - For all other areas– At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.
9. A management regime should be in place to address the risk of these works creating a flooding issue due to constriction of the channel during construction.
10. If temporary access is required across the existing creek or a diversion channel, use a temporary water crossing – see standard drawing 5-1 in Blue Book Vol 1 (Landcom, 2004).
11. Minimise the time that soil is exposed to erosion.

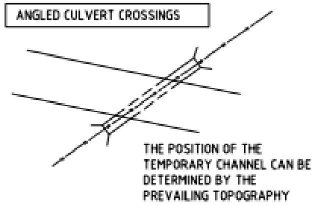
STANDARD DRAWINGS FROM VOL 1 OF THE BLUE BOOK (LANDCOM, 2004) USED HERE:

Sediment fence: SD 6-8
High flow earth bank (diversion drain): SD 5-6
Energy dissipater: SD 5-8
Temporary waterway crossing: SD 5-1

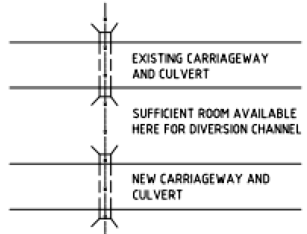
AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

THIS SCENARIO ALSO APPLIES TO:

ANGLED CULVERT CROSSINGS



DIVIDED CULVERT EXTENSION



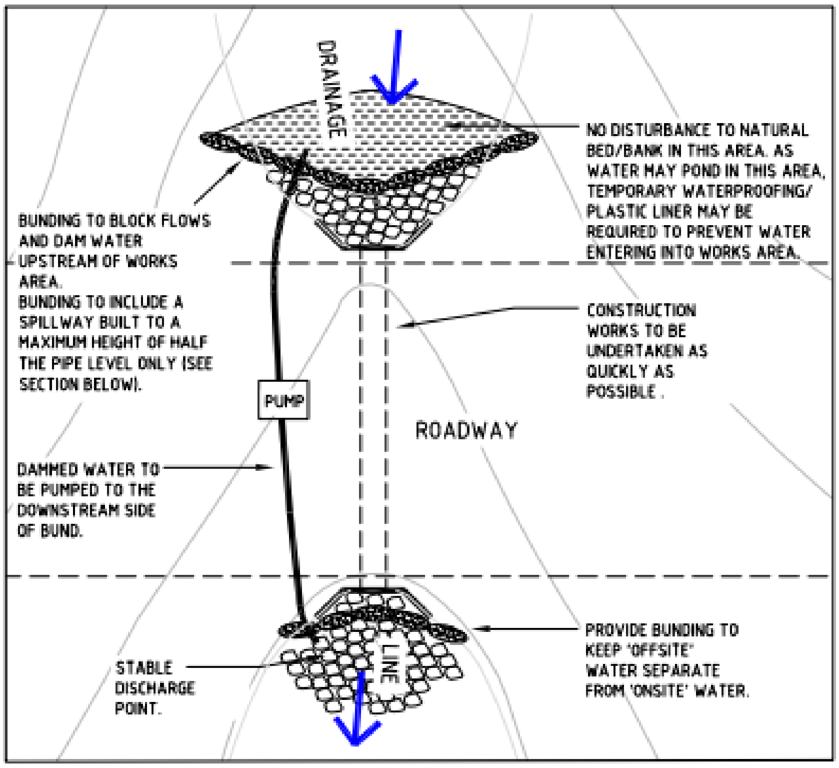
THE APPLICATION OF THIS SCENARIO TO DIVIDED CULVERT EXTENSIONS IS DEPENDENT ON WHETHER THERE IS ENOUGH AVAILABLE SPACE. IF SPACE IS LIMITED PART OF THE TEMPORARY CHANNEL CAN BE CONSTRUCTED OUT OF SHEET PILING OR SIMILAR OR ALTERNATIVELY THE SITE SHOULD BE STABILISED AS FOR A CONTINUOUS ONLINE CULVERT EXTENSION

LEGEND

- S SEDIMENT FENCE (SD 6-8)
- DIVERSION DRAIN FOR 'OFFSITE' WATER (SD 5-6)
- SURFACE CONTOURS
- 'ONSITE' FLOWS
- 'OFFSITE' FLOWS
- CREEK/CHANNEL FLOWS
- CUT/FILL BATTER
- ROCK DISSIPATION/ STABILISATION STRUCTURES (SD 5-8)

NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

ONLINE PIPE REPLACEMENT/INSTALLATION – SMALL INTERMITTENT DEPRESSIONS ONLY (PUMP OPTION)



SITE STABILISATION

THIS METHOD IS ONLY SUITABLE FOR SIMPLE DEPRESSIONS WITH INTERMITTENT FLOWS. TO BE IN PLACE FOR NO MORE THAN 3 MONTHS.

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

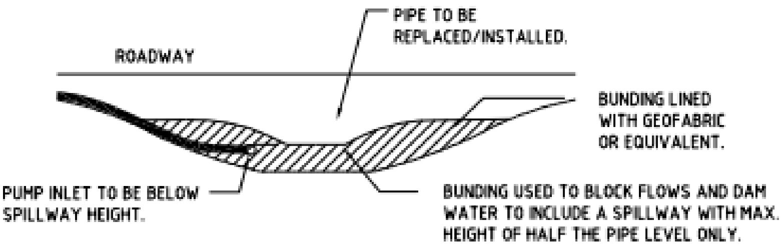
1. Ensure suitable temporary groundcover materials (e.g. geofabric, blankets) are located on site.
2. Ensure a suitable pump is available.
3. Watch the weather forecast to ensure rainfall is not forecast and monitor creek flows ensuring flows are minimal.
4. Position the bunding and line if required.
5. Undertake construction works (including inlet and outlet stabilisation) as quickly as possible. Drainage line to be blocked for no more than 3 months.

At any time during steps 4 - 5 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

LEGEND

- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ROCK STABILISED OUTLET (SD 5-8)
- CREEK/PIPE FLOW ROUTE
- SEDIMENT FENCE (SD 6-8)
- BUNDS

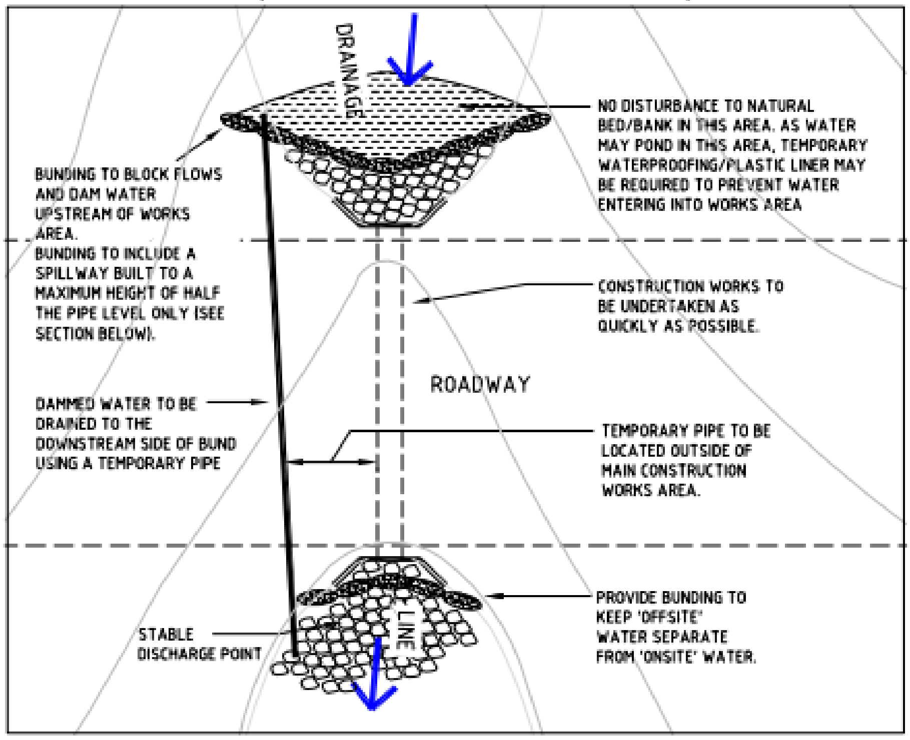
NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.



AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

SECTION THROUGH BUNDING LOCATION

ONLINE PIPE REPLACEMENT/INSTALLATION – SMALL INTERMITTENT DRAINAGE LINES (TEMPORARY PIPE OPTION)



SITE STABILISATION

THIS METHOD IS ONLY SUITABLE FOR SMALL CHANNELS WITH INTERMITTENT FLOWS.

TEMPORARY PIPE TO BE SIZED TO AT LEAST HALF THE PERMANENT PIPE.
e.g. – PERMANENT: 600ø
– TEMPORARY: MINIMUM 300ø

THIS METHOD (TEMPORARY PIPE SYSTEM) WILL NOT BE SUITABLE IN STEEP LOCATIONS WHERE TEMPORARY PIPE CANNOT BE LOCATED OUTSIDE OF WORKS AREA.

LEGEND

- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ROCK STABILISED OUTLET (SD 5-8)
- CREEK/PIPE FLOW ROUTE
- SEDIMENT FENCE (SD 6-8)
- BUNDS

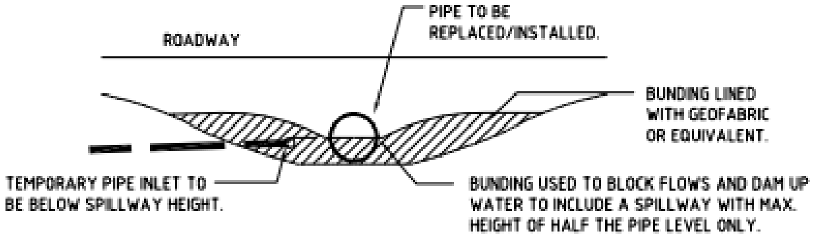
NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

1. Ensure suitable temporary groundcover materials (eg. geofabric, blankets) are located on site.
2. Ensure a temporary pipe is available. Install temporary pipe to ensure flow, preferably by providing continuous fall.
3. Watch the weather forecast to ensure rainfall is not forecast and monitor creek flows ensuring flows are minimal.
4. Position the bunding within the channel to secure the site.
5. Undertake construction works (including inlet outlet stabilisation) as quickly as possible.

At any time during steps 4 – 5 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.



AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

5.3 Proposal-Specific Recommendations

Table 5-2 contains a summary of those locations and aspects that are considered high-risk or that are outside of typical best-practice for a major road construction project, as identified in Table 5-1.

Table 5-2 – Summary of proposal-specific recommendations.

No	Location or aspect	Reason for special consideration	Reference from Table 5.1.	Recommendation(s)
1.	Whole proposal	Progressive planning of erosion and sediment control measures will be required due to the staged nature of the works.	2b	TfNSW QA G38 specification should be amended to include a requirement for the contractor to prepare Progressive ESCPs prior to commencement of any ground-disturbing works.
2.	Whole proposal	Progressive planning of erosion and sediment control measures will need to be documented.	2c	TfNSW QA G38 specification should be amended to include a requirement for the contractor to keep an up to date register of Progressive ESCPs onsite.
3.	Whole proposal	Acidic and infertile soils can limit the potential for effective revegetation.	4a, 4d, 8a and 8c	It is recommended that TfNSW QA G38 specification be amended to include specific requirements relating to rehabilitation methods: • Lime-treat any acidic topsoil that will be used for rehabilitation. The liming rate is to be determined by soil testing. • Apply fertiliser and/or compost to topsoils to improve fertility as required. The application rate is to be determined by soil testing.
4.	Whole proposal particularly around waterway areas	Highly erodible soils occur particularly in flood prone areas.	4b and 6c	It is recommended that TfNSW QA G38 specification be amended to include specific requirements relating to gypsum application: • Temporary stabilisation of exposed surfaces within 40m of the top of bank of a waterway prior to rainfall (>50% chance of rainfall >5mm). • Temporary stabilisation of exposed surfaces across flood prone lands (below the 10 year ARI flood level) prior to a potential flood event that could impact on the works. The trigger event is to be determined in consultation with engineering advice.

No	Location or aspect	Reason for special consideration	Reference from Table 5.1.	Recommendation(s)
5.	Whole proposal	Soils have low water holding capacity, which could affect the success of revegetation.	4c and 8b	It is recommended that TfNSW QA G38 specification be amended to include a requirement to: • Include water holding crystals in site-won soils that are reused for revegetation • Water (via water cart or via irrigation lines) revegetation areas if natural rainfall is insufficient to promote vegetation growth.
6.	Whole proposal	Stockpiling is not recommended in areas below the 2yr ARI flood level and therefore, will be restricted across the site.	4f	Stockpiling is to be in accordance with the following: • Stockpiling is not to occur within 40m from the top bank of a waterway (locations are marked on the Concept ESCPs within Appendix 1). • As much as feasible stockpiling is not to occur within flood prone lands (below the 10-year ARI flood level) (locations are marked on the Concept ESCPs within Appendix 1). • For all other areas (i.e. lands outside of the 10-year ARI flood extents) soil stockpiles are to be managed in accordance with Typical G38 and Blue Book requirements.

No	Location or aspect	Reason for special consideration	Reference from Table 5.1.	Recommendation(s)
7.	Whole proposal	Part of the site lies within flood prone lands and works may be impacted by flooding from the adjacent river and the unnamed drainage line south of Auld Avenue that crosses the works. High groundwater tables also occur across the site particularly within flood prone areas. Typical sediment control measures may not be feasible and alternative erosion and sediment control devices will be required.	5e and 6d	Excavated sediment control devices will likely not be possible in areas of high groundwater and flood prone lands. Linear swale drains, linear passive sediment control devices (e.g. sediment fence) or raised sediment control structures (e.g. rock filter dams) will be used instead in these locations to capture and treat dirty water runoff. Enhanced erosion controls will be used in conjunction with the above sediment control devices during high rainfall and flood events. These include: • Exposed soil surfaces within 40m of the top bank of a waterway (drainage line/river/wetland) are to be stabilised prior to rainfall (>50% chance of rainfall >5mm) and site closure (> 2 days) with a soil binder (e.g. vital stonewall), geofabric, black plastic or similar. • All exposed soil surfaces are to be stabilised prior to a potential flood event. The trigger event is to be determined as per engineering advice. • Stockpiling is not to occur within 40m from the top bank of a waterway or below the 10-year ARI flood level. Refer to the Concept ESCPs within Appendix 1 for site specific recommendations and details.
8.	All construction areas on alluvial sediments (Henry Lawson Drive from Chainage 680 to 1760 (including side street connections to Auld Avenue)	Groundwater tables within 1m of the current ground level could lead to groundwater ingress into trenches and excavations for new services or stormwater infrastructure. Dewatering of groundwater inflows will most likely be required during construction.	5e	A Dewatering Management Plan should be prepared as a sub-plan to the Soil and Water Management Plan (SWMP) for the proposal to detail how dewatering of groundwater inflows into trenches and excavations would occur. Transport G38 specification should be amended to include this requirement.

6 CONCLUSION AND RECOMMENDATIONS

Transport for NSW (TfNSW) is planning to upgrade Henry Lawson Drive along a 1.8-kilometre section between Keys Parade and the approach to the M5 Motorway (known as the Henry Lawson Drive Upgrade Stage 1B).

This report supports the environmental assessment and detailed design for the proposal.

The purpose of this report is to determine management issues for construction-phase erosion and sediment control.

- Section 3 identifies site conditions and identifies any potential constraints to construction-phase erosion and sediment control;
- Section 4 identifies design considerations for erosion and sediment control measures;
- Section 5 assesses the feasibility for constructing typical erosion and sediment control structures, with a series of recommendations to manage or mitigate potential impacts relating to construction-phase erosion and sediment control.

Section 5 is accompanied by a Concept ESCP (Appendix 1) showing the setup of key erosion and sediment control measures.

In preparing the Concept ESCP (Appendix 1), a review was conducted of the site conditions and proposed construction works to determine how these aspects might impact on effective implementation of erosion and sediment control during construction. In a number of locations specific constraints to the implementation of erosion and sediment controls were identified. Recommendations have been included in Table 5.2 and on the Concept ESCP (Appendix 1) to address these issues.

Providing the recommendations in Section 5 of this report and the Concept ESCP (Appendix 1) are adopted during the construction phase (or appropriate alternatives are adopted instead, in consultation with a soil conservationist), the risk of pollution from erosion and subsequent sediment runoff can be managed in accordance with recognised best-practice in NSW (Landcom 2004 and DECC, 2008).

It is recommended that TfNSW QA G38 specifications be modified to ensure that the recommendations in Table 5.2 are incorporated and thus carry through to the construction-phase of the proposal.

7 REFERENCES

Aurecon (2023). Review of Environmental Factors (REF): Henry Lawson Drive Upgrade Stage 1B.

DECC (2008). *Managing Urban Stormwater: Soils and Construction. Volume 2D: Main Road Construction*. Department of Environment and Climate Change, Sydney.

Hazelton, P. and Murphy, B. (2016). *Interpreting Soil Test Results: What Do All the Numbers Mean?* Third Edition, CSIRO Publishing, Australia.

IECA (2008). *Best Practice Erosion and Sediment Control.* International Erosion Control Association (Australasia). Picton, NSW.

Landcom (2004). *Managing Urban Stormwater: Soils and Construction.* Volume 1. NSW Government, Sydney.

NSW Government eSpade web portal. www.espade.environment.nsw.gov.au

Roads and Maritime Services (2011). *Technical Guideline: Temporary stormwater drainage for road construction.* December 2011.

Roads and Maritime Services (2015). *Guideline for Batter Surface Stabilisation Using Vegetation.* April, 2015.

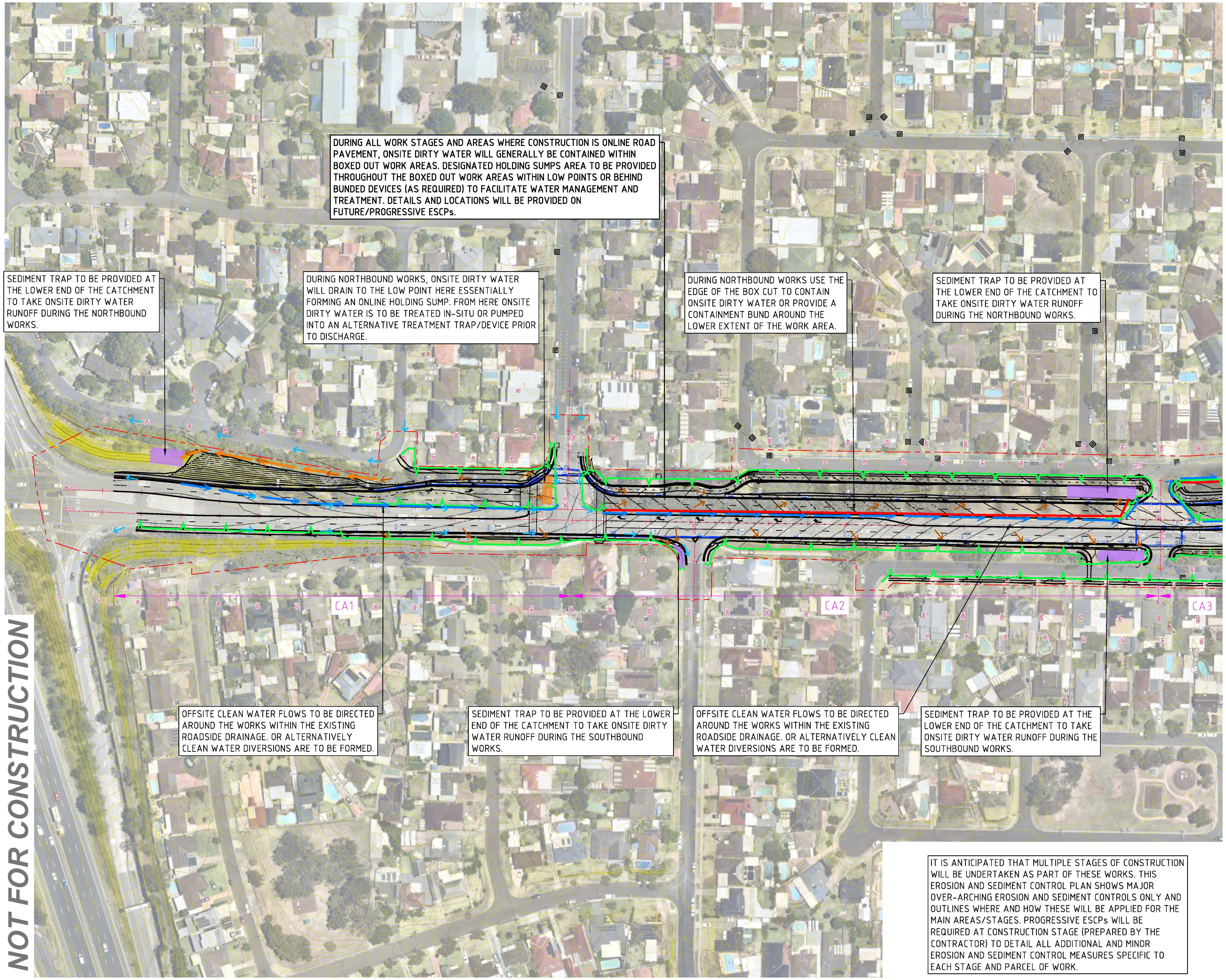
Transport for NSW (2021). *Henry Lawson Drive Upgrade Stage 1A; Review of Environmental Factors.* Transport for NSW. July 2021.

NGH & Transport for NSW (2021). *Surface Water Assessment; Henry Lawson Drive Stage 1A, NSW.* July 2021.

8 APPENDICES

8.1 Appendix 1: Concept Erosion and Sediment Control Plans (ESCP)

See overpage.



IT IS ANTICIPATED THAT MULTIPLE STAGES OF CONSTRUCTION WILL BE UNDERTAKEN AS PART OF THESE WORKS. THIS EROSION AND SEDIMENT CONTROL PLAN SHOWS MAJOR OVER-ARCHING EROSION AND SEDIMENT CONTROLS ONLY AND OUTLINES WHERE AND HOW THESE WILL BE APPLIED FOR THE MAIN AREAS/STAGES. PROGRESSIVE ESCPs WILL BE REQUIRED AT CONSTRUCTION STAGE (PREPARED BY THE CONTRACTOR) TO DETAIL ALL ADDITIONAL AND MINOR EROSION AND SEDIMENT CONTROL MEASURES SPECIFIC TO EACH STAGE AND PARCEL OF WORK.

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- CA1 CATCHMENT EXTENT
- Ø375 Ø375 PROPOSED STORWATER
- Ø375 EXISTING STORMWATER
- RESTRICTED (NO-GO) AREA TO PRESERVE VEGETATION - DO NOT DISTURB

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SD REFER TO BLUE BOOK/IECA STANDARD DETAIL

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ALL LIVE STORMWATER PITS WITHIN THE ACTIVE WORK AREA ARE TO HAVE PIT PROTECTION (E.G. SILT WARDEN OR SEDIMENT CONTROL FILTER) PROVIDED WITHIN/AROUND THE PIT. ALTERNATIVELY FOR NEW STORMWATER PITS WITHIN THE ACTIVE WORK AREA, THEY CAN BE SEALED/BLOCKED OFF UNTIL CONSTRUCTION WORKS IN THAT AREA ARE COMPLETE AND ALL SURFACES ARE STABLE (IF BLOCKING THE PIT WILL NOT CAUSE OR EXACERBATE FLOODING.

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B	21/12/22	A.T.	A.T.	A.M.	SECOND DRAFT – FOR REVIEW
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DESIGN BY	A.T.
DRAWN BY	A.T.
FINAL APPROVAL	A.M.
SCALE: (on A1 Original)	1:1000

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PROJECT TITLE
MR 508 HENRY LAWSON DRIVE UPGRADE – STAGE 1B BETWEEN SOUTH WESTERN MOTORWAY & AULD AVENUE

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN CH 0 – CH 560

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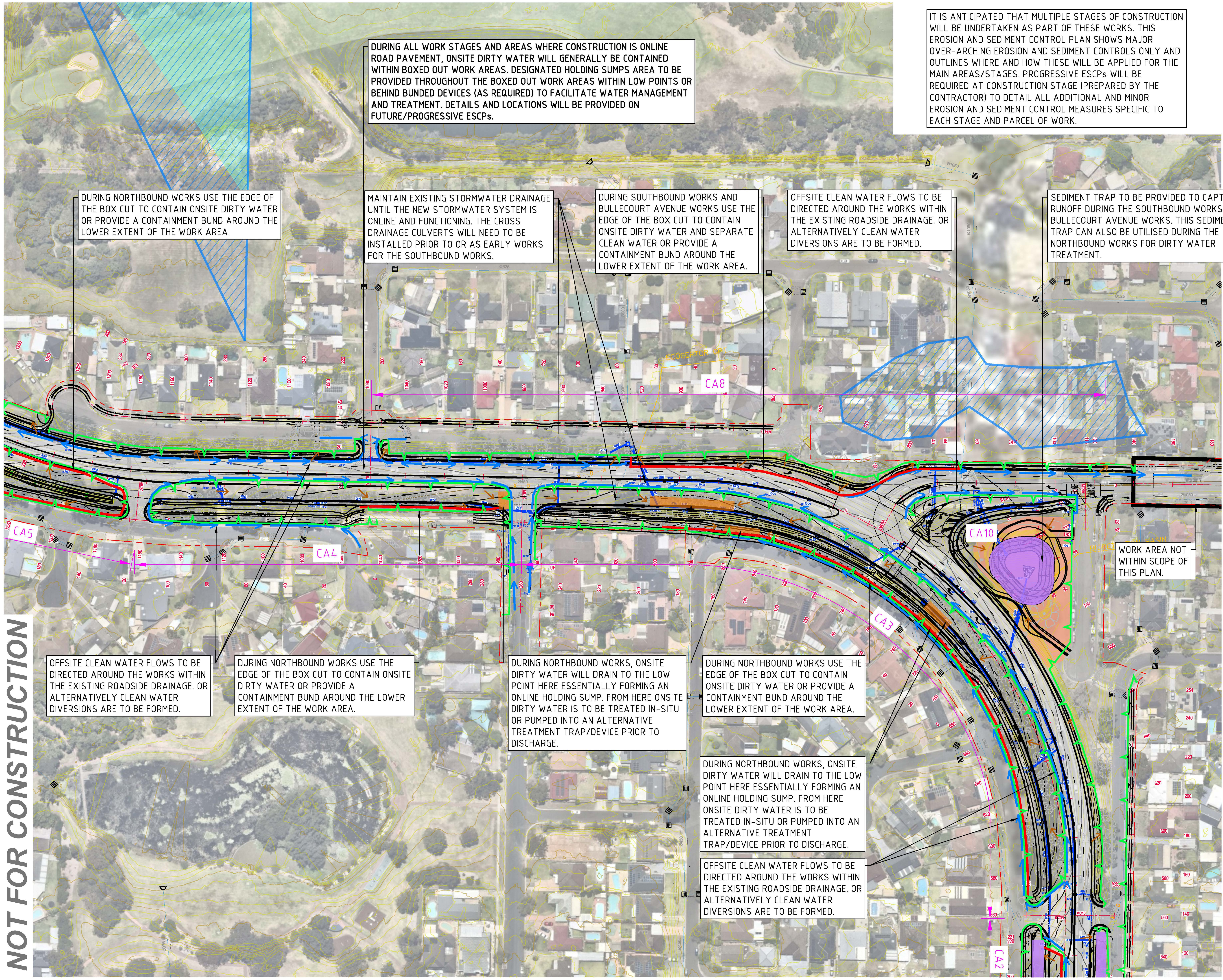

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MR 508 HENRY LAWSON DRIVE UPGRADE - STAGE 1B BETWEEN SOUTH WESTERN MOTORWAY & AULD AVENUE

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN CH 560 - CH 1200

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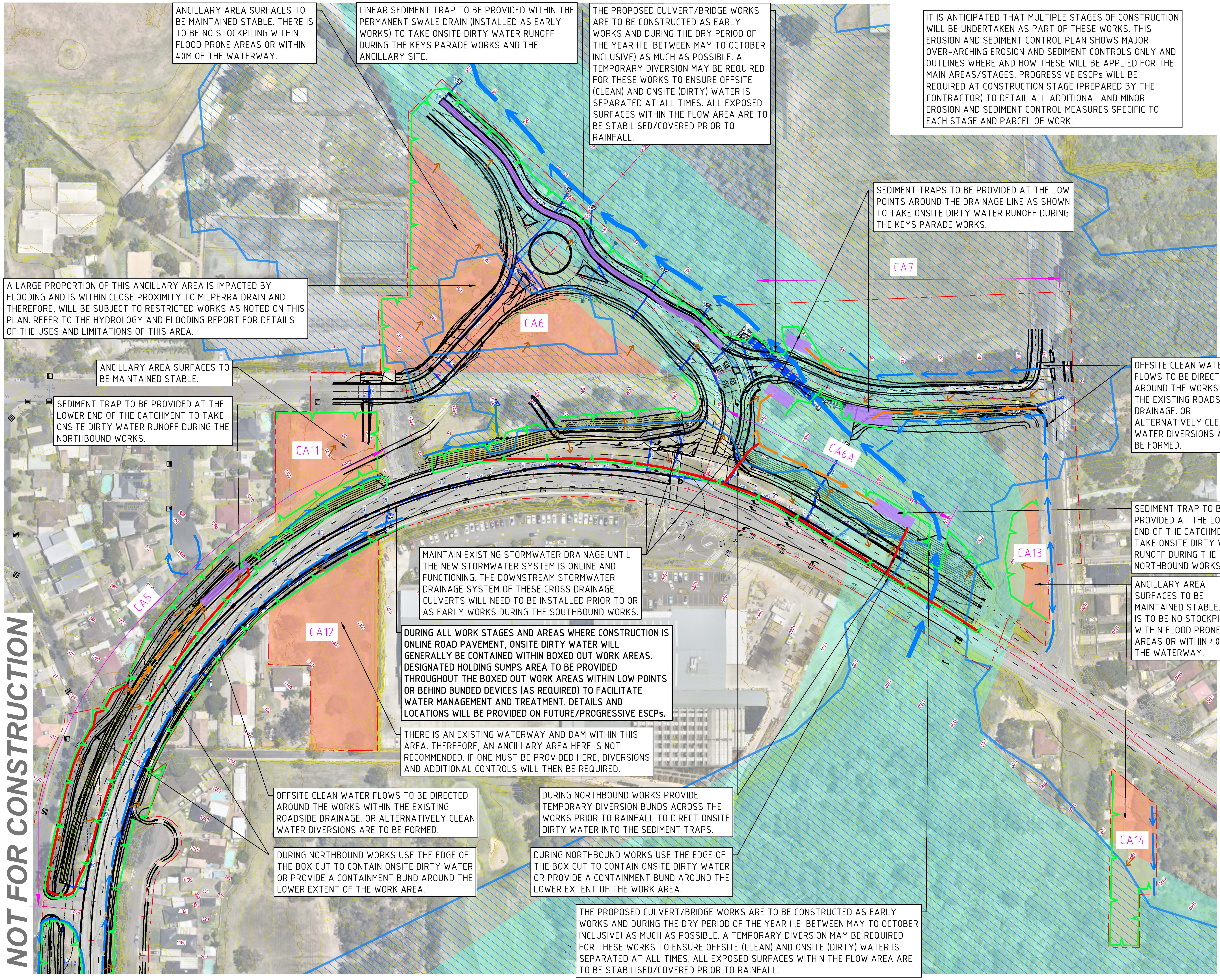

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DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN CH 1200 – CH 1760

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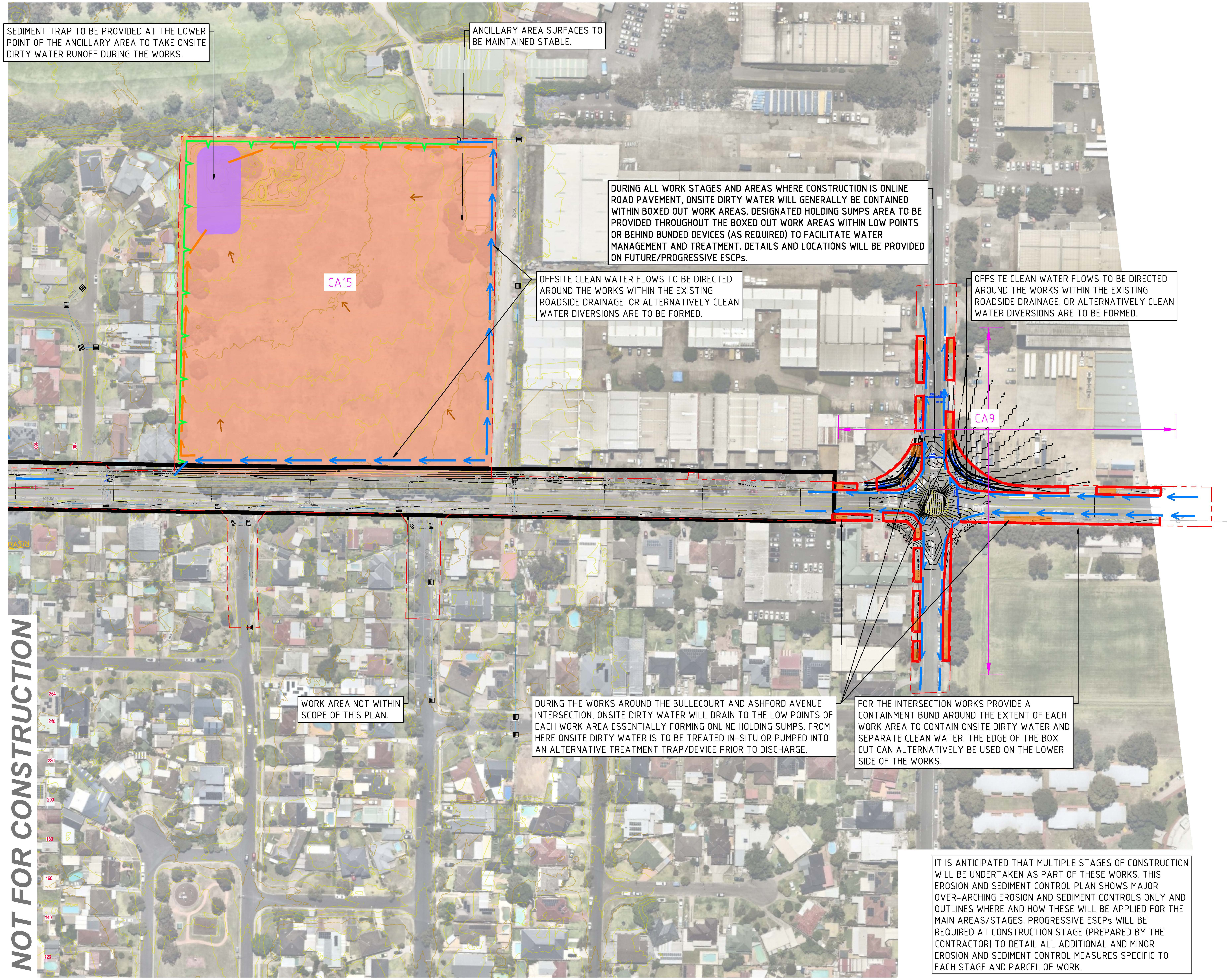

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ALL EXPOSED SOIL SURFACES WITHIN FLOOD PRONE LANDS ARE TO BE STABILISED PRIOR TO A POTENTIAL FLOOD EVENT. THE TRIGGER EVENT IS TO BE DETERMINED AS PER ENGINEERING ADVICE.

ALL LIVE STORMWATER PITS WITHIN THE ACTIVE WORK AREA ARE TO HAVE PIT PROTECTION (E.G. SILT WARDEN OR SEDIMENT CONTROL FILTER) PROVIDED WITHIN/AROUND THE PIT. ALTERNATIVELY FOR NEW STORMWATER PITS WITHIN THE ACTIVE WORK AREA, THEY CAN BE SEALED/BLOCKED OFF UNTIL CONSTRUCTION WORKS IN THAT AREA ARE COMPLETE AND ALL SURFACES ARE STABLE (IF BLOCKING THE PIT WILL NOT CAUSE OR EXACERBATE FLOODING.

OVERFLOWS FROM ALL SEDIMENT BASINS, SEDIMENT TRAPS AND OUTLETS OF DRAINAGE DEVICES ARE TO BE DIRECTED INTO THE DOWNSTREAM STORMWATER SYSTEM VIA A STABLE OUTLET DEVICE/STRUCTURE. UTILISE PERMANENT DRAINAGE OUTLETS AND DISSIPATION DEVICES WHERE APPLICABLE BY INSTALLING THESE STRUCTURES EARLY (OR INSTALL TEMPORARY DEVICES).

0 10 20 30 40 50m
SCALE: 1:1000 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
D	28/04/23	A.T.	L.O.	A.M.	FINAL ISSUE (CONCEPT)
C	28/02/23	A.T.	L.O.	A.M.	DRAFT ISSUE - AMENDED TO REFLECT UPDATED 80% DESIGN
B	21/12/22	A.T.	A.T.	A.M.	SECOND DRAFT - FOR REVIEW
A	06/12/22	A.T.	A.T.	A.M.	DRAFT ISSUE - FOR REVIEW

DRAWING STATUS
DESIGN BY: A.T.
DRAWN BY: A.T.
FINAL APPROVAL: A.M.
SCALE: (on A1 Original) 1:1000
CONCEPT

North

CLIENT: aurecon

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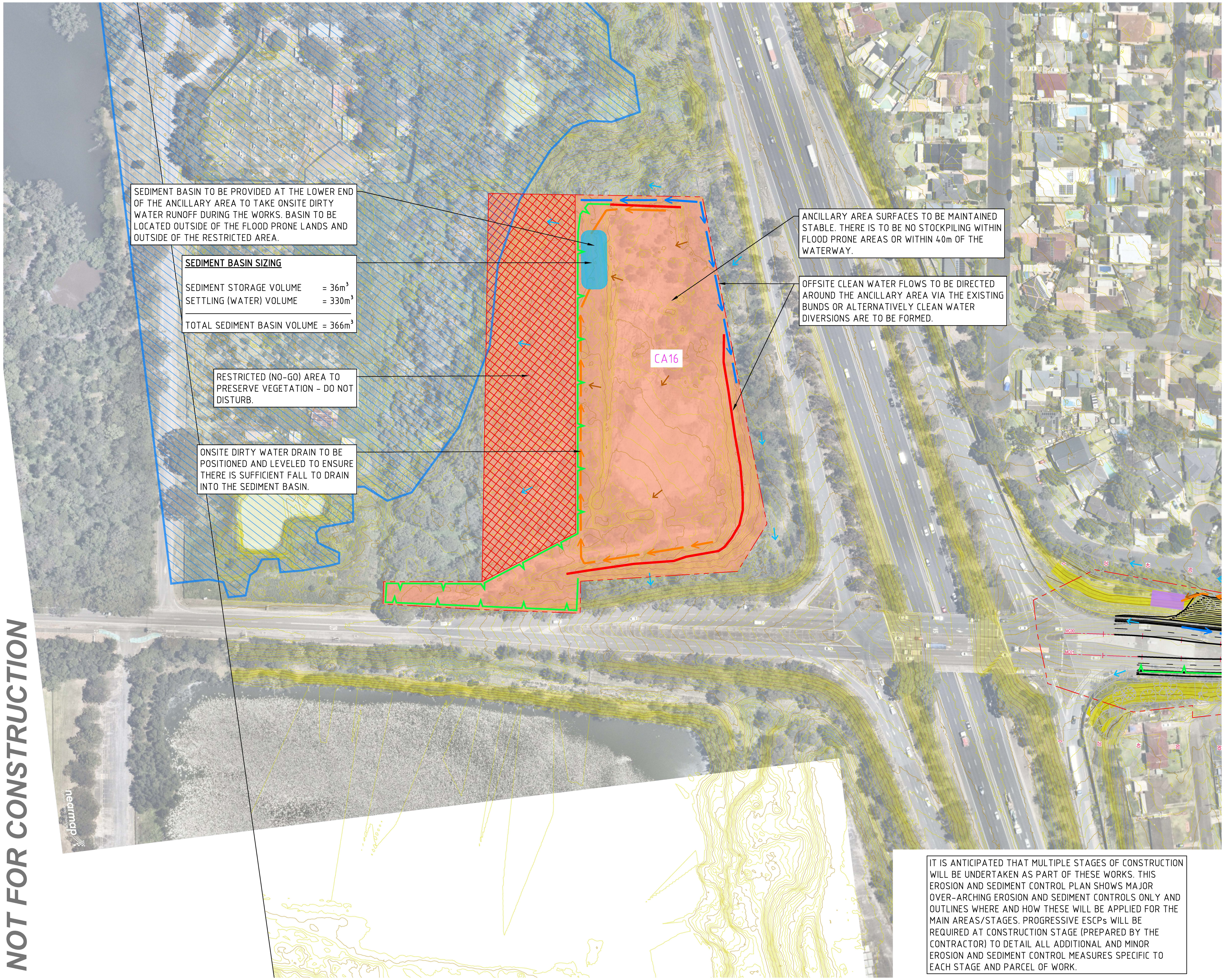
PROJECT TITLE
MR 508 HENRY LAWSON DRIVE UPGRADE - STAGE 1B BETWEEN SOUTH WESTERN MOTORWAY & AULD AVENUE

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN BULLECOURT AVENUE

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
21000288	P01	ESCP104	D

Plot Date: Monday, 1 May 2023 9:50:29 AM   CAD File Name: O:\21000288 Henry Lawson Drive Stage 1B\Drawings\21000288_P01_ESCP_REV D.dwg



LEGEND

- PROJECT BOUNDARY
- ONLINE LOW POINT/HOLDING SUMP [2]
- SEDIMENT TRAP (E.G. EXCAVATED TRAP (SD EST-01), ROCK FILTER DAM (SD RFD-01&02), U-TRAP (SD UST-01&02) OR SIMILAR) [2]
- SEDIMENT BASIN (SB) (SD 6-4) - (INDICATIVE FOOTPRINT ONLY) [1]
- SEDIMENT CONTROL - SEDIMENT FENCE (SD 6-8), COIR LOG BUND, CONTAINMENT BUND OR SIMILAR [2]
- CLEAN (OFFSITE) WATER DIVERSION [2]
- DIRTY (ONSITE) WATER DIVERSION [2]
- OFFSITE CLEAN FLOW DIRECTION
- ONSITE DIRTY FLOW DIRECTION
- ANCILLARY AREA (COMPOUND / LAYDOWN / STOCKPILE (SD 4-1)) [3]
- SURFACES WITHIN 40m OF WATERWAY - SUBJECT TO RESTRICTED WORKS AND ADDITIONAL MEASURES [4]
- FLOOD PRONE LANDS (10YR ARI FLOOD EXTENT) - SUBJECT TO RESTRICTED WORKS AND ADDITIONAL MEASURES [4]
- EXISTING WATERWAY/DRAINAGE LINE
- CONTAINMENT BUND/DIVERSION (SEALED CONCRETE BARRIER, EARTH BUND OR SIMILAR MIN. 500mm HIGH) [1] [2]
- CA1 CATCHMENT EXTENT
- PROPOSED STORWATER
- EXISTING STORMWATER
- RESTRICTED (NO-GO) AREA TO PRESERVE VEGETATION - DO NOT DISTURB

[1] - REFER TO PLAN FOR DETAILS
[2] - DETAILS TO BE CONFIRMED PRIOR TO CONSTRUCTION
[3] - GROUND SURFACES ARE TO BE MAINTAINED STABLE WITH ROADBASE, DGB, GRAVEL, CRUSHED ROCK OR SIMILAR. STOCKPILES MUST BE SET BACK AT LEAST 40m FROM THE TOP BANK OF ANY WATER BODY (E.G. RIVER, CREEK, DRAINAGE LINE, WETLAND)
[4] EXPOSED ONSITE CONSTRUCTION SURFACES THAT ARE WITHIN FLOOD PRONE LANDS AND/OR 40m OF THE TOP BANK OF A WATERWAY (CREEK/RIVER/WETLAND) TO BE STABILISED PRIOR TO RAINFALL (>50% CHANCE OF RAINFALL >5mm) AND SITE CLOSURE (> 2 DAYS) WITH A SOIL BINDER (E.G. VITAL STONEWALL), GEOFABRIC, BLACK PLASTIC OR SIMILAR. STOCKPILING NOT TO OCCUR IN THESE LOCATIONS.

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IT IS ANTICIPATED THAT MULTIPLE STAGES OF CONSTRUCTION WILL BE UNDERTAKEN AS PART OF THESE WORKS. THIS EROSION AND SEDIMENT CONTROL PLAN SHOWS MAJOR OVER-ARCHING EROSION AND SEDIMENT CONTROLS ONLY AND OUTLINES WHERE AND HOW THESE WILL BE APPLIED FOR THE MAIN AREAS/STAGES. PROGRESSIVE ESCPs WILL BE REQUIRED AT CONSTRUCTION STAGE (PREPARED BY THE CONTRACTOR) TO DETAIL ALL ADDITIONAL AND MINOR EROSION AND SEDIMENT CONTROL MEASURES SPECIFIC TO EACH STAGE AND PARCEL OF WORK.

0 10 20 30 40 50m
SCALE: 1:1000 (A1 SHEET)

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PROJECT TITLE
MR 508 HENRY LAWSON DRIVE UPGRADE – STAGE 1B BETWEEN SOUTH WESTERN MOTORWAY & AULD AVENUE

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN SOUTHERN ANCILLARY AREA

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
21000288	P01	ESCP105	D

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