

# SR39B STORMWATER AMENITY IMPROVEMENT WORKS- N14 DARK CREEK, JESMOND

AUGUST 2022

## REVIEW OF ENVIRONMENTAL FACTORS

**HUNTER WATER**

Version 1 authorised by Angus Seberry on 19/02/2020



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## DISCLAIMERS

- This report has relied on information and background searches completed for the CP3559 – SR00039 Stormwater Amenity Improvement Environmental Constraints Memo (Aurecon, 2021a)

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## TABLE OF DEFINITIONS

Term	Definition
<b>The Proposal</b>	<p>The stormwater amenity improvement works that are to be undertaken along the existing concrete-lined stormwater channel at Dark Creek, Jesmond.</p> <p>The amenity improvement works involves around 336m of channel naturalisation work. Native species would be planted within the revetment and along the top of the bank.</p>
<b>Proposal site</b>	<p>The Proposal site is the general area which includes the land within which the structural works and all construction compounds would be contained. The boundary of this Proposal site was used to understand the environmental constraints surrounding the Proposal in the broader Jesmond area. Labelled as "Proposal site" in Figure 1 Site overview of the Proposal.</p>
<b>Upstream section</b>	<p>The section of Dark Creek which runs adjacent to Blue Gum Road.</p>
<b>Downstream section</b>	<p>The section of Dark Creek which runs west through the northern extent of Heaton Park.</p>
<b>Structural works</b>	<p>The amenity improvement works which involves 265m of amenity works (removal of the existing concrete stormwater channel walls, battering the sides of the stormwater channel back to a 1V:2H slope, installation of rock revetment (rip-rap)). The structural works are described in the design drawings in Appendix A.</p>
<b>Structural works extent</b>	<p>Extent of the structural works within the broader Proposal site. Labelled as "Works extent" in Figure 1 Site overview of the Proposal.</p>
<b>Construction boundary</b>	<p>The area within the broader Proposal site which contains the structural works as well as the broader construction compounds such as site sheds and laydown areas and would be directly impacted by construction. Labelled as "Construction boundary" in Figure 1 Site overview of the Proposal.</p>

## 1 INTRODUCTION

Hunter Water Corporation (Hunter Water) propose to undertake amenity works including channel naturalisation and planting along the concrete-lined stormwater channel at Dark Creek, Jesmond (referred to as the Proposal).

Hunter Water intends to construct 1,000 m of channel naturalisation works within the Hunter Water network to improve the amenity of concrete lined waterways in response to various stakeholder preferences for naturalisation of Hunter Water's concrete stormwater open channels. Dark Creek, Jesmond is one of several areas which is proposed to have stormwater amenity and channel naturalisation works undertaken.

The Proposal has been assessed in accordance with the environmental impact assessment requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Hunter Water is the proponent and the determining authority for the Proposal in accordance with Division 5.1 of the EP&A Act.

The purpose of this minor works REF is to describe the proposed works and assess the potential construction and operation environmental impacts with consideration of the factors listed in clause 171 of the *Environmental Planning and Assessment Regulation 2021*. The REF identifies safeguards to mitigate identified impacts.

## 2 PROPOSAL DETAILS

### 2.1 Proposal identification

Proposal name	Stormwater Amenity Improvement – Dark Creek, Jesmond
Reference number	HW2018-1118/8/12.003
Proposal location	The Proposal would be located within Dark Creek adjacent to Blue Gum Road, Jesmond. This section of Dark Creek is located within Heaton Park, Lot 2 – DP 1082079. The location of the Proposal is shown in Figure 1.
Local Government Area	The Proposal is located in the Newcastle Local Government Area (LGA).
Land zoning	The land zoning for the Proposal site is RE1 Public Recreation.

### 2.2 Existing environment

The Proposal is located in the suburb of Jesmond within the Newcastle LGA, managed by the City of Newcastle (Council). The Proposal site is located within a recreational park, Heaton Park, in Jesmond.

The Proposal site is characterised by a flat, grassed parkland with a concrete-lined stormwater channel running east then south through the Proposal site. The eastern extent of the Proposal site runs parallel to Blue Gum Road. The Jesmond Central shopping mall is situated to the south of the Proposal site, whilst low-density residential development borders to the north and east. To the west is a mix of residential and commercial development, including Boral Concrete and an Ausgrid depot.

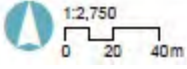
No native vegetation communities are mapped within the Proposal site. Existing vegetation consists of both dispersed mature non-native and native trees. Dark Creek is mapped as key fish habitat for its full extent, however the creek does not contain any mapped distributions of threatened aquatic species, and being a concrete lined channel, the Proposal is therefore not classified as key fish habitat by Fisheries NSW (DPI, 2013).. Overall salinity hazard is mapped as very high for the majority of the Proposal site, however, soil and water samples do not indicate the presence of salts. Both soil landscapes the Proposal site lies within have high erodibility and are a water erosion hazard. No listed non-Aboriginal heritage items have been identified within proximity of the Proposal site. Two Aboriginal sites or places have been recorded around 750m south of the Proposal site, however, would not be impacted by the Proposal.



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- Proposal site
- Works extent
- Cadastral
- Cricket pitch 60m radius
- Sports field strings
- Construction compound
- Construction access
- Construction boundary
- Tree Protection Zone (TPZ) boundary
- TPZ where ground protection must be installed

Sources: Aurecon, Hunter Water, Hunter H2O, DPIE, Neimap, ESRI



Projection: GDA 1994 MGA Zone 55



P512448 Stormwater Amenity

FIGURE : Site Overview - Jesmond (N14)

Figure 1 Site overview of the Proposal



## 2.3 Proposal description

Description of works	<p>The Proposal would involve about 251m of structural works (naturalisation of the creek) along two sections of the stormwater channel. The Jesmond Upstream works include a 177m section of structural works on the western Bank, and the Downstream works include a 159m section of structural works on the southern bank (refer to Figure 1). Naturalisation works will also include planting of a garden bed along the edge of the channel to link the Upstream and Downstream sections. A total of around 336m of amenity improvement and naturalisation works would be completed.</p> <p>The naturalisation works involves the following:</p> <ul style="list-style-type: none"> <li>• removing the existing concrete stormwater channel walls</li> <li>• battering the sides of the stormwater channel back to a 1V:2H slope</li> <li>• installing rock revetment (rip-rap) on the western bank of the Upstream section and the southern bank of the Downstream section</li> <li>• planting native species within the revetment and along the top of the bank</li> <li>• widening the concrete channel base by 600mm.</li> <li>• installing sandstone block transition walls to transition between the concrete bank and the rip-rap bank.</li> </ul> <p>The stormwater channel would remain operational i.e. convey stormwater flows, during construction. Stormwater in the channel would be required to be managed and the works protected during construction. Design drawings are included in Appendix A.</p>
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Construction methodology	<p>Construction works would include:</p> <table border="1"> <thead> <tr> <th>Construction activity</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td><b>Site establishment</b></td> <td> <ul style="list-style-type: none"> <li>• placing temporary fencing and signage to designate site access and construction zones</li> <li>• setting up security measures</li> <li>• establishing construction compounds including site amenities and site sheds, laydown and stockpiling areas</li> </ul> </td> </tr> <tr> <td><b>Environmental controls</b></td> <td> <ul style="list-style-type: none"> <li>• install temporary flow diversion in channel base e.g. sandbags and/ or barriers on a section by section basis</li> <li>• install temporary erosion and sediment controls</li> <li>• place spill kits</li> </ul> </td> </tr> <tr> <td><b>Investigations</b></td> <td> <ul style="list-style-type: none"> <li>• pre-construction asset inspections.</li> </ul> </td> </tr> <tr> <td><b>Materials delivery</b></td> <td> <ul style="list-style-type: none"> <li>• deliver fill materials to laydown areas</li> </ul> </td> </tr> <tr> <td><b>Structural works – Stage 1 (removing concrete channel)</b></td> <td> <ul style="list-style-type: none"> <li>• channel structural works would be completed in sections. This phasing of structural works would ensure protection of the Proposal site during stormwater flow events in the channel</li> <li>• excavator to remove turf and topsoil within Proposal site and move to stockpile</li> <li>• following an arborist assessment, excavator to remove tree within works extent (if required)</li> <li>• sawcut channel wall and undertake bank works within the proposal site</li> </ul> </td> </tr> </tbody> </table>	Construction activity	Description	<b>Site establishment</b>	<ul style="list-style-type: none"> <li>• placing temporary fencing and signage to designate site access and construction zones</li> <li>• setting up security measures</li> <li>• establishing construction compounds including site amenities and site sheds, laydown and stockpiling areas</li> </ul>	<b>Environmental controls</b>	<ul style="list-style-type: none"> <li>• install temporary flow diversion in channel base e.g. sandbags and/ or barriers on a section by section basis</li> <li>• install temporary erosion and sediment controls</li> <li>• place spill kits</li> </ul>	<b>Investigations</b>	<ul style="list-style-type: none"> <li>• pre-construction asset inspections.</li> </ul>	<b>Materials delivery</b>	<ul style="list-style-type: none"> <li>• deliver fill materials to laydown areas</li> </ul>	<b>Structural works – Stage 1 (removing concrete channel)</b>	<ul style="list-style-type: none"> <li>• channel structural works would be completed in sections. This phasing of structural works would ensure protection of the Proposal site during stormwater flow events in the channel</li> <li>• excavator to remove turf and topsoil within Proposal site and move to stockpile</li> <li>• following an arborist assessment, excavator to remove tree within works extent (if required)</li> <li>• sawcut channel wall and undertake bank works within the proposal site</li> </ul>
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	<ul style="list-style-type: none"> <li>excavate channel wall below base of channel (refer detailed design in appendix a) and temporarily stockpile spoil for disposal</li> <li>channel wall below (refer detailed design in Appendix A) batter slopes to be shaped at a 1V:2H to facilitate placement of fill and rock revetment (rip-rap)</li> <li>demolishing existing drainage outlet headwall</li> </ul>
<b>Dewatering</b>	<ul style="list-style-type: none"> <li>dewater groundwater or surface water within excavations using portable pumps as required and appropriate disposal</li> </ul>
<b>Waste disposal</b>	<ul style="list-style-type: none"> <li>dispose construction waste including spoil to a licensed waste facility</li> </ul>
<b>Structural works – Stage 2 (asset protection/restoration, transition wall works and channel base extension)</b>	<ul style="list-style-type: none"> <li>construct transition retaining walls (concrete) grouted to existing bank wall</li> <li>reconstruct drainage outlet headwall from sandstone</li> <li>concrete encase sewer from bend under works if required</li> <li>extend existing concrete base slab including tie-in to existing slab i.e. install starter bars using hammer or core drill</li> <li>removal of abandoned water main and concrete casing of water main to be retained</li> <li>overhead powerline stay pole to be relocated</li> </ul>
<b>Structural works – Stage 3 (bank protection works)</b>	<ul style="list-style-type: none"> <li>place select fill and rock revetment (rip-rap)</li> <li>place planting material in planting areas</li> <li>place erosion control matting (thick jute mat) and plant native plants (refer to species list in design drawings, Appendix A)</li> <li>install permanent fence along downstream section</li> </ul>
<b>Site restoration</b>	<ul style="list-style-type: none"> <li>final landscaping/rehabilitation</li> <li>remove temporary environmental controls</li> <li>remove construction compounds such as construction fencing and signage, waste bins and waste materials</li> </ul>

Construction compounds would include:

- fencing
- site sheds
- portable toilets
- laydown/stockpile locations
- waste facilities.

**Operational requirements**

Plant health management, weed maintenance and inspections of works after significant rainfall events to be undertaken during the two-year contractor maintenance period.

During the operational phase, works are to be periodically inspected in accordance with Hunter Water maintenance regime for weeds and any significant defects. Weed management and defect repair to be undertaken as required.

Equipment and plant	<p>The following indicative plant and equipment would be required:</p> <ul style="list-style-type: none"> <li>○ excavator</li> <li>○ concrete saw</li> <li>○ portable dewatering pumps</li> <li>○ franna/ mobile crane</li> <li>○ concrete pump</li> <li>○ trucks</li> <li>○ wheel loader</li> <li>○ hand tools including hammer or core drills</li> <li>○ pulveriser (preferred) or hydraulic rock breaker attachment for excavator</li> <li>○ small vibratory roller and/ or plate compactor</li> <li>○ generator/s</li> <li>○ auger</li> <li>○ rocks and gravels</li> <li>○ planting material</li> <li>○ geotextile</li> <li>○ erosion control matting (thick jute mat)</li> </ul>
Land tenure	<p>The stormwater channel is located within an easement through a single land parcel owned by Council i.e. Heaton Park. The planned works will result in the channel extending outside of the current easement, requiring an extension of the easement or the creation of a new easement. Construction compounds including site sheds and laydown areas and temporary site access would be on Council land. Council have been provided notification of the Proposal and have been engaged in ongoing consultation with Hunter Water (refer to Section 4).</p>
Commencement and expected duration of construction work	<p>The proposed works are expected to commence in late 2022 and be completed by mid 2024.</p> <p>Once operational, a contractor would be engaged to inspect and maintain the works for 2 years following completion of construction (as part of the defects liability period).</p>
Hours of construction work	<p>Working hours would be standard construction hours:</p> <ul style="list-style-type: none"> <li>○ Monday to Friday – 7am to 6pm</li> <li>○ Saturday 8am to 1pm</li> <li>○ No work on Sundays or public holidays.</li> </ul> <p>Emergency out of hours work may be required to protect the structural works during stormwater flow events in the channel. This would be an exceptional event which occurs following significant rainfall.</p> <p>If out-of-hours works are required, approval must be sought from Hunter Water prior, and respective landholders notified as advised by Hunter Water communications and stakeholder team.</p>
Proposal need	<p>Hunter Water owns approximately 97 km of stormwater drainage assets in the Hunter Water region. Approximately 50% are open channels that were constructed during the 1920s and 1940s, with nearly all concrete lined. These drainage assets run next to parks and through major commercial precincts and are visually unappealing.</p> <p>The NSW State Government has developed a 20-year blueprint for the future of the Hunter Region that reflects community and stakeholder aspirations. Its vision is for the Hunter Region to be the leading regional economy with a vibrant new metropolitan city at its heart, acknowledged globally for a number of attributes including its excitement of the inner city, and great lifestyles. A key objective is to enhance amenity for quality of life including creating great public spaces, access and improving pedestrian and cyclist safety.</p> <p>Hunter Water has investigated how they can help deliver on the region's vision. Hunter Water's stakeholders and customers have indicated a</p>

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preference for naturalisation of Hunter Water’s concrete stormwater open channels, to improve waterway health and improve community amenity. Based on survey results, our customers have also identified a willingness to pay which would be spread across the entire customer base.

Hunter Water has obtained approval from the Independent Pricing and Regulatory Tribunal (IPART) to deliver the Stormwater Amenity Improvement Program in the period from 2020-21 to 2023-24. Hunter Water’s commitment to IPART includes delivering a minimum length of 1,000m of amenity improvement.

This investment is considered 100% discretionary.

Hunter Water has worked with local councils to determine priority areas for stormwater amenity improvement works and Dark Creek in Jesmond was identified as a priority.

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#### Proposal objectives

The Proposal objectives are:

- to improve the amenity of the stormwater system, provide improved community access,
- increase the value of waterways and encourage more recreational activity by the community.

These objectives align with the NSW Government blueprint for the Hunter Region, with its key objective to enhance amenity for quality of life including creating great public spaces, access and improving pedestrian and cyclist safety.

The strategic objectives of the Proposal include:

- protect public safety
  - minimise negative community impacts
  - Increase contribution to liveability outcomes for the community
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#### Options considered and justification

Due to the modified nature of Dark Creek in Jesmond (concrete-lined channel) the Proposal site is appropriate for channel improvement works. These works would provide residents and users of the park extended views of a more naturalised waterway, which is aligned with stakeholder preferences for naturalisation of Hunter Water’s concrete stormwater open channels.

Two structural options were considered for the Proposal, along with the “do nothing” option:

- do nothing – does not improve visual amenity
- option 1 - replaces 265m of concrete channel walls with rock revetment (rip-rap) on 1(V):2(H) batters and provides the best visual impact (the Proposal).
- option 2 - replaces the upper sections of concrete channel walls, while retaining the lower portions of concrete walls. This option balances visual impact with construction costs and risks.

Option 1 was selected as the preferred option to maximise the extent of concrete to be replaced with more natural materials and maximise the improvements in visual impact.

Option 1 to improve stormwater amenity through creek naturalisation works at Dark Creek, Jesmond best fulfills the Proposal’s objectives.

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## 3 STATUTORY CONTEXT

### 3.1 Environmental planning instruments

#### Newcastle Local Environment Plan 2012

The Proposal is located within the Newcastle Local Government Area (LGA). Local development control and land use zoning within the Newcastle LGA is managed under the Newcastle Local Environmental Plan 2012 (Newcastle LEP). The operation of the Transport and Infrastructure State Environmental Planning Policy 2021 (T&ISEPP) means that the Newcastle LEP does not apply where they impose controls that are inconsistent with the T&ISEPP. However, the LEP is still relevant in identifying land use objectives, potential land use impacts and planning policy conflicts and as such, has still been considered.

The Proposal is located within land zoned as RE1: Public Recreation under the Newcastle LEP. The Proposal is consistent with the objectives of this zone, which are:

- To enable land to be used for public open space or recreational purposes.
- To provide a range of recreational settings and activities and compatible land uses.
- To protect and enhance the natural environment for recreational purposes.

#### State Environmental Planning Policy (Transport and Infrastructure) 2021

The T&ISEPP describes certain developments that may be carried out without consent in order to facilitate the delivery of infrastructure in NSW.

Clause 2.136 (1) of T&ISEPP enables development for the purpose of stormwater management systems to be carried out by or on behalf of a public authority without consent on any land. As the Proposal would form part of a stormwater management system and Hunter Water is a public authority, it is considered permissible without consent pursuant to the provisions of T&ISEPP and can be assessed under Division 5.1 of the EP&A Act. Development consent from Council is not required.

### 3.2 Relevant legislation

#### Environmental Planning & Assessment Act 1979

The *Environment Planning and Assessment Act 1979* (EP&A Act) is the principal legislation for environmental planning and assessment in NSW. The EP&A Act provides for creation and implementation of State Environment Planning Policies (SEPPs) and Local Environment Plans (LEPs), collectively referred to as Environmental Planning Instruments (EPIs).

The description of the Proposal and associated environmental impacts has been carried out with consideration of clause 171 of the Environmental Planning and Assessment Regulation 2021 (summarised in Appendix B), the *Biodiversity Conservation Act 2016* (BC Act), the *Fisheries Management Act 1994* (FM Act), and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In doing so, the REF helps to fulfill the requirements of Section 5.5 of the EP&A Act that Hunter Water examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environmental by reason of the activity.

#### Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is administered by the NSW Environment Protection Authority (EPA). Part 3.2 of the POEO Act requires an Environment Protection Licence (EPL) for scheduled development work and the carrying out of scheduled activities. The Proposal does not trigger these requirements.

Section 120 of the POEO Act prohibits the pollution of waters. The REF includes measures to address the risk of water pollution, refer to Section 5.2.

Air pollution-related sections 124 to 126 (Chapter 5, Part 5.4., Division 1) of the POEO Act require activities to be conducted in a proper and efficient manner, while section 128 (Chapter 5, Part 5.4., Division 1) of the POEO Act requires that all necessary practicable means be used to prevent or minimise air pollution. Air quality is addressed in Section 5.10.

Pollution of land and waste is covered by Part 5.6 of the POEO Act. The Act defines 'waste' for regulatory purposes and establishes management and licensing requirements for waste. It defines offences relating to waste and sets penalties. The POEO Act also establishes the ability to set various waste management requirements via the Protection of the Environment Operations (Waste) Regulation 2014.

Waste and resource use is addressed in Section 5.11. Contamination is addressed in Section 5.1. Noise is addressed in Section 5.4.

### **Biodiversity Conservation Act 2016**

The *Biodiversity Conservation Act 2016* (BC Act) is directed at maintaining a healthy, productive and resilient environment consistent with the principles of ecologically sustainable development (ESD). The BC Act sets out the assessment framework for threatened species and ecological communities.

Certain species of animals or plants are identified as endangered species, populations or communities or vulnerable species under the Act. Areas of land comprising the habitats of listed endangered species may also be declared Areas of Outstanding Biodiversity Value under the Act.

Under Part 7 of the BC Act, an activity that is likely to significantly affect threatened species (which is defined to include ecological communities, or their habitats) requires either:

- A biodiversity development assessment report prepared by an accredited assessor in accordance with the Biodiversity Assessment Method (BAM); or
- A species impact statement and the concurrence of the Environment Agency Head.

Potential impacts on biodiversity as a result of the Proposal are considered in Section 5.3. Significant impacts are not expected.

### **Biosecurity Act 2015**

Under the *Biosecurity Act 2015*, which came into effect on 1 July 2017, 'all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable'.

A number of weed species may be present within the Proposal site. Management of these weed species during the work would be undertaken in a manner to minimise their further proliferation under the *Biosecurity Act 2015*. The REF includes measures to address weed management, refer to Section 5.3.

### **National Parks and Wildlife Act 1974**

The harming or desecrating of Aboriginal objects or places is an offence under Section 86 of the *National Parks and Wildlife Act 1974* (NPW Act). Under Section 90, an Aboriginal heritage impact permit may be issued in relation to a specified Aboriginal object, Aboriginal place, land, activity or person or specified types or classes of Aboriginal objects, Aboriginal places, land, activities or persons. Further provisions include the protection of Aboriginal objects and places and offences relating to harm or desecration of an Aboriginal object or declared Aboriginal place. Harm includes destroying, defacing damage or moving items or places without consultation.

No Aboriginal objects or places would be impacted by the Proposal. An assessment of potential impacts to Aboriginal objects or places is included in Section 5.6.

### **Hunter Water Act 1991**

The *Hunter Water Act 1991* provides for the establishment and operation of Hunter Water as a state-owned corporation to supply water, provide sewerage and drainage services, and dispose of wastewater. Hunter Water's primary functions are established in the Act and are regulated by the NSW Government through the current Operating Licence administered by the Independent Pricing and Regulatory Tribunal. The Operating Licence sets out conditions relating to wastewater transport as well as drinking water quality and environmental requirements.

### **Fisheries Management Act 1994**

The *Fisheries Management Act 1994* (FM Act) provides for the identification, conservation and recovery of threatened fish, aquatic invertebrates and marine vegetation. One of the key objectives of the FM Act is to conserve fish stocks and key fish habitats.

Part 7 of the FM Act establishes that a permit is generally required to dredge, reclaim, obstruct fish passage, harm marine vegetation, use explosives or electrical devices in a waterway that is classified as key fish habitat.

The section of Dark Creek which sits within the Proposal site is mapped as key fish habitat, however, is not classified as key fish habitat under the *Fisheries NSW Policy for fish habitat conservation and management* (DPI, 2013) as it is a concrete lined channel. Despite this, as no marine vegetation exists within the waterway, a section 205 permit under Part 7 of the FM Act would not be required. Furthermore, given that the stormwater drain will remain operational during works, fish passage will not be obstructed, thereby negating the need for a Section 219 permit. Maintenance of the fish passage during works is discussed in Section 5.3.

### **Waste Avoidance and Resource Recovery Act 2011**

The *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) aims to encourage the most efficient use of resources and to reduce environmental harm in accordance with the principles of ecologically sustainable development. The Proposal would involve efficient use of resources, including utilising resources from local sources where practicable. Waste generation and management is discussed in Section 5.11.

### **Heritage Act 1977**

The *Heritage Act 1977* (Heritage Act) is designed to protect both known heritage items (such as standing structures) and items that may not be immediately obvious (such as potential archaeological remains or 'relics'). Different parts of the Heritage Act deal with different situations and types of heritage and the Act provides a number of mechanisms by which items and places of heritage significance may be protected.

Section 57(1) of the Heritage Act lists the types of activities/works that require approval from Heritage NSW (a branch of the NSW Department of Premier and Cabinet) under Section 60 of the Heritage Act, when working on/in an item/place listed on the State Heritage Register (SHR). An application for an exemption can also be made under some circumstances.

No non-Aboriginal heritage items would be impacted by the Proposal given that there are none within the Proposal site. Non-Aboriginal heritage is further discussed in Section 5.5 with mapping provided in Appendix D.

### **Environment Protection and Biodiversity Conservation Act 1999**

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) a referral is required to the Australian Government Department of Agriculture, Water and the Environment for

proposed actions that have the potential to significantly impact on Matters of National Environmental Significance (MNES) or the environment of Commonwealth land.

The assessment of the Proposal's impact on nationally listed threatened species, endangered ecological communities and migratory species has found that there is unlikely to be a significant impact on relevant MNES. These are considered in Section 5.3.



## 4 CONSULTATION

### 4.1 State Environmental Planning Policy (Transport and Infrastructure) 2021 consultation

Part 2.2 General, Division 1 of the T&ISEPP prescribes consultation to be undertaken by a public authority prior to the commencement of certain activities. A review of the T&ISEPP consultation requirements for the Proposal is provided in Table 4-1.

Table 4-1 Infrastructure SEPP consultation requirements

Is consultation with Council required under clauses 2.10-2.14 of T&ISEPP?	Yes/No
Is the proposal likely to have a substantial impact on stormwater management services which are provided by council?	No
Is the proposal likely to generate traffic to an extent that will strain the capacity of the existing road system in a local government area?	No
Will the proposal involve connection to a council owned sewerage system? If so, will this connection have a substantial impact on the capacity of any part of the system?	No
Will the proposal involve connection to a council owned water supply system? If so, will this require the use of a substantial volume of water?	No
Will the proposal involve the installation of a temporary structure on, or the enclosing of, a public place which is under local council management or control? If so, will this cause more than a minor or inconsequential disruption to pedestrian or vehicular flow?	Yes. However, idisruption to pedestrian and vehicular flow is considered minor.
Will the proposal involve more than minor or inconsequential excavation of a road or adjacent footpath for which council is the roads authority and responsible for maintenance?	No
Is the proposal likely to have a more than minor or inconsequential impact on a local heritage item (that is not also a State heritage item) or a heritage conservation area?  <i>(Note: local heritage item means —</i> <i>(a) a place, building, work, relic, tree, archaeological site or Aboriginal object that is identified as a heritage item (or by a similar description) in a local or regional environmental plan, or</i> <i>(b) an item of local heritage significance, as defined by the Heritage Act 1977, that is the subject of an interim heritage order in force under that Act or is listed as an item of local heritage significance on the State Heritage Inventory under that Act.)</i>	No
Is the proposal located on flood liable land? If so, will the works change flood patterns to more than a minor extent?	Yes. However, works will not change flood patterns to more than a minor extent.
Is the proposal within the coastal vulnerability area and is inconsistent with a certified coastal management program applying to that land?  Note: See interactive map here: <a href="https://www.planning.nsw.gov.au/policy-and-legislation/coastal-management">https://www.planning.nsw.gov.au/policy-and-legislation/coastal-management</a> . Note the coastal vulnerability area has not yet been mapped.  Note: a certified coastal zone management plan is taken to be a certified coastal management program	No
Is the proposal characterised as stormwater management systems under Division 20 and located on flood liable land? If so, do the works comprise more than minor	Yes

alterations or additions to, or the demolition of, a building, emergency works or routine maintenance?

Note: Flood liable land means land that is susceptible to flooding by the probable maximum flood event, identified in accordance with the principles set out in the manual entitled Floodplain Development Manual: the management of flood liable land published by the New South Wales Government.

Is consultation with a public authority other than Council required under clauses 2.15 and 2.16 of T&ISEPP?	Yes/No
Is the proposal adjacent to a national park or nature reserve, or other area reserved under the <i>National Parks and Wildlife Act 1974</i> , or on land acquired under that Act?	No
Is the proposal on land in Zone E1 National Parks and Nature Reserves or in a land use zone equivalent to that zone?	No
Does the proposal consist of a fixed or floating structure in or over navigable waters?	No
Will the proposal increase the amount of artificial light in the night sky and that is on land within the dark sky region as identified on the dark sky region map – the Director of the Observatory? Note: The dark sky region is land within 200 kilometres of the Siding Spring Observatory.	No
Is the proposal on defence communications facility buffer land within the meaning of clause 5.15 of the Standard Instrument – the Secretary of the Commonwealth Department of Defence? Note: Defence communications facility buffer land is located around the defence communications facility near Morundah. See the Defence Communications Facility Buffer Map referred to in clause 5.15 of <i>Lockhart Local Environmental Plan 2012</i> , <i>Narrandera Local Environmental Plan 2013</i> and <i>Urana Local Environmental Plan 2011</i> .	No
Is the proposal on land in a mine subsidence district within the meaning of the <i>Coal Mine Subsidence Compensation Act 2017</i> ?	No
Is the proposal to be carried out in an area that is bush fire prone land? If so, has the <i>Planning for Bush Fire Protection</i> been considered before carrying out the development? Note: <i>bush fire prone land</i> means land recorded for the time being as bush fire prone land on a map certified under the Act, section 10.3(2). <i>Planning for Bush Fire Protection</i> means the document entitled <i>Planning for Bush Fire Protection</i> , ISBN 978 0 646 99126 9, prepared by the NSW Rural Fire Service in co-operation with the Department of Planning, Industry and Environment, dated November 2019.	No

## 4.2 T&ISEPP Consultation Letters

Under the requirements of the T&ISEPP, Hunter Water consulted with City of Newcastle Council (CoN) and NSW State Emergency Services (NSW SES) on 12 April 2022 providing details about the Proposal including scope and reason for consultation.

NSW SES have reviewed the consultation letter and responded without raising any concerns or comments.

Following the review of the consultation letter, CoN have recommended the following:

- In the instance the cycleway is constructed prior the Proposal, the cycleway fence must be designed and constructed in accordance with Austroads Guide to Road Design Part 6A Pedestrian and Cyclist Paths (i.e. fence 1.4m high) and Council Standard Drawings A3503 and A3504.

- A flood impact assessment to be prepared showing negligible impacts across the private properties adjoining Heaton Park.
- Preparation and submission of an Arboricultural Impact Assessment and Tree Protection Plan in accordance with AS4970:2009.

Hunter Water have considered the recommendations of CoN and a Flood Impact Assessment and an Arboricultural Impact Assessment have been prepared to support this MWREF.

Consultation records are included in Appendix C.

### 4.3 Other consultation

As part of obtaining approval from IPART for project funding, consultation was undertaken with Hunter Water customers. Engagement surveys conducted with the local community in 2018 had indicated that most residential customers were willing to pay more in their bills in return for investment in amenity works to naturalise stormwater channels.

Following this community consultation, Hunter Water worked with local councils to determine key areas where stormwater naturalisation works would have the most benefit for the community. In 2020 the key sites identified were prioritised in consultation with the councils. The Proposal was identified as a priority by CoN. Hunter Water consulted again with CoN in June 2021 to confirm that Dark Creek in Jesmond was the site preference prior to design development.

Further consultation with CoN was carried out during the concept design phase in 2021. This involved a Constraints Workshop and Deliverables Review in August and November 2021.

### 4.4 Department of Primary Industries

Will the proposal involve dredging or reclamation works in a waterway?	Yes/No
This includes any excavation within, or filling or draining of, water land or the removal of woody debris, snags, rocks or freshwater native aquatic vegetation or the removal of any other material from water land.	No

## 5 ENVIRONMENTAL ISSUES IDENTIFICATION

This section provides a description of potential impacts associated with the Proposal and specifies measures to mitigate identified impacts. All aspects of the environment potentially impacted by the Proposal are considered. A summary of the consideration of factors specified in clause 171 of the *Environmental Planning and Assessment Regulation 2021* is provided in Appendix B. A summary of the matters of national environmental significance under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* is provided in Appendix B.

Database searches referred to in the following tables are included as Appendix D. Further site-specific detail is contained in Appendices E (Flood Impact Assessment), F (Dewatering Memo) and G (Noise and Vibration Impact Assessment).

### 5.1 Topography, soils and geology

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Would the work require excavations or other ground disturbing activities?	Yes	<p>The Proposal would require excavation and ground disturbing works. As listed in Section 2.3, excavation works will include:</p> <ul style="list-style-type: none"> <li>○ Removing turf and topsoil along channel</li> <li>○ Saw cutting channel walls</li> <li>○ Removing one mature tree within the structural works footprint</li> <li>○ Excavating to required depth to facilitate placement of fill and rock revetment (rip-rap) (refer typical sections in detailed design in Appendix A)</li> </ul> <p>Mitigation measures listed in Section 6.1 will minimise potential erosion and sediment impacts.</p>	N/A
Would the work require plant/vehicular movements on unsealed areas?	Yes	Access to the Proposal site would be via existing sealed roads (Mordue Parade) as shown in Figure 2-1, however, plant and vehicles would have to track into the Proposal site and creek channel across the park using temporary access tracks through Heaton Park.	N/A
Could the work occur in an area of high erosion risk (eg, due to nature of soils, topography)?	Yes	The Proposal site lies within two soil landscapes (Department of Planning, Industry and Environment, 2020), being the Killingworth landscape to the west of Dark Creek and the Beresfield landscape to the east of Dark Creek. Both soil landscapes have high erodibility and are a water erosion hazard.	eSPADE – 6 September 2021 (updated 25 April 2022)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		<p>The scope of excavation and ground disturbance for this Proposal would be confined to the extent of the structural works extent. During construction, there is potential for erosion of exposed soils on cut batter slopes to occur during storm events prior to bank protection (rock rip rap or erosion control matting) being installed.</p> <p>A Flow Management Plan would be developed to manage works within the channel and minimise the risk of flood and erosion. The potential for erosion would be appropriately managed by the mitigation measures listed in Section 6.1.</p>	
<p>Could the work impact on or have the potential to impact on Acid Sulphate Soils (ASS)?</p>	<p>No</p>	<p>The Proposal site is not considered to be located within an ASS risk area given that the area has been identified as Class 5 in the Newcastle LEP ASS Mapping. The Proposal is unlikely to impact on ASS given that ASS are not typically found in Class 5 areas.</p> <p>Approximately 400m downstream of the western extent of the Proposal site, Dark Creek is mapped as category 'H2'/Class 3, meaning there is a high probability of ASS 1 – 3m below the ground surface. Given the distance of the Proposal site to the Class 3 area, it is unlikely that ASS will be impacted as a result of the Proposal, however, an elevated risk of encountering ASS should be considered during excavation works.</p> <p>In the unlikely event that ASS is discovered, mitigation measures listed in Section 6.1 will appropriately address the potential risks.</p>	<p>Naylor, Guidelines for the Use of Acid Sulfate Soil Risk Maps, 2nd ed., 1998</p>
<p>Could the work impact on areas of known salinity risk?</p>	<p>Yes</p>	<p>Most of the site is mapped as having a very high overall salinity hazard. The majority of the Proposal site is mapped as high hazard due to land salinity, salt export and instream electrical conductivity (Department of Planning, Industry and Environment, 2020). However, the north-west corner of Heaton Park is mapped as having low overall salinity hazard. Whilst the mapping indicates the potential for salinity, a soil profile taken approximately 800m south-west of the Proposal site indicates no salting evident. Further, water quality sampling in Dark Creek downstream of the Proposal site indicates that instream water quality is fresh water and not saline.</p> <p>The Proposal will accommodate the potential for saline or sodic soils without exacerbating erosion or collapse and will preserve existing</p>	<p>eSPADE – 6 September 2021 (updated 25 April 2022) Department of Planning, Industry and Environment, 2020</p>

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		groundwater levels and flow patterns. All materials being used in the naturalisation works are resistant to salt. Plants will be established in suitable soils, and it is very unlikely that any saline groundwater (if present) would contact the roots. It is therefore considered unlikely that the works would impact on or be exposed to salinity risk.	
Could the work result in disturbance of contaminated land?	No	<p>A search of the NSW Environment Protection Authority (EPA) contaminated land record of notices for the suburb of Jesmond returned no known contaminated sites in the vicinity of the Proposal site.</p> <p>The preliminary waste classification (Aurecon, 2021b) and geotechnical investigation prepared for the Proposal site (Aurecon, 2022) considered background and historical site information, and included field investigation, boreholes and test pits. Based on the sampling results, the preliminary classification of fill material on site is general solid waste (non-putrescible) with no asbestos containing materials (ACM) observed. Soil samples from boreholes taken on site detected PAHs with Benzo(a)pyrene concentrations above General Solid Waste criteria for two samples and above the Restricted Solid Waste criteria for one sample. Further Toxicity Characteristic Leaching Procedure (TCLP) testing for benzo(a)pyrene was conducted which returned a reading of &lt;1 µg/L, enabling the preliminary classification of General Solid Waste (non-putrescible), however, further testing of fill prior to offsite disposal should be undertaken. If the material meets the recreational land use criteria of excavated natural material (ENM) or virgin excavated natural material (VENM) or meets the NEPM criteria relevant to the proposed land use (i.e., recreational land use criteria) it could be reused on site rather than disposed. Mitigation measures have allowed for unexpected finds of incidental contamination during earthworks (such as illegally dumped wastes and stockpiles) and the management of asbestos if encountered.</p>	<p>NSW EPA contaminated land record of notices and list of notified NSW contaminated sites (as of 25 May 2022)</p> <p>Preliminary waste classification (Aurecon, 2021b)</p> <p>Geotechnical report (Aurecon, 2022)</p>

## 5.2 Hydrology and water quality

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Could the work impact a water catchment area? Do any of the work areas drain directly to Hunter Water special areas?	No	The Proposal is not located within or upstream of a drinking water catchment or Hunter Water special area.	
Could the work impact directly or indirectly on a waterway? (including creek crossings and underboring a waterway)	Yes	<p>The Proposal would directly impact Dark Creek by replacing the existing concrete channel walls with laid back rock revetment (rip rap) and plantings. During construction, there is a potential for exposed soils to be eroded during storm events potentially resulting in water quality impacts to Dark Creek associated with sedimentation downstream.</p> <p>Erosion and sediment control measures and appropriate procedures would be in place, including implementation of a Flow Management Plan, during construction to minimise the potential for bank erosion and impacts to water quality during storm events. These measures will also prevent exposed construction fill material being washed into the channel prior to completion of the works. Refer to the mitigation measures in Section 6.1. The works would also be staged and completed in sections to minimise these risks during construction.</p> <p>In accordance with Clause 41 of the Water Management (General) Regulation 2018, as a state-owned body, Hunter Water are exempt from requiring a controlled activity approval to undertake works on waterfront land providing the activity does not cause any change in the course of the river. Hunter Water has considered the environmental impact of the activity and is satisfied that the activity is not likely to significantly affect the environment as per Clause 37 of Schedule 4 of Water Management (General) Regulation 2018. Safeguards to manage potential impacts to Dark Creek as a result of works within waterfront land are outlined in Section 6.1.</p>	<p>Water Management (General) Regulation 2018</p> <p>Controlled activity approval exemptions Fact Sheet, (Department of Planning, Industry and Environment 2021)</p>
<p>Is the work located on flood prone land?</p> <p>Could the work result in impacts to flooding regimes and flows?</p> <p>Could the work be impacted by flooding?</p>	Yes	<p>The Proposal is located within flood prone land in the Dark Creek floodplain (Newcastle Floodplain Risk Management Plan, (BMT WBM, 2012)).</p> <p>A flood impact assessment was undertaken (refer Appendix E), where the bank-full flow (the approximate flow that results in the concrete channel flowing at full capacity), 10% Annual Exceedance Probability</p>	Flood impact assessment (Appendix E)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		<p>(AEP), 1% AEP and probable maximum flood (PMF) events were modelled using a newly-developed two-dimensional hydraulic model (TUFLOW). A comparison between flood conditions was undertaken for the Proposal site with and without the proposed stormwater amenity works.</p> <p>In the 10% AEP the impacts around the works transitions result in an increase &lt; 60 mm in peak flood levels in the undeveloped lot on the north side of the channel over an extent of 126m<sup>2</sup>, and 11m<sup>2</sup> that is newly inundated. This impact is at the end of the works where the channel profile changes from the design profile back to the existing concrete walls. Within this same lot on the north side of the channel there is also large extent (approximately 2088m<sup>2</sup>) of reduced flood levels (an average of 11mm reduction), and a total of 44m<sup>2</sup> that is no longer inundated.</p> <p>The peak flood level impacts maps show that for the 1% AEP and greater, flood impacts are limited to the extent of bank works or are located directly around the works transitions. Extending the proposed works will not impact on private property or roads in the 1% AEP and therefore the modelling demonstrates that the works will not have a negative impact on flooding on the community or the feasibility of establishing development on adjacent land above the current flood planning level.</p> <p>A check of the flow hydrographs upstream and downstream of the project works for both existing case and proposed design scenario runs were compared to determine whether the design altered the flow regime. These comparisons show that the flow behaviour between existing and proposed scenarios are effectively the same, and this behaviour remains similar both upstream and downstream of the proposed works. This indicates that while there does appear to be local flood impacts (in both an increase and decrease in levels) over the site works, the flow behaviour and floodplain storage remains effectively unchanged.</p> <p>In the absence of scour protection, the structural works would experience flooding and associated scour forces in a range of flows.</p>	



Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		<p>The design of the structural works would reduce scour through the placement of rock and erosion control matting. It is expected that flood events would not cause damage during construction with the implementation of erosion protection and a wet-weather shutdown plan. Modelling results demonstrate the expected scour velocities could be withstood once all works are complete and stabilisation planting has been established.</p>	
<p>Would the work be likely to encounter groundwater or require discharge of accumulated water?</p>	<p>Yes</p>	<p>The Groundwater Dewatering Memorandum (Appendix F) prepared for the Proposal indicated that excavation works are likely to encounter some groundwater. The groundwater dewatering memorandum estimated the potential volume of dewatering required for the project and identified approval and licensing requirements.</p> <p>Despite the measured groundwater level (1.6m BGL) being lower than the maximum depth of excavation works (1.5m BGL), 0.4m has been adopted as the required drawdown value. This value was drawn using a conservative approach and after accounting for variability in groundwater levels. It was estimated that a total of 0.16 ML of groundwater may be encountered over the duration of the works. A Flow Management Plan would be developed for managing construction works within the channel, and the works would be completed in sections to minimise the length of excavated, exposed areas requiring soil and water management.</p> <p>The contractor may propose to place fill materials within a wet environment if the groundwater ingress is minimal, however some dewatering may still be required to prevent uncontrolled releases to the creek in accordance with the proposed mitigation measures (refer Section 6.1) Disposal options for extracted groundwater are described in Appendix F and include discharge to Dark Creek or the stormwater system, discharge to sewer or offsite disposal at a licensed wastewater facility. The preference would be dewatering downstream provided that the discharge assessment has demonstrated that the groundwater quality is suitable and will not have deleterious impacts to the receiving water body. Groundwater would be tested prior to the works commencing to ensure there is no existing contamination or abnormal water quality parameters present, refer Section 6.1.</p>	<p>Groundwater dewatering memorandum (Appendix F)</p>

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		<p>Due to the minimal length of works, and the limited amount of groundwater ingress expected, temporary shoring to prevent groundwater intrusion would not be required.</p> <p>Any dewatering requires a Water Supply Works (WSW) approval. The groundwater assessment estimated that around 0.16 ML of groundwater would need to be dewatered. A Water Access License (WAL), under the Water Management Act 2000 is only required where more than 3 ML/year of groundwater is anticipated to be extracted. Therefore a WAL is not expected to be required for the Proposal.</p>	
Would the works result in permanent changes to existing surface drainage patterns?	No	The Proposal would retain all existing surface water drainage paths.	N/A

### 5.3 Biodiversity

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Would the work require vegetation removal?	Yes	<p>An arboricultural impact assessment (AIA) and tree protection plan (TPP) was prepared in accordance with AS4970:2009 Protection of trees on development sites by a suitably qualified arborist, to consider the proposal and its potential impacts on vegetation within the construction boundary. A site inspection was undertaken on 27 June 2022 with trees inspected and characteristics recorded in a tree schedule (Appendix G).</p> <p>The Proposal would require the removal of two low-retention value trees, which are considered small or in poor condition. These trees, a Jacaranda and a Weeping Willow, are indicated as Trees 2 and 5 on the Tree Management Plan within Appendix G. The retention of significant boundary tree cover (Eucalyptus species) will ensure there is little impact on the wider setting. Minor pruning of several trees to the west of the Proposal site may be required to facilitate plant access beneath the tree canopies.</p>	Arboricultural impact assessment (Appendix G)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
<p>Would the work occur within the Tree Protection Zone of any trees? (Defined as: 12 x diameter of the trunk at 1.4m high)</p>	<p>Yes</p>	<p>Appropriate mitigation measures identified by the arborist to mitigate and minimise impacts to vegetation have been included in Section 6.1.</p> <p>The Proposal would require works within several tree protection zones (TPZ), and pruning may be required to facilitate access into the structural works area (refer to the Tree Management Plan within Appendix A). The arborist has assessed the requirements for access and works within the TPZ, particularly for Trees 3 and 4 (both <i>Eucalyptus saligna</i>), and has determined that if adequate precautions to protect the retained trees are implemented in accordance with the arboricultural method statement in Appendix G, the Proposal will have no adverse effects on the TPZ and no adverse impact on the contribution of trees to local amenity or character. Placement of materials, site laydown areas and parking of plant and vehicles would be located outside of the tree protection zones within the Proposal site as indicated in Figure 1.</p>	<p>Arboricultural impact assessment (Appendix G)</p>
<p>Could the work impact directly or indirectly on <i>Biodiversity Conservation Act 2016</i> or <i>Fisheries Management Act 1994</i> listed species or threatened ecological community or areas of outstanding biodiversity value under the BC Act or critical habitat under the FM Act?</p>	<p>No</p>	<p>The NSW BioNet Atlas was reviewed in June 2022 for species listed under the BC Act that have the potential to occur within 100km<sup>2</sup> of the Proposal site.</p> <p>The NSW BioNet Atlas identified no records within the Proposal site, however, the search returned records of Category 3 species within 1km of the Proposal site. Category 3 species are considered to be at medium to high risk of threats such as disturbance or exploitation.</p> <p>Given that the Proposal would only require removal of two non-native trees (Weeping willow and Jacaranda) and potentially may require minor pruning of <i>Eucalyptus</i> trees for access within Heaton Park, no impacts to any BC Act or FM Act listed species or threatened ecological communities would be expected.</p> <p>The mitigation measures in the AIA have been included in Section 6.1 and would be implemented to minimise any adverse biodiversity impacts.</p>	<p>NSW BioNet Atlas search on 22 June 2022</p>

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Could the work impact directly or indirectly on an <i>Environment Protection and Biodiversity Conservation Act 1999</i> listed species, ecological community or migratory species?	No	A protected matters search identified the potential presence of 48 threatened species, 33 migratory species and four listed threatened ecological communities within one kilometre of the Proposal. The recorded threatened fauna species include 18 birds, three frogs, eight mammals and 19 plant species.  No EPBC Act listed threatened species, ecological communities and migratory species would be impacted as a result of the Proposal.	Protected Matters database 22 June 2022
Could the work impact (directly or indirectly) on areas mapped in the Coastal Management SEPP, littoral rainforests, marine parks, national parks estate, biodiversity stewardship sites or wilderness areas?	No	There are no areas mapped in the Coastal Management SEPP, littoral rainforests, marine parks, national parks estate, biodiversity stewardship site or wilderness area near the Proposal.	SEPP Coastal Management 2018 ePlanning spatial viewer in September 2021
Could the work impact (directly or indirectly) on aquatic or riparian vegetation including seagrasses, mangroves or saltmarshes?	No	Due to the nature of the concrete lined channel, there is no aquatic or riparian vegetation present. The Proposal would not result in direct or indirect impacts on aquatic or riparian vegetation.	N/A
Would the work require the disturbance or removal of any priority or environmental weeds listed in the <i>Hunter Regional Strategic Weed Management Plan 2017-2022</i> ?	No	The Proposal would not require the disturbance or removal of any priority or environmental weeds listed in the <i>Hunter Regional Strategic Weed Management Plan 2017-2022</i> .	N/A
Would the work impact on fish passage?	No	A search of the Fisheries NSW Spatial Data Portal (Department of Primary Industries, 2012) has shown that Dark Creek is mapped as Key Fish Habitat (KFH) for its fullest extent within the Proposal site and upstream and downstream of the Proposal site.  Dark Creek is classified as KFH due to falling under the following definition for a KFH as provided by the Department of Primary Industries (DPI) - Flood channels or flood runners that may normally be dry but would be used by fish to move/migrate across or along floodplains between habitats during high flow events.	Fisheries NSW Spatial Data Portal in September 2021

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		<p>Whilst the channel is mapped as key fish habitat, because it is concrete-lined, it is not considered 'key fish habitat' under the Fisheries NSW <i>Policy for fish habitat conservation and management</i> (DPI, 2013). Further, it has no instream woody vegetation or 'habitat' for fish, however, the channel naturalisation may help to improve this.</p> <p>Given the scope of the Proposal and that the stormwater channel will remain operational during works through the Flow Management Plan, fish passage is not expected to be impacted as a result.</p>	
Would the work have potential to displace fauna or create a barrier to fauna movements?	No	The Proposal requires removal of one mature non-native tree and pruning of several trees to the west of the Proposal site. A permanent fence is proposed to be installed in the East-west section however, this is unlikely to displace fauna or create a barrier to fauna movements.	N/A

#### 5.4 Noise and vibration

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Are there any sensitive receivers in the vicinity of the proposal? (e.g. residential, schools, church, important native fauna populations)	Yes	<p>A noise and vibration impact assessment (NVIA) was undertaken by Renzo Tonin in April 2022 (Appendix H) to assess the potential noise and vibration impacts of the Proposal on the surrounding environment and sensitive receivers.</p> <p>A desktop land use survey was carried out to identify sensitive receivers in the vicinity of the Proposal. Neary sensitive receivers included residential lots, educational facilities, a place of worship, commercial facility, recreational facility and child-care centre. These receivers are further detailed in Appendix H.</p>	NVIA (Appendix H)
Could the proposal result in construction noise impacts for longer than three weeks, or outside of standard working hours? Was	Yes	Long term unattended noise monitoring was conducted for a continuous period from 26 April to 6 May 2022, to measure ambient and background noise levels in the vicinity of residential receivers	NVIA (Appendix H)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
a quantitative noise assessment undertaken?		<p>around the proposed works. A summary of the unattended noise monitoring results are included in Appendix H.</p> <p>Given the Proposal will result in construction for a duration longer than three weeks, a quantitative assessment has been carried out. No construction works are proposed outside of standard working hours.</p>	
Could the proposal result in noise impacts on receivers during construction?	Yes	<p>During standard construction hours, residential receivers located near the Proposal site have the potential to be affected by works during various louder construction stages. Nearby residences are likely to experience highly intrusive levels of noise greater than 20 dB(A) above the Noise Management Level. During periods of high noise plant and equipment use, such as an excavator with hydraulic hammer, up to 11 nearby residential receivers on Blue Gum Road are predicted to be highly noise affected (i.e. &gt; 75 dB(A)). During typical construction works without the use of high noise generating plant and equipment, receivers are not predicted to be highly noise affected.</p> <p>Noise impacts would be greatest during usage of high noise generating plant and equipment, such as concrete saws and rock breakers.</p> <p>Construction related traffic noise is predicted to comply with the road traffic noise goals given the rate of traffic volume (three heavy vehicles per hour) and daytime noise goal of Mordue Parade (60 dB(A) <math>L_{Aeq,1hr}</math>).</p> <p>Mitigation measures have been provided in the NVIA (Appendix H) to ensure impacts are minimised as far as practicable.</p>	NVIA (Appendix H)
Could the proposal result in noise impacts on receivers during operation?		<p>The Proposal (the naturalised channel) would not introduce any new noise sources and would not permanently change existing background noise levels. The Proposal would not have any operational noise impacts.</p>	NVIA (Appendix H)
Could the proposal result in vibration impacts on nearby properties or infrastructure?		<p>The Proposal has potential to result in vibration impacts on nearby residences to the north on Blue Gum Road, and to the east on Blue Gum Road. These residences are within the minimum working distance for human comfort. Given the use of rollers would occur only</p>	NVIA (Appendix H)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		<p>for a limited duration, the risk of human annoyance is considered low. However, these residences may be able to feel vibration during roller usage.</p> <p>There are no reinforced or unreinforced structures within the minimum working distance for cosmetic damage.</p> <p>Mitigation measures have been provided in the NVIA (Appendix H) to ensure impacts are minimised as far as practicable.</p>	

## 5.5 Non-Aboriginal heritage

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Were all relevant heritage database searches carried out?	Yes	<p>The search of the heritage registers identified no heritage items within the Proposal site and one heritage item within 500m of the Proposal site (mapped in Appendix D):</p> <ul style="list-style-type: none"> <li>o The Regal Cinema, Heritage Item ID 2171429, located approximately 500m north of the Proposal site at 4 Moore Street, Birmingham Gardens and is of local heritage significance under the Newcastle LEP.</li> </ul> <p>This heritage items is located approximately 500m from the Proposal site and would therefore not be directly or indirectly impacted by the proposal, including from ground-borne vibration.</p>	<p>NSW Heritage database (inventory)</p> <p>Newcastle Local Environmental Plan 2012</p>
Could the works impact on an item of heritage significance or a heritage conservation area?	No	There are no items of heritage significance or heritage conservation areas that would be impacted by the Proposal.	N/A
Could the works impact on areas of archaeological potential?	No	The proposal would require excavation to remove turf and topsoil and soil behind the existing channel walls within the works extent. However, given the disturbed nature of the area from the established stormwater drainage infrastructure, the potential for unknown archaeological features is considered negligible.	N/A

## 5.6 Aboriginal heritage

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Would the work require ground disturbance?	Yes	The proposal would involve excavating to remove turf, topsoil and soil behind the existing channel walls within the structural works extent, to create the naturalised channel batter slopes.	N/A
Has an Aboriginal Heritage Information Management System (AHIMS) search been completed and were any known Aboriginal items or places identified within or in the vicinity of the proposal site?	Yes	A search of the AHIMS Web Service has shown that: <ul style="list-style-type: none"> <li>○ 2 aboriginal sites are recorded in or near the Proposal site</li> <li>○ 0 aboriginal places have been declared in or near the Proposal site</li> </ul>	AHIMS searched on 1 September 2021 (Updated 22 June 2022)
Would the work occur in or near sensitive landscape features as defined in the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (2010)?	No	The extent of the Proposal site does not coincide with any sensitive landscape features as defined in the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (2010).	N/A
Could harm to AHIMS listed sites or places or landscape features be avoided?	No	Two Aboriginal heritage sites have been identified approximately 750m south of the Proposal site in the Jesmond Bushlands. Given that construction involving ground disturbances is strictly limited to the extent of the structural works extent and the significant distance between the Proposal site and the identified Aboriginal heritage sites, no impacts are expected.  Due to the extensive previous ground disturbance in this area due to the initial construction of the stormwater channel, it is unlikely that any unknown Aboriginal heritage items would be identified.	AHIMS searched on 1 September 2021 (Updated 22 June 2022)

## 5.7 Traffic and access

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Would the works occur on a public road and could the proposal disrupt traffic flow or access during construction?	No	The proposal is located west of Blue Gum Road and north of Mordue Parade which are both public roads. The works would not occur on the public roads however access to the construction site from the roads would be required which may cause short-term disruption to traffic flows.	N/A



Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		<p>Access for construction plant and vehicles to the Proposal site would be through Mordue Parade.</p> <p>The Proposal would result in a temporary increase in vehicle movements on the surrounding road network due to the need to transport equipment, materials, and resources to and from the construction footprint and compound locations, as well as construction staff vehicle movements. Vehicles would park within the site compounds shown on Figure 1. The road network and intersections are anticipated to have capacity to temporarily accommodate the increased vehicle traffic. Therefore, no impacts or disruptions to local traffic would not be expected as a result of the Proposal.</p> <p>A Traffic and Pedestrian Management Plan would be prepared by the contractor to manage construction traffic impacts.</p>	
Could the proposal disrupt pedestrian or cycle access during construction?	Yes	The Proposal may result in minor disruptions to pedestrian or cycle access. The general area around the Proposal site may continue to be utilised by the public for walking and riding, as there would be sufficient space to divert public around the construction boundary. A Traffic and Pedestrian Management Plan would be prepared by the contractor as part of the CEMP to manage pedestrian movements.	N/A
Could the proposal result in permanent changes to traffic flow or access during operation?	No	The Proposal would not result in any permanent changes to traffic flow or access following completion of work.	N/A
Could the proposal result in impacts on available parking during construction or operation?	No	The Proposal would not require the use of existing public parking areas during construction or operation.	N/A

## 5.8 Visual environment

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Could the proposal be visible by residential or other sensitive receivers?	Yes	<p>The Proposal would be visible from residences and road users close to the vicinity of the Proposal site on Fraser Street, Mordue Parade and Blue Gum Road during construction.</p> <p>Temporary worksites established during construction may have a short-term negative visual impact from nearby viewpoints, however, the long-term visual impact is a positive improvement in amenity for residences, recreational and road users.</p> <p>The works would also be visible to people undertaking recreational and sporting activities in the park and oval areas, and users of the commercial Jesmond shopping district, directly south of the Proposal. However, these receivers are transient and impacts would be considered minor and temporary.</p>	N/A
Would the proposal result in permanent changes to the visual environment through installation of any above ground infrastructure or removal of vegetation?	Yes	<p>The Proposal would result in net positive, permanent changes to the current existing visual environment through the channel naturalisation and bank improvements. Proposed plantings would provide a beneficial level of visual modification in the long-term for nearby residents and transient users of the park.</p>	N/A
Would the work be located in an area of high scenic value?	No	<p>The location of the Proposal is not located in an area of high scenic value as the existing site contains a highly modified stormwater drainage channel. The Proposal would not be visually intrusive and would result in a positive impact on the scenic value of the area or views upon completion. The Proposal would be in keeping with the current surroundings.</p>	N/A
Would the work require additional lighting during construction or operation?	No	<p>The Proposal would take place during standard construction hours and is not expected to require lighting during construction, except in the event of unplanned emergency works.</p> <p>There is no lighting included in the Proposal and so there would be no new lighting during operation.</p>	N/A

## 5.9 Socioeconomic, land use and services

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Could the work impact private property including access?	No	The Proposal would not impact private property or access. The Proposal site is located within Heaton Park and would be accessed by residential streets. Access around the Proposal site would be maintained at all times.	N/A
Could the work impact busy commercial areas or local businesses?	No	Impacts on commercial areas or local businesses are not expected as a result of the Proposal.	N/A
Could the work result in a loss of an existing land use either during construction or operation?	Yes	The Proposal would result in a minor loss of existing land use. Under the Proposal, the stormwater channel is being benched back and widened into public space, including a public park, and Council-owned land, thus reducing its existing Public Recreation land use. The increased amenity of the naturalised channel is considered to somewhat compensate for the reduced land area.	N/A
Would the proposal result in the installation of a structure or facility that could be considered objectionable or a nuisance?	No	The Proposal would not be considered objectionable or a nuisance and would be consistent with the existing landuse. The Proposal is in response to community feedback and a desire to naturalise Hunter Water drainage channels.	N/A
Would the work require disruption to water or sewerage services?	No	The Proposal would not disrupt water or sewer services. All water, stormwater, sewer and other utilities locations were identified within the Proposal site. Design precautions have been taken to ensure all utilities have been avoided by works.	N/A

## 5.10 Energy and air quality

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Could the work result in air quality impacts on sensitive receivers during construction or operation? (e.g. dust, odours)	Yes	The Proposal would have the potential to generate dust during construction. Given the minor nature of ground disturbance and distance to receivers, sensitive receivers are not expected to be impacted. Measures would be implemented to minimise the generation of dust during the work required (refer to Section 6.1). There would be no long-	N/A

		term potential for air quality impacts once the disturbed areas are stabilised.	
Would the work involve the use of fuel-driven machinery or equipment (other than from vehicles transporting personnel to site)?	Yes	The Proposal would involve the use of a small number of fuel driven vehicles and equipment on site during construction. This would result in minor emissions.	N/A
Would the operation of the proposal result in high energy use and was energy use considered in the design development?	No	The operation of the Proposal would not result in a change in energy use.	N/A

### 5.11 Waste and resource use

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Would the work result in generation of 'non-hazardous' waste? If so, how would this be managed?	Yes	It is estimated the Proposal would generate around 1,048m <sup>3</sup> of spoil due to the construction methodologies and the benching back of the channel walls. Spoil would be reused onsite if suitable and practical, or separated and sent for recycling or disposal at an appropriate facility in accordance with a Spoil Management Plan (Section 6.1).  All waste generated from the Proposal would be managed in accordance with the principles of waste minimisation. Waste materials would be classified and disposed of in accordance with the Waste Classification Guidelines.	N/A
Would the work result in the generation of 'wastewater' (e.g. process wastewater, chlorinated water, sediment-laden water, drilling fluid, groundwater generated by drilling)?	Yes	If water is used for dust suppression, it would be applied in a controlled manner such that runoff would not be expected  Excavation works are likely to encounter groundwater, and therefore the Proposal is expected to generate some wastewater (sediment-laden water). Water treatment options may enable the water to not be classified as 'wastewater'. Disposal options for extracted groundwater are described in Appendix F, and will depend on water quality parameters.	Appendix F
Would the work result in asbestos, contaminated soils or other hazardous waste?	No	No asbestos or other hazardous waste is expected to be generated from this Proposal. As identified in Section 5.1, whilst elevated PAHs were observed in boreholes within the Proposal site, further testing provided a preliminary waste classification of General Solid Waste (non-putrescible)	Preliminary waste classification (Aurecon, 2021b)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		for the fill on site, should it be disposed of offsite. It is recommended that further testing of fill should be undertaken prior to offsite disposal. Mitigation measures in Section 6.1 have allowed for unexpected finds of incidental contamination during earthworks (such as illegally dumped wastes and stockpiles) and the management of asbestos if encountered.	
Have opportunities for waste reduction and/or reuse been considered?	No	Given the minimal resources required and potential waste generation, waste reduction opportunities were not considered.	N/A

### 5.12 Hazards and risks

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Would the proposal be located in a bushfire risk area or have potential to result in a bushfire risk?	No	The Proposal is not located in a bushfire risk area and has no potential to result in a bushfire risk.	ePlanning Spatial Viewer – 25 April 2022
Would the work include handling hazardous chemicals or dangerous goods?	No	The Proposal would not require the use of hazardous chemicals or dangerous goods.	N/A
Would the proposal be located in a coastal area that could be subject to coastal hazards?	No	The Proposal is not located in a coastal area and therefore would not be susceptible to coastal hazards.	N/A
Would the work result in any other hazards or risks to the environment?	No	The Proposal would not result in hazards or risk to the environment subject to the implementation of the mitigation measures contained in Section 6.1.	N/A

### 5.13 Cumulative impacts

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
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<p>Could impacts from other projects interact with the proposal?</p>	<p>No</p>	<p>Given the minor nature and duration of the Proposal, and the restriction of the construction impacts to the park, cumulative impacts as a result of other projects in the surrounding area (residential developments at Blue Gum Road and addition of a silo at a concrete batching plant off Mordue Parade) are not anticipated.</p> <p>The Newcastle City Bypass – Rankin Park to Jesmond northern interchange will be developed adjacent to the Proposal, and construction works may coincide. It is advised that the Contractor subscribe to the Transport for NSW project updates to ensure the Proposal is not impacted by traffic and road closures associated with the Bypass.</p>	<p>City of Newcastle Development Application Tracker – 27 May 2022</p> <p>Transport for NSW – Rankin Park to Jesmond – Newcastle Inner City Bypass – 2 June 2022</p>
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## 6 ENVIRONMENTAL SAFEGUARDS AND OTHER REQUIREMENTS

### 6.1 Mitigation measures

This section provides a list of environmental mitigation measures to be implemented to reduce the potential for environmental impacts during the construction and operation of the Proposal . The measures must be incorporated as conditions of contract in any contract or work specification for the Proposal and a Construction Environmental Management Plan (CEMP) for the works.

Aspect	Ref no.	Mitigation measure
General	G1	<p>A Construction Environmental Management Plan (CEMP) will be prepared prior to commencement of work and will address the following:</p> <ul style="list-style-type: none"> <li>• Any requirements associated with statutory approvals</li> <li>• Details of how the project will implement the identified safeguards outlined in the REF</li> <li>• Issue-specific environmental management plans</li> <li>• Roles and responsibilities</li> <li>• Communication requirements</li> <li>• Induction and training requirements</li> <li>• Procedures for monitoring and evaluating environmental performance, and for corrective action</li> <li>• Reporting requirements and record-keeping</li> <li>• Procedures for emergency, incident and hazard management</li> <li>• Procedures for audit and review.</li> </ul> <p>The endorsed CEMP will be implemented during the undertaking of the activity.</p>
	G2	All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the project.
	G3	Potentially affected receivers will be notified of the work at least five working days prior to commencement and provided with contact details in the event of a complaint.
	G4	Following any significant rainfall events, inspection of works will be undertaken during the two-year contractor maintenance period to detect any significant defects. Repairs of defects are to be undertaken as required.
Soils	S1	The CEMP prepared for the works is to include an erosion and sediment control plan (ESCP) which must include as a minimum the type and location of sediment/erosion controls to be used.
	S2	<p>Erosion and sediment controls are to be implemented and maintained consistent with Managing Urban Stormwater: Soils and Construction. Fourth Edition ed. Sydney (NSW) (Landcom, 2004) (the Blue Book). Controls include:</p> <ul style="list-style-type: none"> <li>• be installed prior to disturbance commencing</li> </ul>

Aspect	Ref no.	Mitigation measure
		<ul style="list-style-type: none"> <li>• prevent sediment moving off-site and sediment laden water entering any watercourse, drainage line, or drain inlets</li> <li>• divert clean surface flow around exposed areas and stockpiles</li> <li>• reduce water velocity and capture sediment</li> <li>• minimise the amount of material tracked onto paved surfaces</li> <li>• be cleaned out before 30% capacity of controls is reached.</li> </ul>
	S3	The CEMP for the works must have an unexpected finds protocol (UFP) for incidental potential contamination finds during earthworks and construction (such as illegally dumped wastes and stockpiles). The CEMP must detail works methodology to identify, manage, handle and dispose of any contaminated materials or wastes.
	S4	The CEMP must include mitigation measures for ASS to demonstrate how ASS would be managed and treated if encountered.
	S5	The CEMP must also outline the management of asbestos, in the even that asbestos is encountered.
	S6	Parking of vehicles and storage of plant/equipment is to occur in clearly designated existing cleared areas. Vehicles and machinery must not be parked on vegetated areas. Access will be on designated roads/tracks.
	S7	Plant and equipment will be thoroughly cleaned down prior to arrival/departure at the site to avoid introducing contaminants, soil and seeds and to prevent soil tracking onto roads
	S8	A Spoil Management Plan would be prepared by the contractor as part of the CEMP. Excavated material will be reinstated or reused on-site where possible. Where not possible to re-use, spoil material would be tested and disposed of at a suitable waste facility.
	S9	Weather forecasts will be checked regularly and scheduled to avoid heavy rain and flood events.
Hydrology and Water Quality	HWQ1	An Incident Management Plan (IMP) will be prepared as part of the Contractor's CEMP and will include a contingency plan and emergency procedures for dealing with the potential spillage of fuel or other environmental incidents that may occur on the work site. The IMP should also contain procedures dealing with the unexpected onset of rainfall during the work period.
	HWQ2	Regular visual monitoring of local water quality would be undertaken to identify potential turbidity from deficient erosion and sediment control measures, potential spills, or other water quality impacts.
	HWQ3	In the event of a sewage spill from the existing network during construction works, the Hunter Water project manager will be notified immediately so management controls can be implemented if required.
	HWQ4	A Flow Management Plan will set out the construction approach for working in the Dark Creek channel and how works, equipment and staff will be protected during storm events during construction. This would include how



Aspect	Ref no.	Mitigation measure
		construction will be sequenced and undertaken to minimise the potential for exposed banks to be scoured during the earthworks phase as a result of flash storm events.
	HWQ6	The water quality of dewatered groundwater shall be tested to demonstrate whether it is suitable for release to the environment (either to Dark Creek channel or via local land application). The proposed testing requirements and water quality discharge criteria will be documented within the Dewatering Management Plan within the CEMP. Where water quality discharge or irrigation criteria are not achieved, groundwater shall be disposed of offsite at licensed liquid waste facility or to sewer in accordance with a trade waste agreement.
	HWQ7	A Dewatering Management Plan will be incorporated into the Contractor's CEMP to document requirements for dewatering during the project.
Biodiversity	B1	The contact details of the local wildlife rescue organisation (i.e. Native Animal Trust Fund / Hunter Wildlife Rescue 0418 628 483 and Port Stephens Koalas 1800 775 625 or 1800 PS Koalas) are to be documented in the CEMP and displayed in a prominent location e.g. on wall of site office in the event of offspring (e.g. nestlings) or injured fauna being encountered on-site.
	B2	Areas for materials/equipment lay-down and vehicle parking will be shown in the CEMP(s) and located in cleared or degraded areas that are outside of tree protection zones to prevent any damage to the surrounding vegetation or habitat.
	B3	Materials, plant and equipment will not be stored within the drip-lines of any trees at the site(s) or near the site(s).
	B4	To prevent damage to vegetation outside the boundaries of access tracks/roads and minimise the spread of weeds, vehicles and machinery will be restricted to designated access roads and tracks.
	B5	Where excavated soil is to be used in site restoration, it will be excavated and stockpiled in sequential layers corresponding to the existing soil profile. Topsoil and leaf litter is to be removed first and windrowed in separate signposted stockpiles of less than 1m in height on the upslope side of excavations. Soil layers will be replaced sequentially so that the soil profile is restored as closely as possible to its pre-work status.
	B6	Disturbed areas will be stabilised as soon as possible and in a progressive manner as works are completed.
	B7	During the operational phase, works will be periodically inspected in accordance with Hunter Water maintenance regime for weeds. Weed management will be undertaken as required.
	B8	No weed spray shall be used onsite. Weeds shall be pulled by hand in accordance with the technical specification, transported in a sealed container or bag and disposed at a licenced waste disposal facility.

Aspect	Ref no.	Mitigation measure
	B9	Works would be undertaken generally in accordance with the Aboricultural Method Statement in Appendix G, including tree protection fencing, ground protection, precautions when working within TPZs, pruning, and site management
	B10	Tree protection fencing and signs would be erected and maintained in accordance with the illustrative specification found in Appendix 4 of the AIA (Appendix G).
	B11	Root zone and trunk protection would be undertaken in accordance with the illustrative specification provided in Appendix 5 of the AIA (Appendix G).
	B12	Works within the TPZ (which may include pruning, excavation, placement of fill, access, and soft landscaping) would be undertaken in accordance with the Guideline provided in Appendix 6 of the AIA (Appendix G).
	B13	Work stages indicated in the schedule in Appendix 7 of the AIA (Appendix G) (such as establishment of tree protection) must be certified by a Project Arborist. This may be undertaken via site inspection or via certification of photographic records.
Noise and Vibration	NV1	<p>Provide at least seven (7) days' notice to affected receivers prior to starting work unless it is emergency works or it is discussed with the affected receivers face-to-face. Include the following information in notification letters:</p> <ul style="list-style-type: none"> <li>• a description of the works and why they are being undertaken</li> <li>• details of the works that will be noisy</li> <li>• work hours and expected duration</li> <li>• what is being done to minimise the impacts (e.g. respite periods)</li> <li>• 24 hour contact number.</li> </ul>
	NV2	Works will be carried out during standard work hours (i.e. 7:00 am to 6:00 pm Monday to Friday and 8:00 am to 1:00 pm Saturday). For any work that is performed outside normal work hours or on Sunday or public holidays, the contractor must complete the Hunter Water OOHW Approval Form and adhere to the OOHW Construction Noise Guideline.
	NV3	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable.
	NV4	<p>Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided.</p> <ul style="list-style-type: none"> <li>• The offset distance between noisy plant and adjacent sensitive receivers is to be maximised.</li> <li>• Plant and vehicles used intermittently to be throttled down or shut down when not in use.</li> </ul> <p>Noise-emitting plant to be directed away from sensitive receivers.</p>

Aspect	Ref no.	Mitigation measure
	NV5	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site
	NV6	<p>Minimise disturbance arising from stockpiling, laydown and deliveries:</p> <ul style="list-style-type: none"> <li>• Loading/unloading of deliveries, laydown and stockpile areas to be located as far as possible from sensitive receivers</li> <li>• Delivery vehicles to be fitted with straps rather than chains where possible</li> <li>• Consider shielding of loading/unloading areas where close to sensitive receivers</li> </ul> <p>Consider locating site sheds to shield nearby residences from airborne noise</p>
	NV7	Personnel will be inducted and trained in noise control measures to reduce impacts on receivers during inductions and toolbox talks.
	NV8	<p>A register of most affected noise and vibration sensitive receivers would be kept on site. The register would include the following details for each NVSR:</p> <ul style="list-style-type: none"> <li>• Address of receiver</li> <li>• Category of receiver (e.g. Residential, Commercial etc.)</li> </ul> <p>Contact name and phone number.</p>
	NV9	A complaint management procedure will be developed. Community complaints will be allocated to a responsible contractor representative immediately to facilitate investigation, respond to the complainant, review noise mitigation measures and to implement any corrective actions. The details of the complaint will also be circulated to the applicable construction personnel for action, where required.
	NV10	Construction vehicles including trucks will not be allowed to queue on local roads or if it is required for safety reasons, engines will be switched off.
Aboriginal and Non-Aboriginal Heritage	H1	If Non-Aboriginal heritage items are discovered during the course of the project, all work will cease in the area and the Contractor will inform the Hunter Water Project Manager and Archaeologist as soon as possible. HWC will determine the preferred management approach and the local council and/or NSW Heritage Office will be notified via the HWC Project Manager if required.
	H2	All parties involved in the proposed works are to be made aware that it is an offence under Section 86 of the NPW Act to harm or desecrate an Aboriginal object unless that harm or desecration is the subject of an Aboriginal Heritage Impact Permit (AHIP).
	H3	In the event that an Aboriginal object (or objects) is uncovered during the proposed works, ground disturbance works would cease within 20 metres of the object(s) and the Hunter Water Archaeologist should be contacted. The

Aspect	Ref no.	Mitigation measure
		Hunter Water Archaeologist would advise the Heritage Office and the relevant Aboriginal parties so that appropriate management strategies can be identified.
	H4	In the unlikely event that human skeletal material is uncovered during the proposed construction works, all works should cease within 20 metres of the skeletal remains. Should the remains be verified as human, the NSW Police and OEH will be contacted. No works will proceed within the vicinity of the skeletal remains until an appropriate course of action has been determined in consultation with NSW Police, OEH and Aboriginal parties (if the remains are identified as Aboriginal).
Traffic and Access	TA1	A Traffic and Pedestrian Management Plan would be prepared by the contractor to manage construction traffic and pedestrian movements.
	TA2	Appropriate exclusion barriers, signage and site supervision will be employed at all times to ensure that the work site is controlled and that unauthorised vehicles and pedestrians are excluded from the works area.
	TA3	Movements of heavy vehicles would be restricted to standard work hours (i.e 7:00 am to 6:00 pm Monday to Friday and 8:00 am to 1:00 pm Saturday)
	TA4	Vehicle access routes to and within the site(s) are to be defined via 'paraweb' or other clearly visible and robust fencing.
	TA5	Current traffic movements and property accesses will be maintained during the works.
Visual Environment	VE1	Restore work sites as close to their original condition as possible at completion of the works.
	VE2	On completion of the works, all vehicles, construction equipment, materials, and refuse relating to the works will be removed from the work site(s) and any adjacent affected areas.
	VE3	Work areas are to be maintained, kept free of rubbish and cleaned up at the end of each working day.
Energy and Air Quality	EAQ1	Odour or air pollutant emission complaints will be dealt with promptly and the source will be eliminated wherever practicable.
	EAQ2	Equipment, machinery and vehicles used on site would be maintained to manufacturer's specifications to minimise potential emissions.
	EAQ3	Visually monitor dust and where necessary: <ul style="list-style-type: none"> <li>• Apply water (or alternate measures) to exposed surfaces that are generating dust</li> <li>• Appropriately cover loads on trucks transporting material to and from the construction site</li> <li>• Securely fix tailgates of road transport trucks prior to loading and immediately after unloading</li> </ul>

Aspect	Ref no.	Mitigation measure
		<ul style="list-style-type: none"> <li>Avoid dust generating works during strong winds</li> </ul> <p>Prevent where possible, or remove, mud and dirt being tracked onto sealed road surfaces.</p>
Waste and Resource Use	WR1	<p>A Waste Management Plan will be included in the CEMP, detailing works methodology to identify wastes or resources, segregate, store and transport them in accordance with relevant legislation and guidelines The Contractor's recycling and reuse proposal will be detailed in the CEMP following the resource management hierarchy principles (in accordance with the Waste Avoidance &amp; Resource Recovery Act 2001):</p> <ul style="list-style-type: none"> <li>avoid unnecessary resource consumption as a priority</li> <li>avoidance is followed by resource recovery (including reuse of materials, reprocessing, recycling and energy recovery)</li> <li>disposal is undertaken as a last resort.</li> </ul>
	WR2	<p>Dispose of all excess material (that cannot be reused or recycled) as soon as practicable, to a facility licensed to accept the waste as per the waste classification results (tested by a suitably qualified person in accordance with the NSW Waste Classification Guidelines 2014). Evidence of the lawful disposal or reuse of waste will be retained and provided to the HWC Project Manager on request.</p>
	WR3	<p>Segregate and label waste to improve recycling opportunities, avoid cross contamination and reduce disposal costs.</p>
	WR4	<p>All temporary erosion and sediment control devices will be removed from the site at the completion of the works or when the site(s) are restored/stabilised.</p>
Hazard and Risk	HR1	<p>Emergency contacts will be kept in an easily accessible location. All workers will be advised of these contact details and procedures.</p>

## 6.2 Licensing and other requirements

Approval Requirement	Timing	Attached	Responsible for obtaining
Water Supply Works (WSW) approval	Prior to construction	N	Hunter Water

No further licenses or approvals in addition to the Division 5.1 of the (EP&A Act) approval is required for the Proposal .

## 7 CERTIFICATION

This REF provides a true and fair review of the Proposal and its potential impacts on the environment in accordance with the environmental impact assessment requirements of the EP&A Act.

Prepared by:



Sajana Athukorala

Consultant

Date: 1 August 2022

Reviewed by:



Katie Schultz

Manager

Date: 1 August 2022

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## APPENDIX A

### Design drawings



# HUNTER WATER

## STORMWATER AMENITY IMPROVEMENT – SITE N14

### Dark Creek, Heaton Park, Jesmond



#### DRAWING INDEX

DRAWING No.	DRAWING TITLE
85222-16266-001	INDEX SHEET/DRAWING LIST AND LOCALITY PLAN
85222-16266-002	GENERAL NOTES
85222-16266-003	GENERAL ARRANGEMENT AND SET OUT PLAN - SHEET 1
85222-16266-004	GENERAL ARRANGEMENT AND SET OUT PLAN - SHEET 2
85222-16266-005	TYPICAL SECTION DETAIL 1 - SHEET 1
85222-16266-006	TYPICAL SECTION DETAIL 2 - SHEET 2
85222-16266-007	TRANSITION WALL DETAILS SHEET1
85222-16266-008	TRANSITION WALL DETAILS SHEET2
85222-16266-009	PLANTING PLAN - SHEET 1
85222-16266-010	PLANTING PLAN - SHEET 2
85222-16266-011	PLANTING LAYOUT AND SPECIES

CONSTRUCTION ISSUE

No.	REVISION DETAILS	DWN	DATE
0	CONSTRUCTION ISSUE	QN	04.08.22
B	100% DETAIL DESIGN ISSUE	QN	12.07.22
A	80% DETAIL DESIGN ISSUE	QN	25.05.22

CONSULTANT DETAILS:  
 Aurecon Australia Pty Ltd ABN 54 005 139 873  
 23 Warabrook Boulevard, Warabrook  
 NSW 2304 Australia  
 Telephone: +61 2 4941 5415  
 Email: newcastle@aurecongroup.com

CONSULTANT REFERENCE No.  
 521943 - HW DESP - SR00039



DESIGNED: SJ	DATE: 23/06/22	COMPANY: AURECON	TITLE: SR00039B DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL					
DRAWN: QN	DATE: 01/07/22	COMPANY: AURECON	INDEX SHEET/DRAWING LIST & LOCALITY PLAN					
CHECKED: WL	DATE: 01/07/22	COMPANY: AURECON	SIZE:	SCALE: NTS	INDEX No. 85222	DRAWING No. 16266	SHEET 001	REV No. 0
APPROVED: PG	DATE: 01/07/22	COMPANY: AURECON						

**GENERAL NOTES**

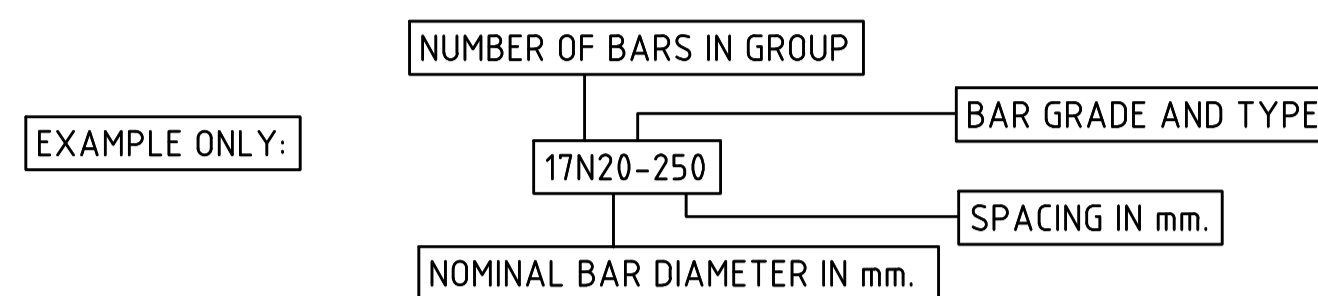
- THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH OTHER PROVIDED REPORTS, TECHNICAL SPECIFICATIONS, SPECIFICATIONS AND WRITTEN INSTRUCTIONS ISSUED BY THE PRINCIPAL OR ITS REPRESENTATIVE.
- ALL CONDITIONS CONTAINED WITHIN THE REVIEW OF ENVIRONMENTAL FACTORS (REF) AND ALL OTHER PLANNING APPROVAL DOCUMENTS FOR THIS PROJECT MUST BE COMPLIED WITH.
- ALL CONSTRUCTION MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE RELEVANT SPECIFICATION FOR THE WORKS TOGETHER WITH THE REQUIREMENTS OF ALL RELEVANT CODES OF PRACTICE REFERRED TO THEREIN, THE REQUIREMENTS OF STATUTORY AUTHORITIES WHERE APPLICABLE AND ANY INSTRUCTIONS GIVEN BY THE PRINCIPAL.
- CONSTRUCTION HOURS TO BE IN ACCORDANCE WITH THE REF.
- ALL LOCATIONS, ORIENTATION, DIMENSIONS AND LEVELS SHALL BE VERIFIED ON SITE BEFORE COMMENCING ANY CONSTRUCTION OR FABRICATION WORK. IN THE EVENT OF ANY DISCREPANCIES, THE PRINCIPAL SHALL BE NOTIFIED WITHIN REASONABLE TIME.
- UNLESS NOTE OTHERWISE:
  - ALL DIMENSIONS ARE IN MILLIMETRES
  - ALL CHAINAGES, STATIONS AND CO-ORDINATES ARE IN METRES
  - ALL REDUCED LEVELS ARE QUOTED RELATIVE TO AUSTRALIAN HEIGHT DATUM (mAHD)
- EXISTING SERVICES SHOWN ON PLANS ARE NOT GUARANTEED COMPLETE OR CORRECT AND HAVE BEEN SOURCED INFORMATION SUPPLIED BY THE RELEVANT AUTHORITIES AND / OR FIELD INVESTIGATIONS. THE CONTRACTOR IS TO CONFIRM THE LOCATIONS AND LEVELS OF ALL EXISTING SERVICES PRIOR TO COMMENCING CONSTRUCTION AND MAKE ARRANGEMENTS WITH THE RELEVANT AUTHORITY TO RELOCATE OR ADJUST THESE SERVICES IF NECESSARY.
- THE CONTRACTOR IS RESPONSIBLE FOR THE REPAIR OF ANY DAMAGE TO THE NATURAL ENVIRONMENT AND INFRASTRUCTURE INCLUDING SERVICES, STORMWATER AND CYCLEWAY INFRASTRUCTURE, SUCH REPAIR OR REINSTATEMENT IS TO BE CARRIED OUT IMMEDIATELY TO THE SATISFACTION OF THE PRINCIPAL.
- THE CONTROL OF CREEK FLOWS AND STORMWATER FLOWS THROUGH AND AROUND THE WORKS DURING CONSTRUCTION SHALL BE IN ADHERENCE TO THE PRINCIPAL REQUIREMENTS AND WILL BE THE RESPONSIBILITY OF THE CONTRACTOR.
- UNLESS DRAWINGS ARE IDENTIFIED AS "FOR CONSTRUCTION", THEY SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.
- NOMINATIONS OF A PROPRIETARY ITEM DOES NOT INDICATE EXCLUSIVE PREFERENCE BUT INDICATES THE REQUIRED PROPERTIES OF THE ITEM. SIMILAR ALTERNATIVES HAVING THE REQUIRED PROPERTIES MAY BE SUBMITTED FOR APPROVAL BY THE PRINCIPAL.
- DO NOT OBTAIN DIMENSIONS BY SCALING FROM THE DRAWINGS.
- REFER ANY DISCREPANCY TO THE PRINCIPAL BEFORE PROCEEDING WITH THE WORKS.
- DURING CONSTRUCTION, THE CONTRACTOR SHALL ENSURE THAT THE STRUCTURES ARE MAINTAINED IN A STABLE CONDITION AND NO PART IS OVER STRESSED.
- PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL ENSURE THAT ANY NECESSARY FOUNDATION TREATMENT IS COMPLETED PRIOR TO COMMENCEMENT OF CONSTRUCTION OF THE STRUCTURES.
- ABBREVIATIONS USED IN THESE DRAWINGS:

APPROX.	- APPROXIMATE	G	- GALVANIZED	REF	- REFERENCE LINE
CL	- CONTROL LINE	LV	- LENGTH VARIES -	REW	- REINFORCED EARTH WALL
CFW	- CONTINUOUS FILLET	MIN	- MINIMUM	RL	- REDUCED LEVEL
CRS	- CENTRES	C.J	- CONSTRUCTION JOINT	EL	- ELEVATED LEVEL
DIA	- DIAMETER	CRJ	- CONTRACTION JOINT	REINF	- REINFORCEMENT
DWG	- DRAWING	NOM	- NOMINAL	S.S.	- STAINLESS STEEL
DRG	- DRAWING	PC	- PRECAST CONCRETE	STN	- STATION
D/S	- DOWNSTREAM	PL	- PLATE	TYP	- TYPICAL
FF	- FAR FACE	QTY	- QUANTITY	T.O.C	- TOP OF CONCRETE -
FSL	- FULL SUPPLY LEVEL	RC	- REINFORCED CONCRETE	UNO	- UNLESS NOTED OTHERWISE
		REQ'D	- REQUIRED	U/S	- UPSTREAM

**REINFORCEMENT**

- STEEL REINFORCING MATERIALS SHALL COMPLY WITH AS/NZS 4671 (AS4671). REINFORCEMENT SHALL BE FABRICATED AND PLACED IN ACCORDANCE WITH AS3600 AND THE PROJECT'S TECHNICAL SPECIFICATION.
- SYMBOLS ON DRAWINGS FOR GRADE AND TYPE OF REINFORCEMENT ARE AS FOLLOWS:
  - N DENOTES GRADE 500 NORMAL DUCTILITY DEFORMED BAR TO AS4671
  - R DENOTES GRADE 250 NORMAL DUCTILITY PLAIN ROUND BAR TO AS4671
  - SL DENOTES GRADE 500 LOW DUCTILITY WELDED SQUARE MESH TO AS4671
  - RL DENOTES GRADE 500 LOW DUCTILITY WELDED RECTANGULAR MESH TO AS4671

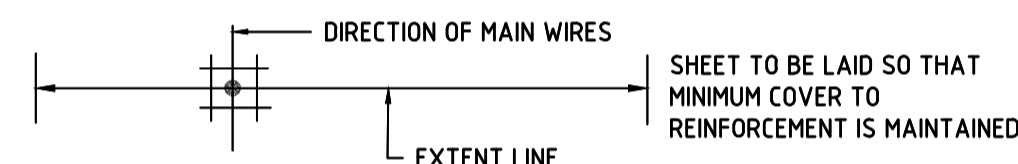
DESIGNATION OF REINFORCEMENT BARS IS AS FOLLOWS:



THE NUMBERS AND DISTRIBUTION OF BARS ARE INDICATED AS FOLLOWS (BY EXAMPLE):

- 20N32 INDICATES 20 GRADE 500N 32mm DIAMETER BARS.
- N20-200 INDICATES GRADE 500N 20mm DIAMETER BARS AT 200mm SPACING FOR THE EXTENT INDICATED.
- 10N24-200 INDICATES 10 GRADE 500N 24mm DIAMETER BARS AT 200mm SPACING.

- THE FOLLOWING ABBREVIATIONS APPLY TO THE LOCATION OF REINFORCEMENT:
  - B - DENOTES BOTTOM FACE
  - CP - DENOTES CENTRALLY PLACED
  - T - DENOTES TOP FACE
  - EW - DENOTES EACH WAY
  - EF - DENOTES EACH FACE
  - NF - DENOTES NEAR FACE
  - FF - DENOTES FAR FACE
  - H - DENOTES HORIZONTAL
  - V - DENOTES VERTICAL
- COGS AND HOOKS TO BE STANDARD IN ACCORDANCE WITH AS3600.
- MAIN WIRES OF FABRIC AND WIDTH OF SHEETS SHOWN IN FLOOR PLAN OR WALL ELEVATION THUS:



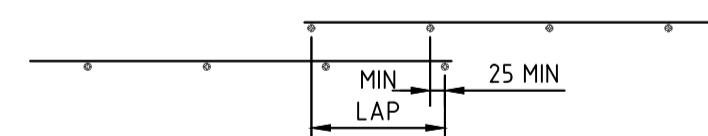
- EXTENT OF BARS SHOWN THUS: EXTENT OF BARS SHOWN THUS:



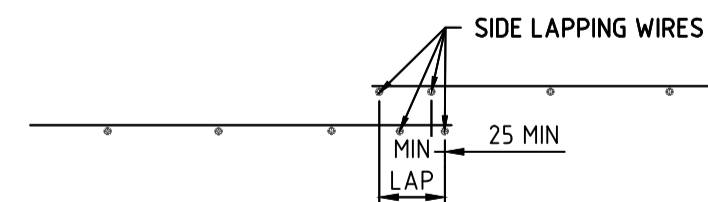
- REINFORCEMENT IS REPRESENTED DIAGRAMMATICALLY AND IS NOT NECESSARILY IN EXACT POSITION.
- SPLICE REINFORCEMENT ONLY AT LOCATIONS SHOWN ON DRAWINGS OR AS APPROVED BY CONSTRUCTION MANAGER.
- REINFORCEMENT SPLICES SHALL CONFORM TO THE FOLLOWING TABLE UNLESS NOTED OTHERWISE:

BAR SIZE:	N12	N16	N20	N24	N28	N32
a) HORIZONTAL BARS WITH >300mm OF CONCRETE CAST BELOW THE BAR:	460	650	940	1250	1580	1930
b) OTHER BARS:	350	500	720	960	1210	1490

- WHERE THE BAR SIZES AT LAP VARY, THE LAP LENGTH SHALL BE BASED ON THE SIZE OF THE SMALLER BAR
  - REINFORCEMENT MAY BE DISPALCED SLIGHTLY WHERE NECESSARY TO CLEAR CLASHES WITH PROJECTING REINFORCEMENT, DOWELS, ETC.
- STEEL MESH SPLICES SHALL BE MADE BY EITHER OF THE FOLLOWING METHODS:



(1) LAPPING OF STANDARD STEEL MESH WITHOUT SIDE LAPPING WIRES.



(2) LAPPING OF STEEL MESH WITH EDGE SIDE LAPPING WIRES

- WELDING OF REINFORCEMENT IS ONLY PERMITTED WHERE SHOWN ON THE DRAWINGS OR OTHERWISE APPROVED BY WELDING OF REINFORCEMENT IS ONLY PERMITTED WHERE SHOWN ON THE DRAWINGS OR OTHERWISE APPROVED BY THE PRINCIPAL. WHERE WELDING OF REINFORCEMENT IS APPROVED, IT SHALL BE CARRIED OUT IN ACCORDANCE WITH AS 1554, PART 3.
- DOWELS SHALL BE SAWN TO LENGTH. IN SKEWED JOINTS, DOWELS SHALL BE ALIGNED WITH THE LONGITUDINAL REINFORCEMENT. DOWEL ALIGNMENT TO BE MAINTAINED BY USE OF A SUPPORT ASSEMBLY SUITABLE TO ENSURE A HORIZONTAL AND VERTICAL TOLERANCE OF 1 IN 100.

**CONCRETE**

- OTHERWISE SPECIFIED IN DRAWINGS, A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF REINFORCED CONCRETE SHALL BE 32MPa.
- CONCRETE EXPOSURE CLASSIFICATION: B1
- NOMINAL COVER TO REINFORCEMENT NEAREST TO THE CONCRETE SURFACE SHALL BE 50mm, UNO.
- CONCRETE SUPPLY AND CONSTRUCTION TO BE IN COMPLIANCE WITH HUNTER WATER SPECIFICATION STS 104.
- NO-FINES CONCRETE WORK TO BE IN COMPLIANCE WITH HUNTER WATER SPECIFICATION STS 404 IN CONJUNCTION WITH TfNSW QA SPECIFICATION 3222 FOR NO-FINES CONCRETE MIX.

**LEGEND**

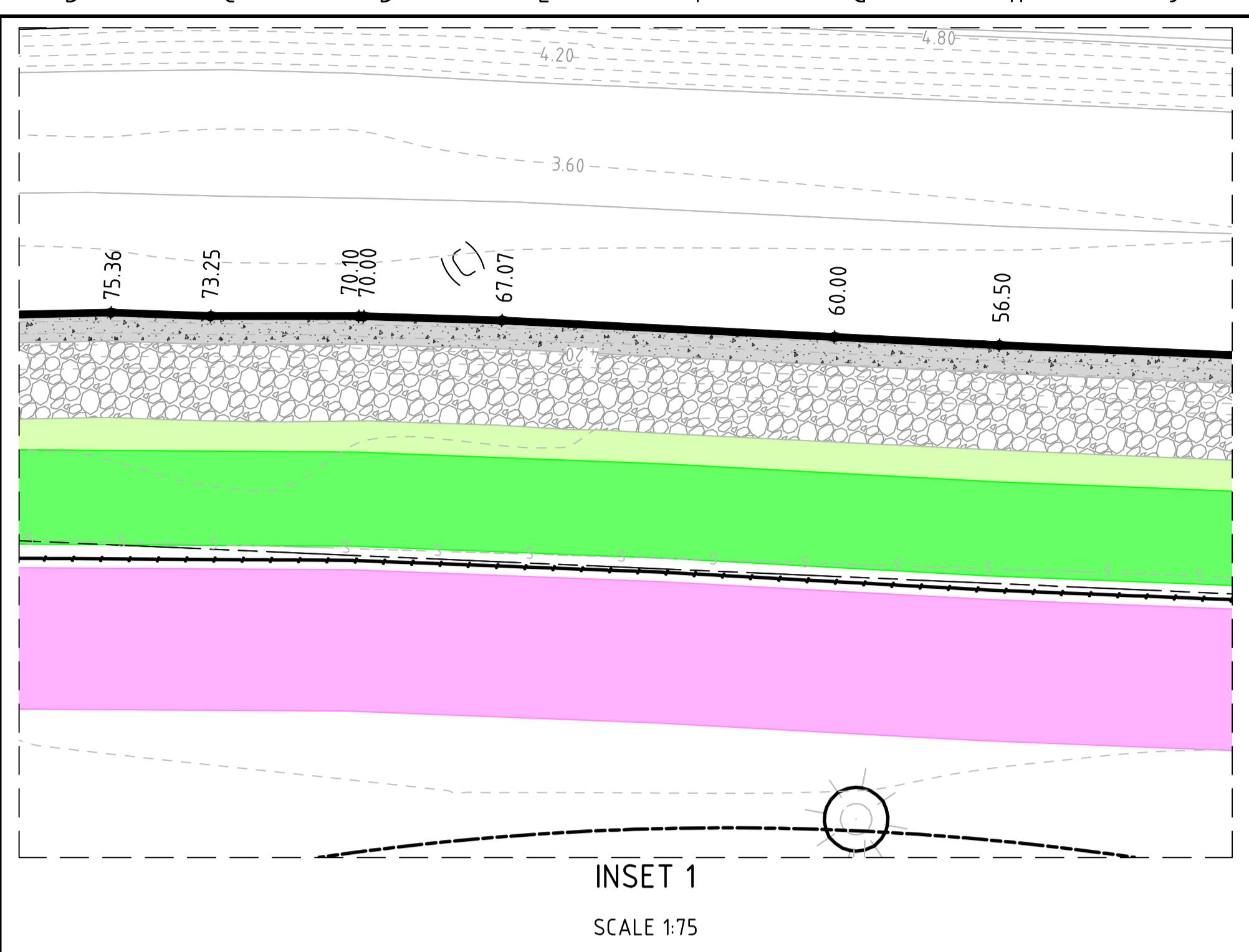
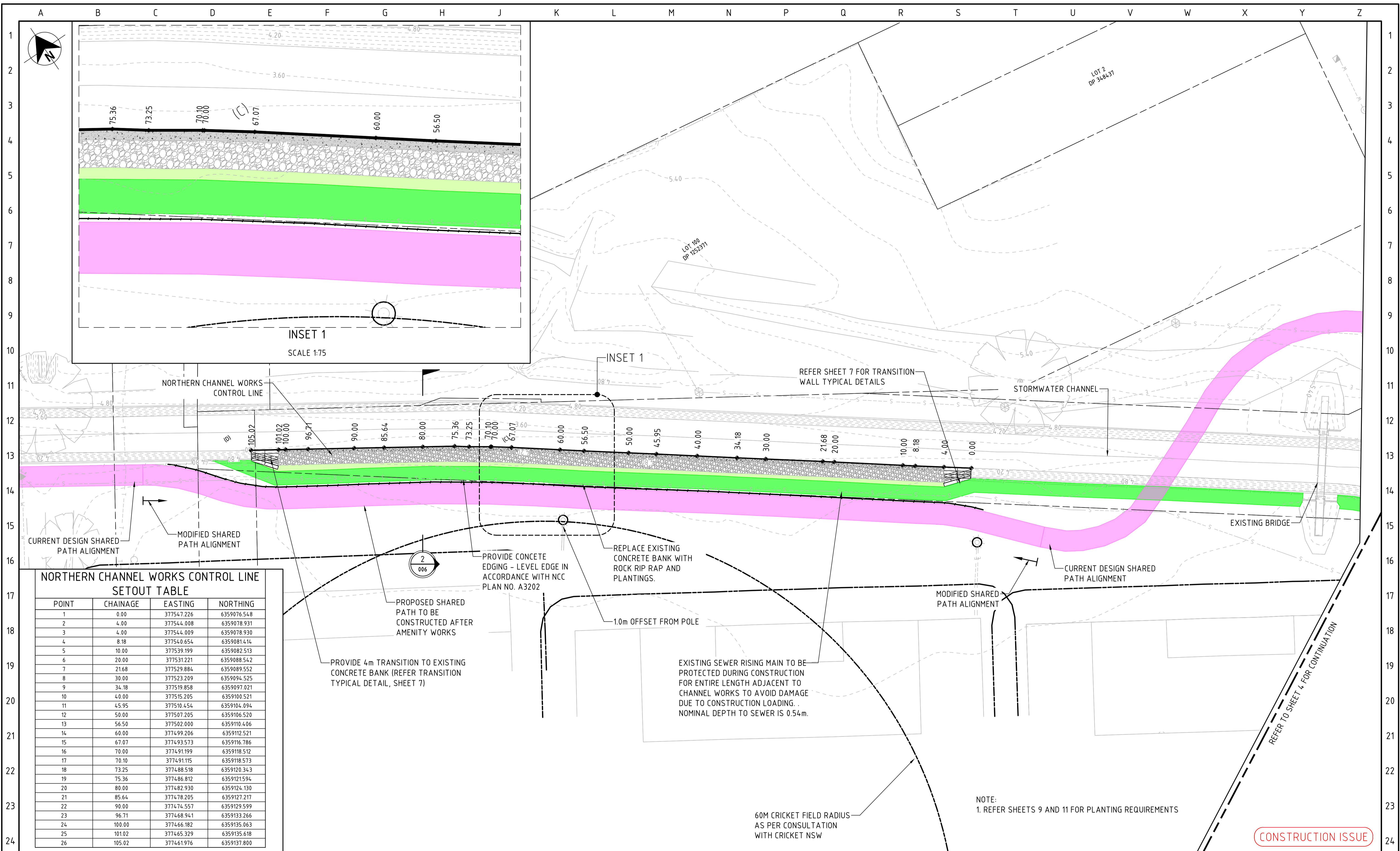
	PLANTING ZONE DC1		ROCK RIP RAP
	PLANTING ZONE DC2		BACKFILL
	PLANTING ZONE DC3		BEDDING LAYER
	PLANTING ZONE DC4		TOP SOIL
	RIPRAP AND PLANTING		SUBGRADE
	FUTURE PROPOSED SHARED PATH (BY OTHERS)		NO-FINES CONCRETE
	UPPER BANK PLANTING		MASS CONCRETE
	OVERBANK PLANTING		REINFORCED CONCRETE
	CONCRETE CHANNEL EXTENSION		EROSION CONTROL MATTING
	SPORTS FIELD/ CONSTRAINT OFFSETS		GEOTEXTILE
	FENCING		
	SETOUT POINT		

**EXISTING LEGEND**

	WATER SERVICES
	SEWER SERVICES
	ELECTRIC SERVICES
	COMMS SERVICES
	EXISTING CONTOUR
	EXISTING FENCING
	WATER VALE
	SEWER MANHOLE
	TRASH

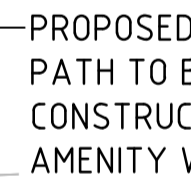
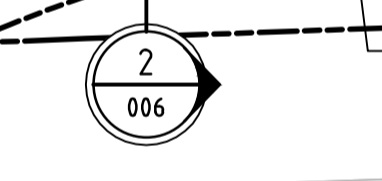
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CONSULTANT DETAILS: Aurecon Australia Pty Ltd ABN 54 005 139 873 23 Warabrook Boulevard, Warabrook NSW 2304 Australia Telephone: +61 2 4941 5415 Email: newcastle@arecongroup.com						DESIGNED: SJ	DATE: 23/06/22	COMPANY: AURECON	TITLE: SR00039B DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL								
0 CONSTRUCTION ISSUE		Q	04.08.22			CHECKED: WL	DATE: 01/07/22	COMPANY: AURECON	GENERAL NOTES								
A 80% DETAIL DESIGN ISSUE		Q	25.05.22			APPROVED: PG	DATE: 01/07/22	COMPANY: AURECON	SIZE: A1	SCALE: NTS	INDEX No. 85222	DRAWING No. 16266	SHEET 002	REV No. 0			
No.	REVISION DETAILS		DWN	DATE	521943 - HW DESP - SR00039												



**NORTHERN CHANNEL WORKS CONTROL LINE SETOUT TABLE**

POINT	CHAINAGE	EASTING	NORTHING
1	0.00	377547.226	6359076.548
2	4.00	377544.008	6359078.931
3	4.00	377544.009	6359078.930
4	8.18	377540.654	6359081.414
5	10.00	377539.199	6359082.513
6	20.00	377531.221	6359088.542
7	21.68	377529.884	6359089.552
8	30.00	377523.209	6359094.525
9	34.18	377519.858	6359097.021
10	40.00	377515.205	6359100.521
11	45.95	377510.454	6359104.094
12	50.00	377507.205	6359106.520
13	56.50	377502.000	6359110.406
14	60.00	377499.206	6359112.521
15	67.07	377493.573	6359116.786
16	70.00	377491.199	6359118.512
17	70.10	377491.115	6359118.573
18	73.25	377488.518	6359120.343
19	75.36	377486.812	6359121.594
20	80.00	377482.930	6359124.130
21	85.64	377478.205	6359127.217
22	90.00	377474.557	6359129.599
23	96.71	377468.941	6359133.266
24	100.00	377466.182	6359135.063
25	101.02	377465.329	6359135.618
26	105.02	377461.976	6359137.800



No.	REVISION DETAILS	DATE
0	CONSTRUCTION ISSUE	04.08.22
B	100% DETAIL DESIGN ISSUE	12.07.22
A	80% DETAIL DESIGN ISSUE	25.05.22

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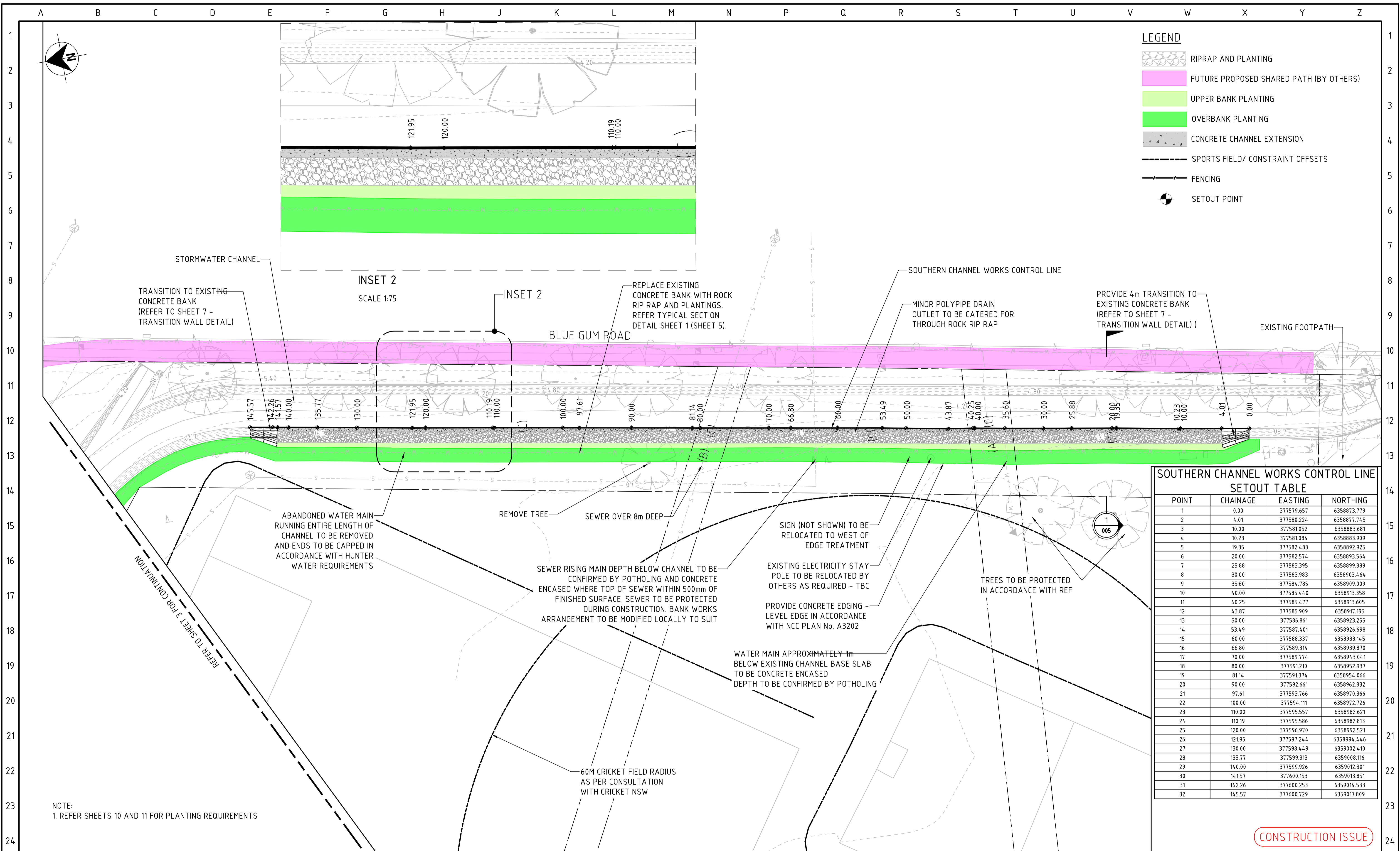


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CHECKED: WL	DATE: 01/07/22	COMPANY: AURECON
APPROVED: PG	DATE: 01/07/22	COMPANY: AURECON

TITLE: SR00039B DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL	SIZE: A1	SCALE: 1:250	INDEX No. 85222	DRAWING No. 16266	SHEET 003	REV No. 0
GENERAL ARRANGEMENT AND SETOUT PLAN - SHEET 1						

**CONSTRUCTION ISSUE**

VERSION 4



**SOUTHERN CHANNEL WORKS CONTROL LINE SETOUT TABLE**

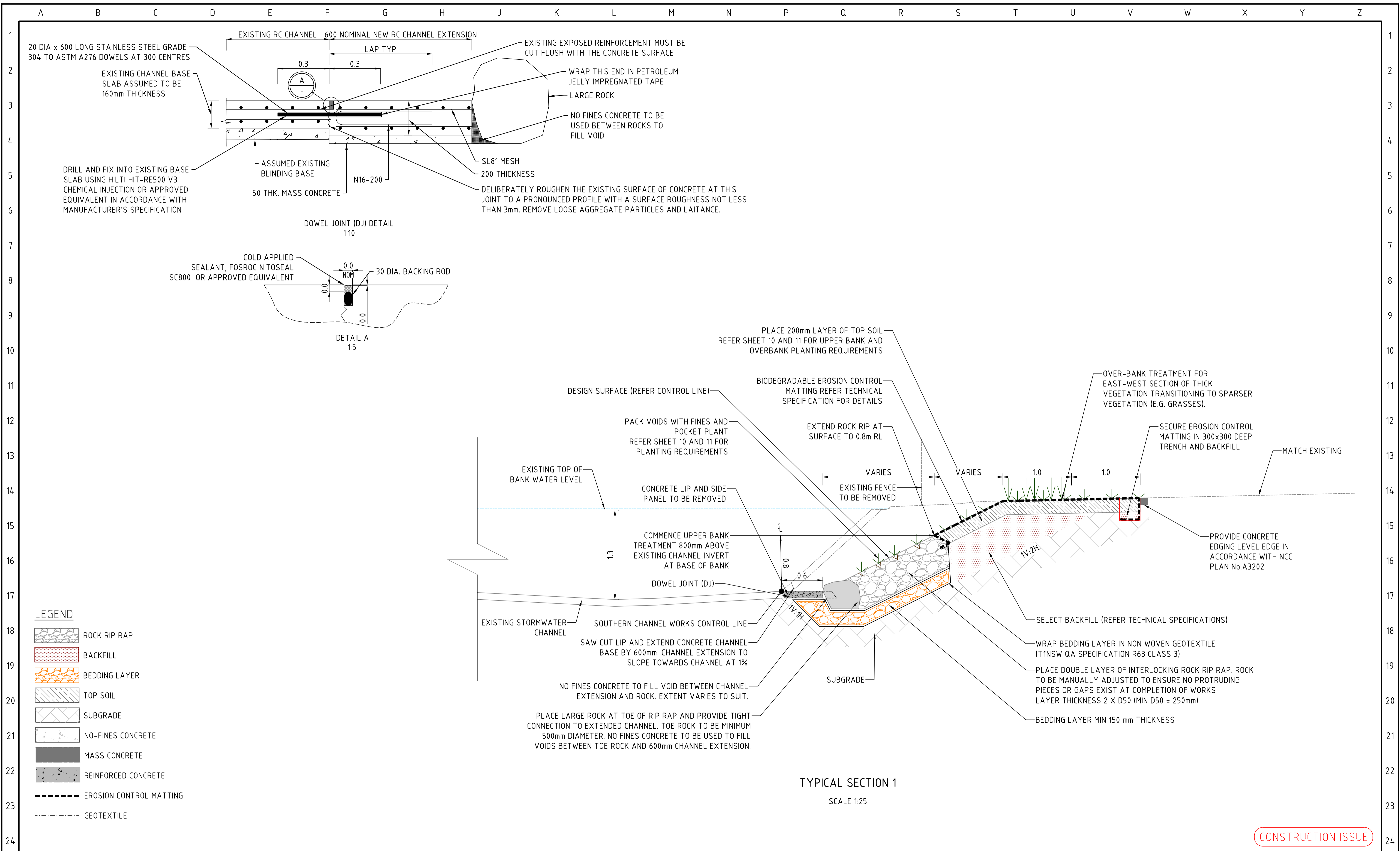
POINT	CHAINAGE	EASTING	NORTHING
1	0.00	377579.657	6358873.779
2	4.01	377580.224	6358877.745
3	10.00	377581.052	6358883.681
4	10.23	377581.084	6358883.909
5	19.35	377582.483	6358892.925
6	20.00	377582.574	6358893.564
7	25.88	377583.395	6358899.389
8	30.00	377583.983	6358903.464
9	35.60	377584.785	6358909.009
10	40.00	377585.440	6358913.358
11	40.25	377585.477	6358913.605
12	43.87	377585.909	6358917.195
13	50.00	377586.861	6358923.255
14	53.49	377587.401	6358926.698
15	60.00	377588.337	6358933.145
16	66.80	377589.314	6358939.870
17	70.00	377589.774	6358943.041
18	80.00	377591.210	6358952.937
19	81.14	377591.374	6358954.066
20	90.00	377592.661	6358962.832
21	97.61	377593.766	6358970.366
22	100.00	377594.111	6358972.726
23	110.00	377595.557	6358982.621
24	110.19	377595.586	6358982.813
25	120.00	377596.970	6358992.521
26	121.95	377597.244	6358994.446
27	130.00	377598.449	6359002.410
28	135.77	377599.313	6359008.116
29	140.00	377599.926	6359012.301
30	141.57	377600.153	6359013.851
31	142.26	377600.253	6359014.533
32	145.57	377600.729	6359017.809

**CONSTRUCTION ISSUE**

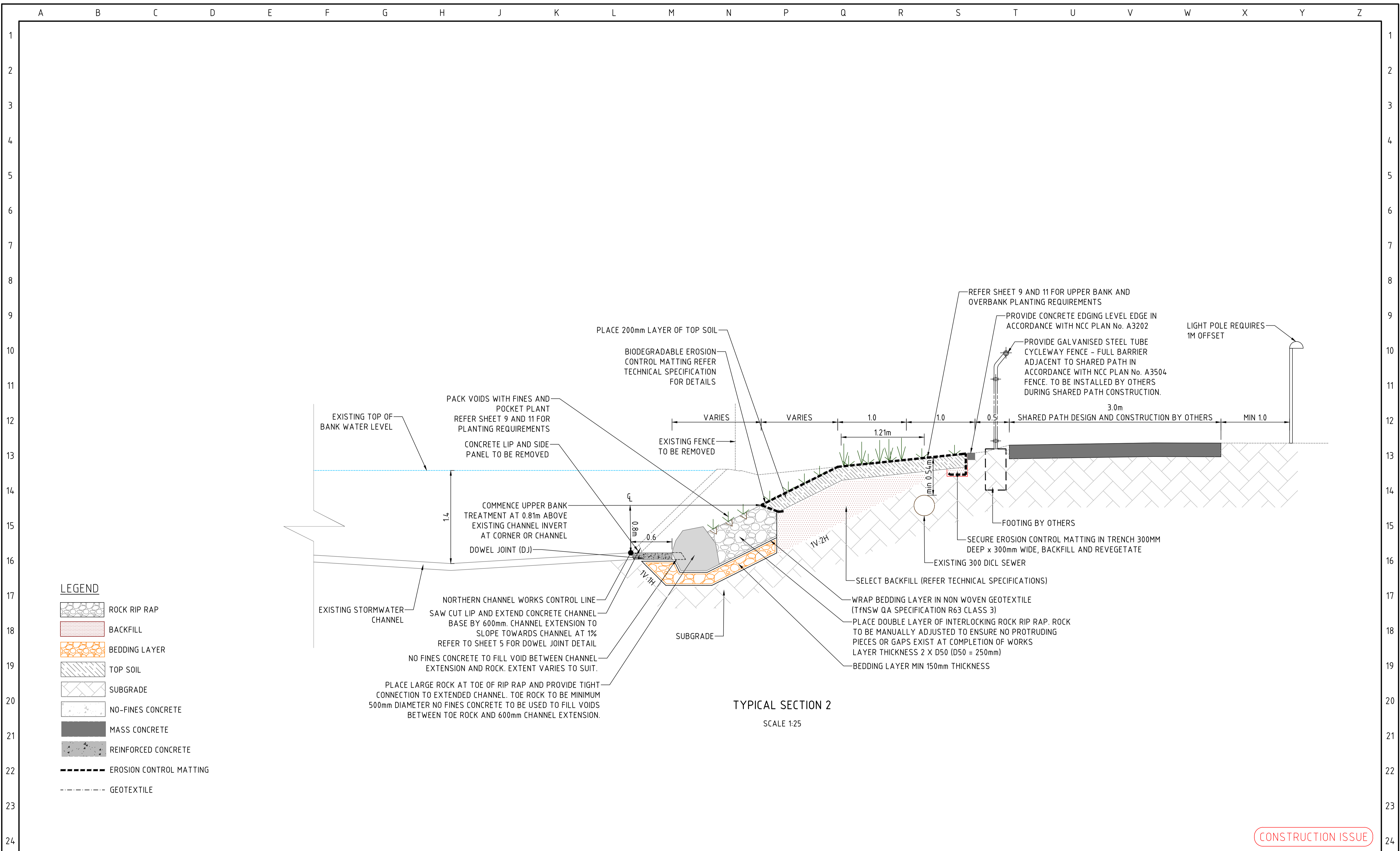
<b>CONSULTANT DETAILS:</b> Aurecon Australia Pty Ltd ABN 54 005 139 873 23 Warabrook Boulevard, Warabrook NSW 2304 Australia Telephone: +61 2 4941 5415 Email: newcastle@aurecongroup.com		<b>DESIGNED:</b> SJ <b>DATE:</b> 23/06/22 <b>COMPANY:</b> AURECON		<b>TITLE:</b> SR00039B DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL	
<b>CONSULTANT REFERENCE No.</b> 521943 - HW DESP - SR00039		<b>DRAWN:</b> QN <b>DATE:</b> 01/07/22 <b>COMPANY:</b> AURECON		<b>GENERAL ARRANGEMENT AND SETOUT PLAN - SHEET 2</b>	
<b>REVISION DETAILS</b>		<b>CHECKED:</b> WL <b>DATE:</b> 01/07/22 <b>COMPANY:</b> AURECON		<b>APPROVED:</b> PG <b>DATE:</b> 01/07/22 <b>COMPANY:</b> AURECON	
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B	100% DETAIL DESIGN ISSUE	QN	12.07.22	SCALE:	1:250
A	80% DETAIL DESIGN ISSUE	QN	25.05.22	INDEX No.	85222
No.		DWN		DRAWING No.	16266
				SHEET	004
				REV No.	0



VERSION 4



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CONSULTANT REFERENCE No. 521943 - HW DESP - SR00039														



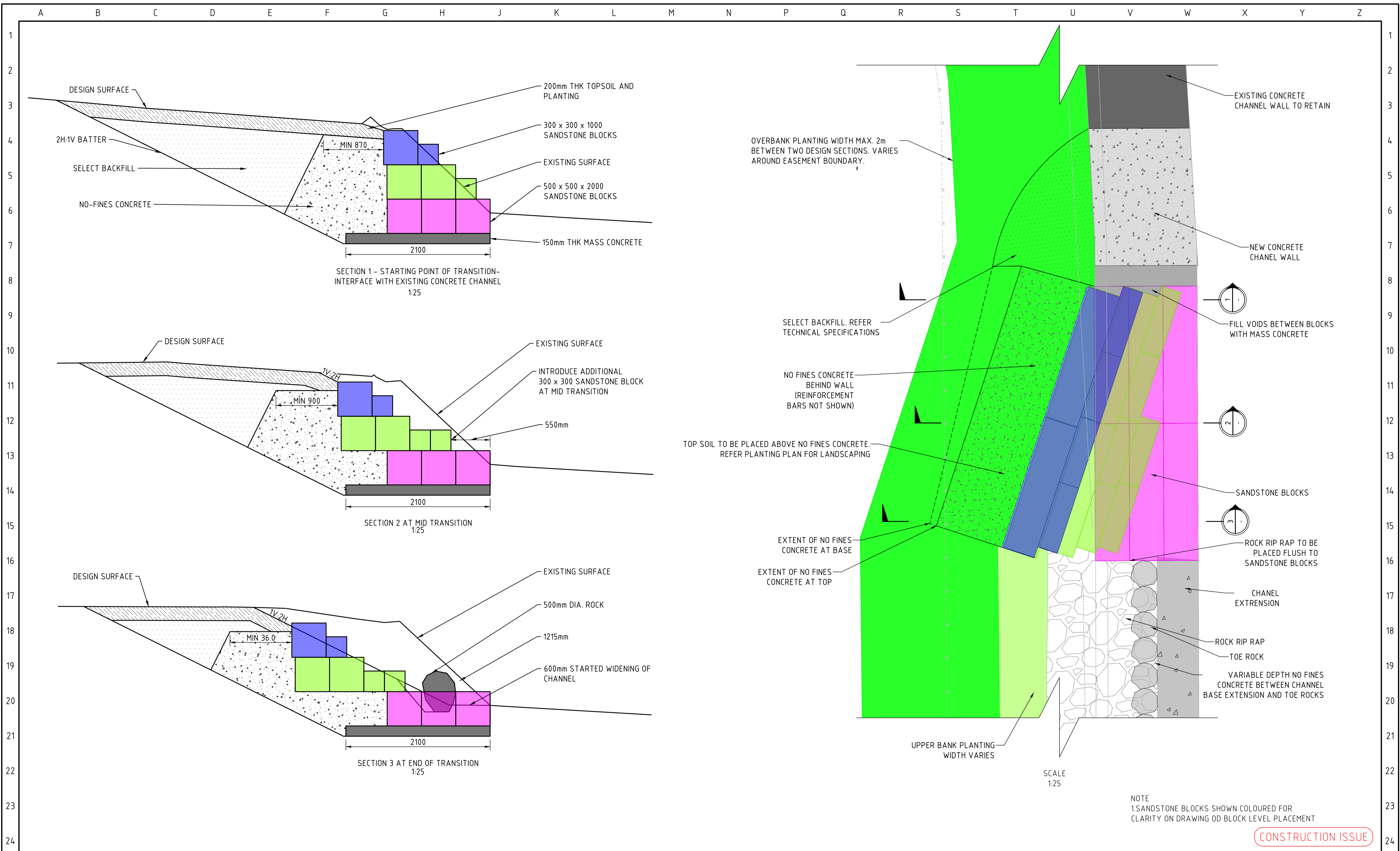
TYPICAL SECTION 2  
SCALE 1:25

**LEGEND**

	ROCK RIP RAP
	BACKFILL
	BEDDING LAYER
	TOP SOIL
	SUBGRADE
	NO-FINES CONCRETE
	MASS CONCRETE
	REINFORCED CONCRETE
	EROSION CONTROL MATTING
	GEOTEXTILE

CONSTRUCTION ISSUE

CONSULTANT DETAILS: Aurecon Australia Pty Ltd ABN 54 005 139 873 23 Warabrook Boulevard, Warabrook NSW 2304 Australia Telephone: +61 2 4941 5415 Email: newcastle@aurecongroup.com						DESIGNED: SJ	DATE: 23/06/22	COMPANY: AURECON	TITLE: SR00039B DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL					
CONSULTANT REFERENCE No. 521943 - HW DESP - SR00039		DRAWN: QN	DATE: 01/07/22			COMPANY: AURECON	TYPICAL SECTION DETAIL DETAIL - SHEET 2							
VERSION 4 No.      REVISION DETAILS      DWN      DATE				CHECKED: WL	DATE: 01/07/22	COMPANY: AURECON	SIZE: 1:25	SCALE: 1:25	INDEX No. 85222	DRAWING No. 16266	SHEET 006	REV No. 0		



**CONSTRUCTION ISSUE**

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0	CONSTRUCTION ISSUE	QN	04.08.22
B	100% DETAIL DESIGN ISSUE	QN	12.07.22
A	80% DETAIL DESIGN ISSUE	QN	25.05.22

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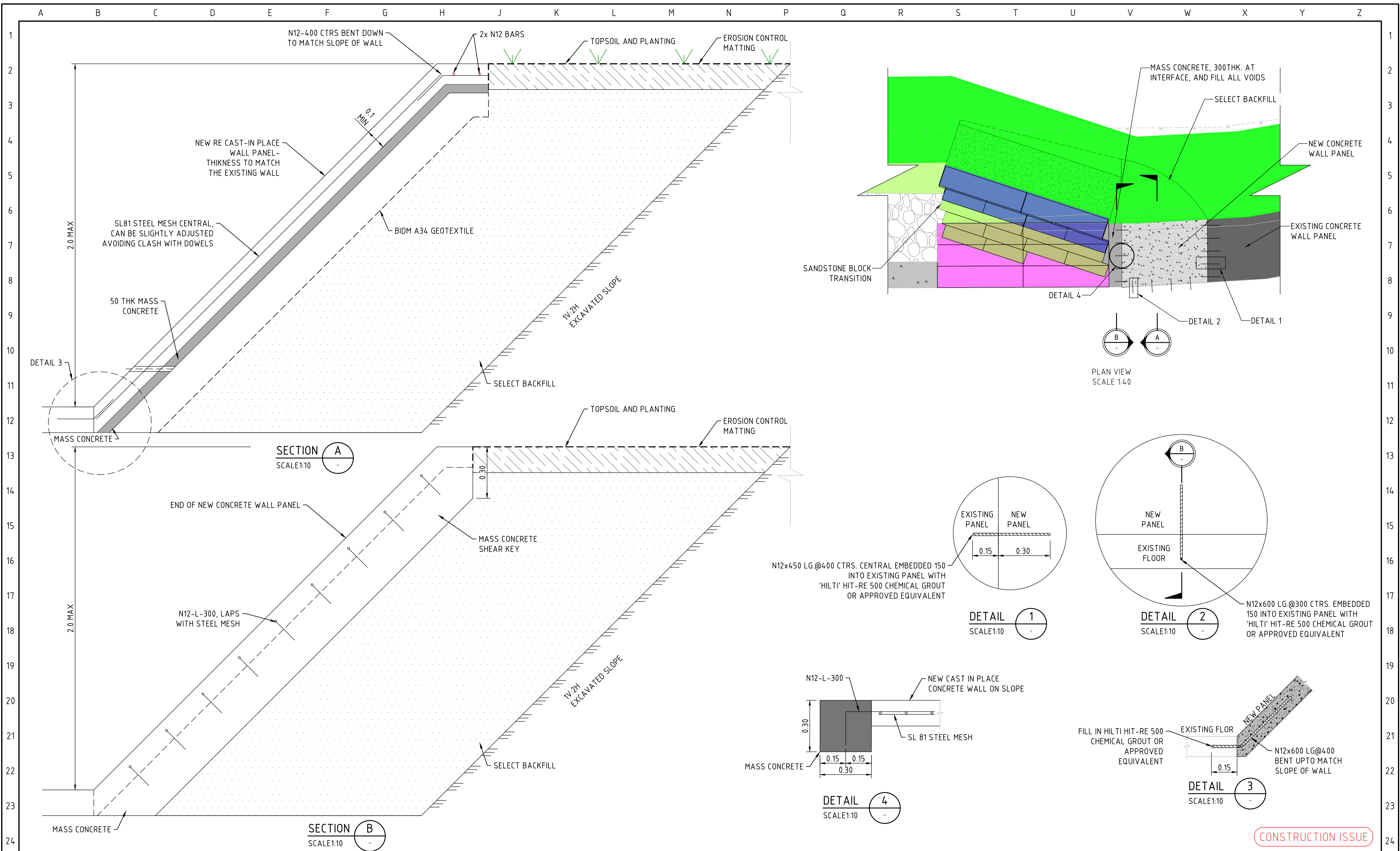
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TITLE: SR00039B DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL		SIZE: NTS	SCALE: 1:25	INDEX No. 85222	DRAWING No. 16266	SHEET 007	REV No. 0
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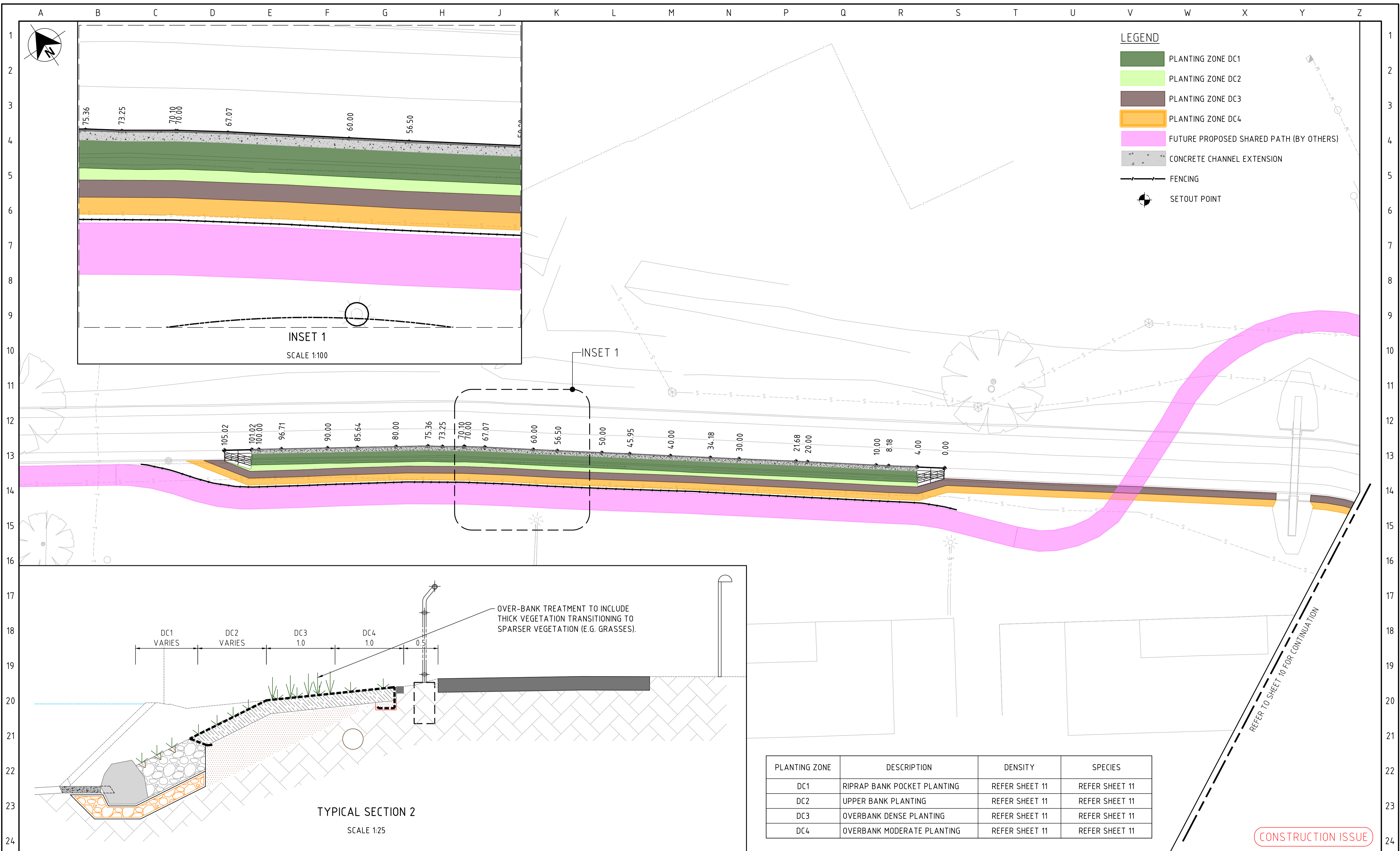


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VERSION 4





**LEGEND**

- PLANTING ZONE DC1
- PLANTING ZONE DC2
- PLANTING ZONE DC3
- PLANTING ZONE DC4
- FUTURE PROPOSED SHARED PATH (BY OTHERS)
- CONCRETE CHANNEL EXTENSION
- FENCING
- SETOUT POINT

**INSET 1**  
SCALE 1:100

**INSET 1**

OVER-BANK TREATMENT TO INCLUDE THICK VEGETATION TRANSITIONING TO SPARSER VEGETATION (E.G. GRASSES).

**TYPICAL SECTION 2**  
SCALE 1:25

PLANTING ZONE	DESCRIPTION	DENSITY	SPECIES
DC1	RIPRAP BANK POCKET PLANTING	REFER SHEET 11	REFER SHEET 11
DC2	UPPER BANK PLANTING	REFER SHEET 11	REFER SHEET 11
DC3	OVERBANK DENSE PLANTING	REFER SHEET 11	REFER SHEET 11
DC4	OVERBANK MODERATE PLANTING	REFER SHEET 11	REFER SHEET 11

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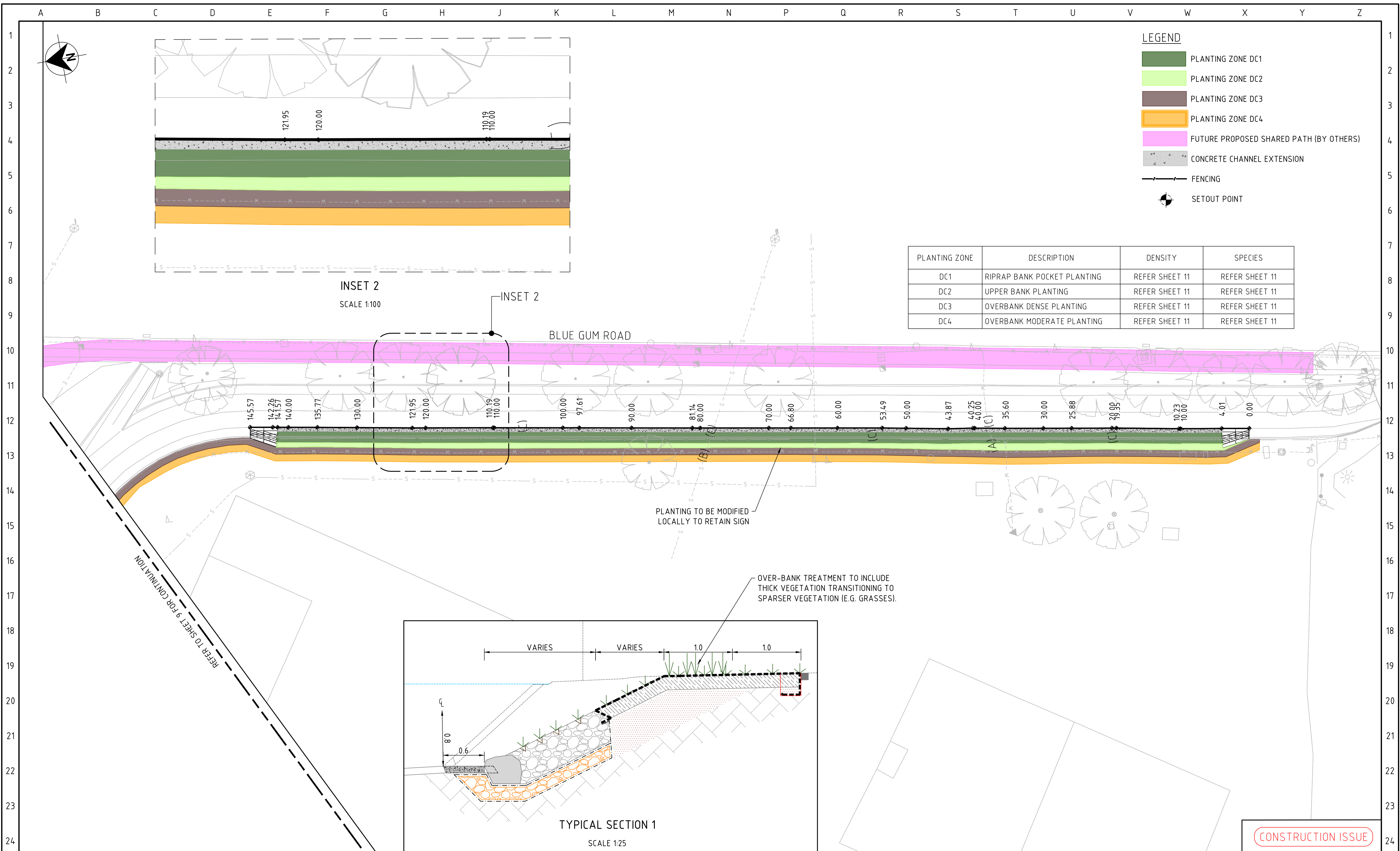
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<b>TITLE:</b>		SR00039B DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL	
<b>PLANTING PLAN - SHEET 1</b>		SIZE: 1:250	INDEX No. 85222
DRAWING No. 16266	SHEET 009	REV No. 0	

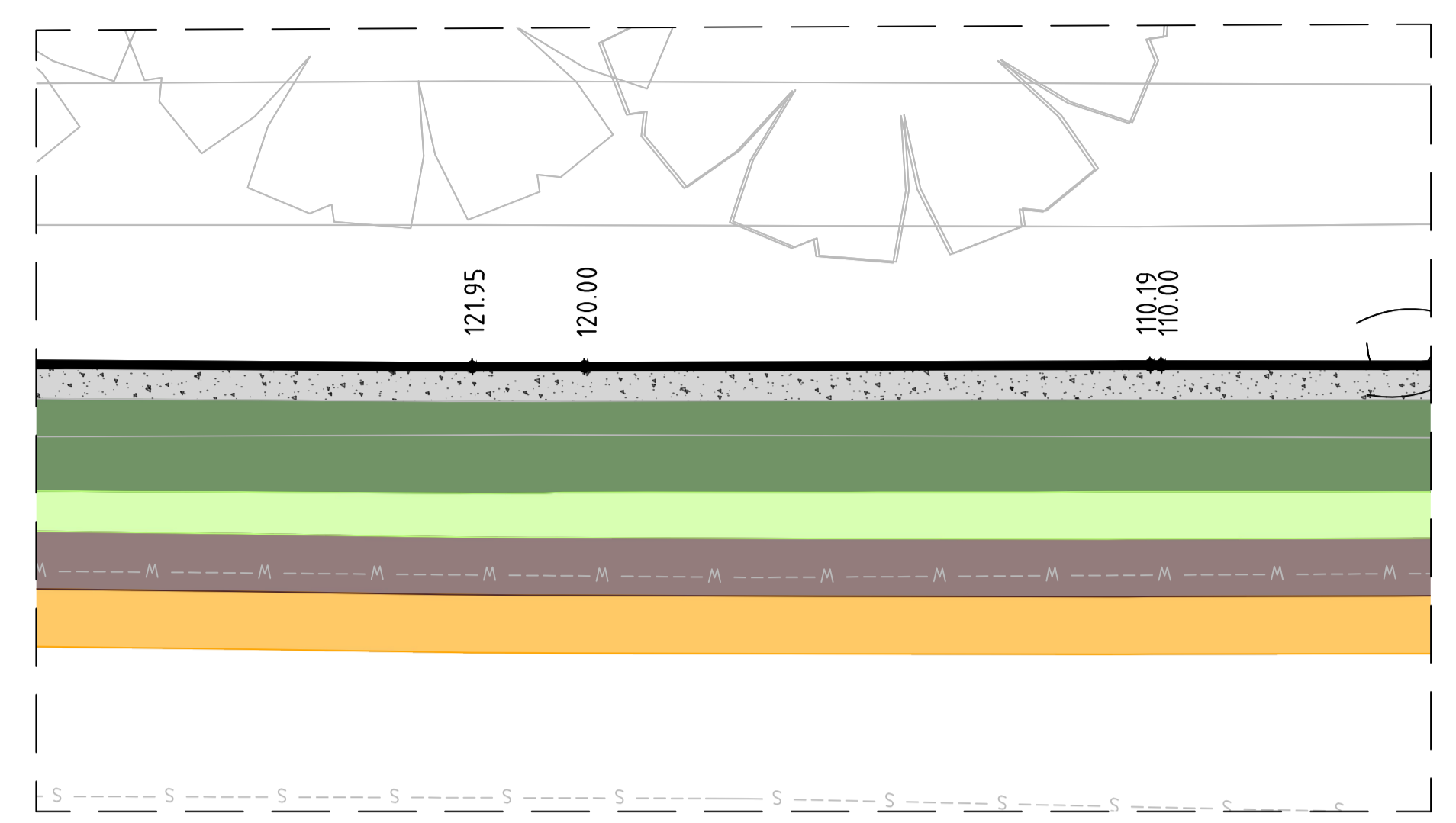
VERSION 4



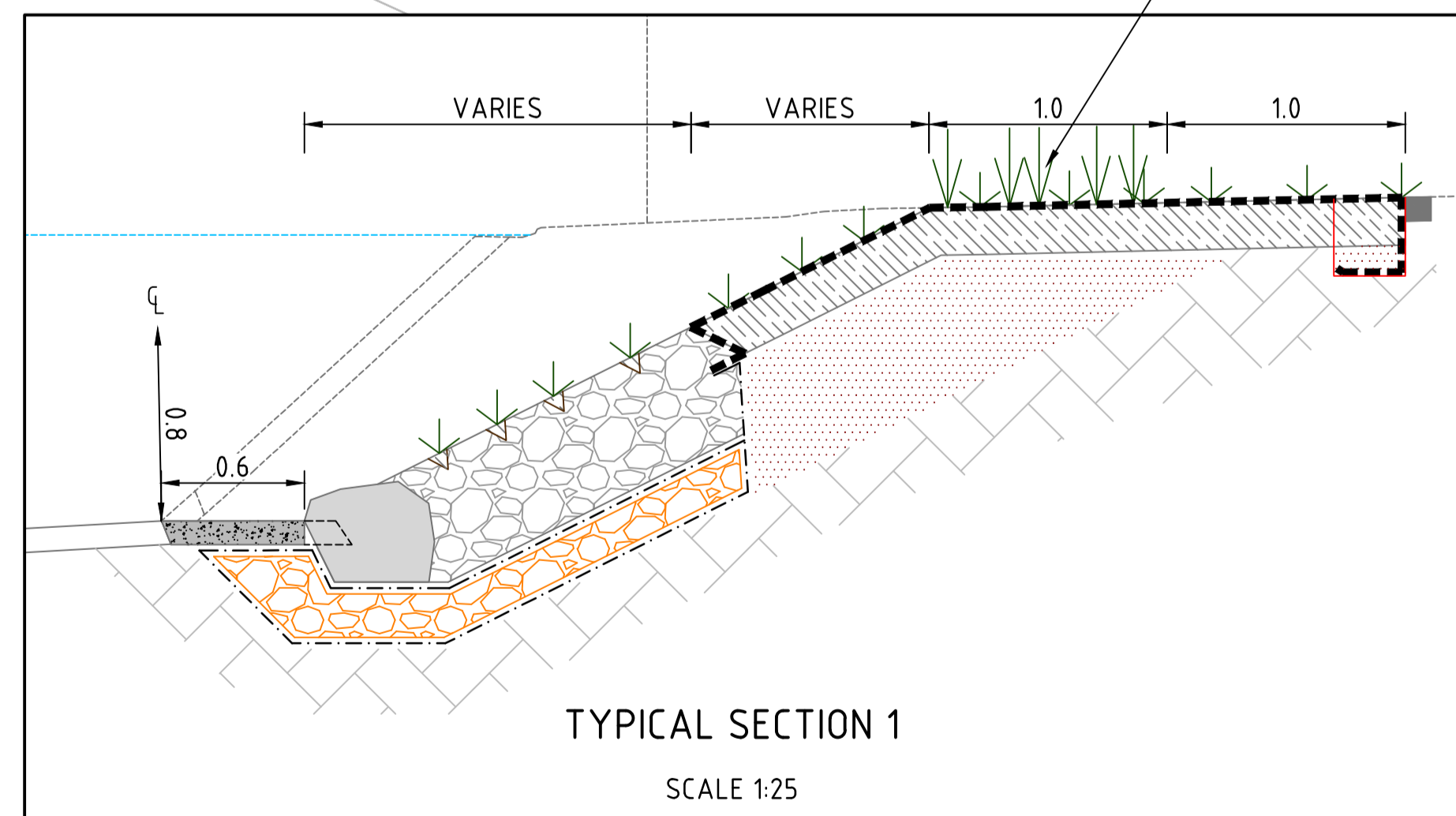
**LEGEND**

- PLANTING ZONE DC1
- PLANTING ZONE DC2
- PLANTING ZONE DC3
- PLANTING ZONE DC4
- FUTURE PROPOSED SHARED PATH (BY OTHERS)
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- SETOUT POINT

PLANTING ZONE	DESCRIPTION	DENSITY	SPECIES
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DC3	OVERBANK DENSE PLANTING	REFER SHEET 11	REFER SHEET 11
DC4	OVERBANK MODERATE PLANTING	REFER SHEET 11	REFER SHEET 11



**INSET 2**  
SCALE 1:100



**TYPICAL SECTION 1**  
SCALE 1:25



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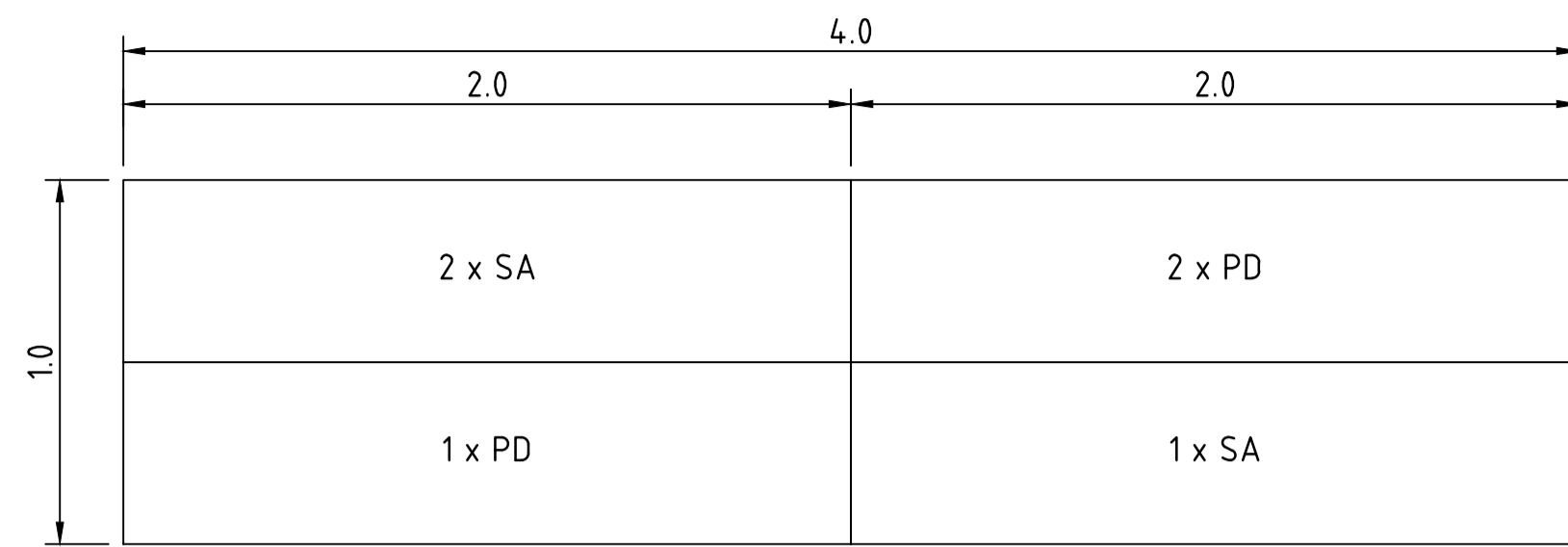
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 SR00039B  
 DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL  
 PLANTING  
 PLAN - SHEET 2

**SIZE:** SCALE: INDEX No. DRAWING No. SHEET REV No.  
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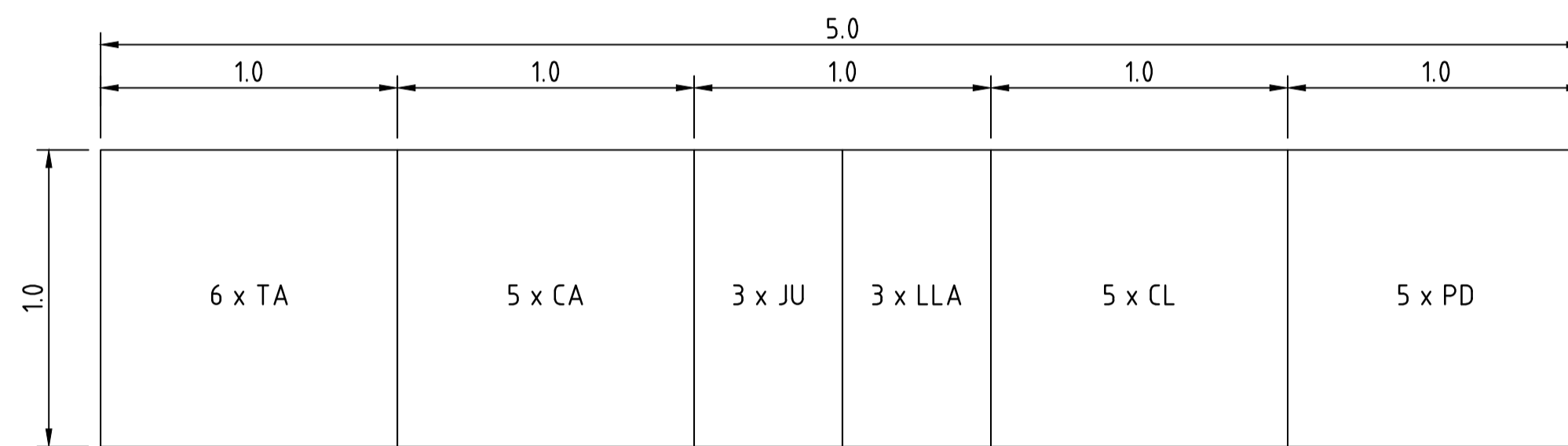
**CONSTRUCTION ISSUE**

VERSION 4



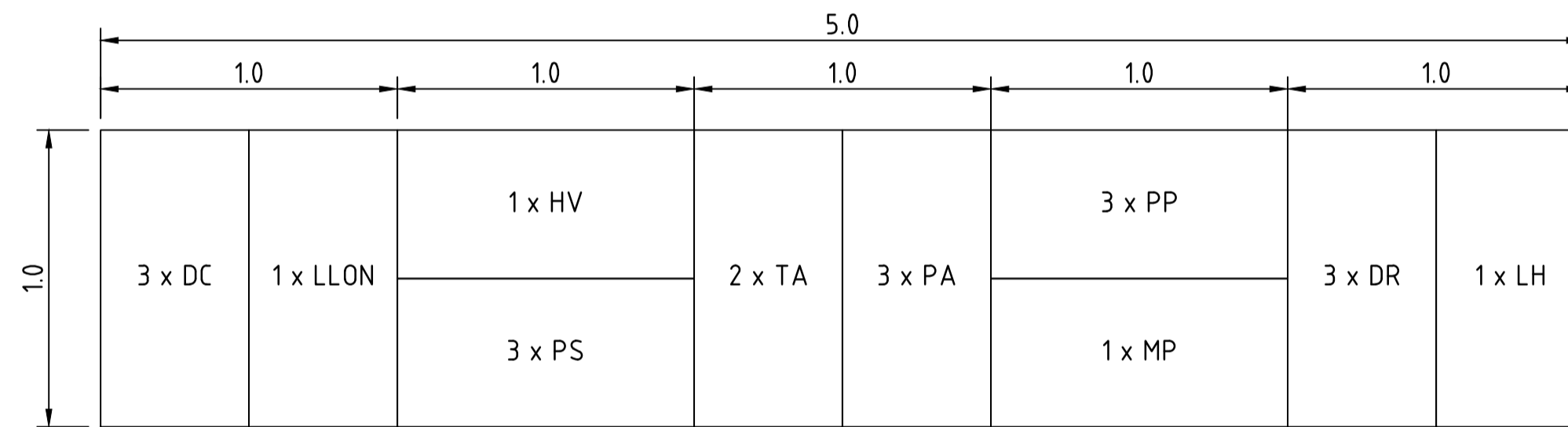
DC1 RIP RAP BANK POCKET PLANTING

SCALE 1:20



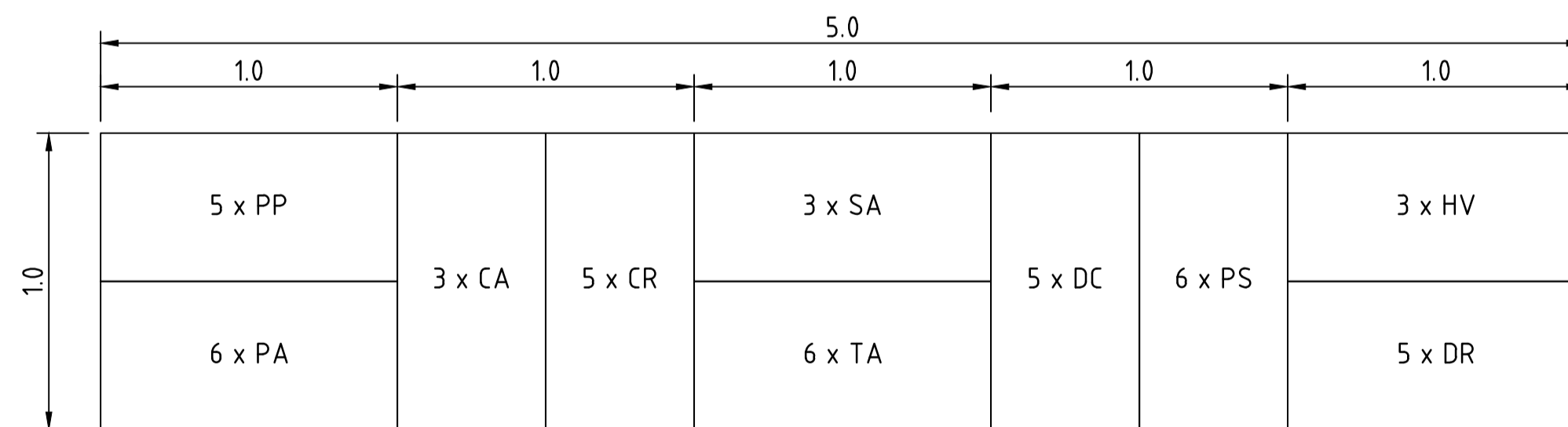
DC2 UPPER BANK PLANTING

SCALE 1:20



DC3 OVERBANK DENSE PLANTING

SCALE 1:20



DC4 OVERBANK MODERATE PLANTING

SCALE 1:20

DC1 RIP RAP POCKET PLANTING

SCIENTIFIC NAME	COMMON NAME	POT
<i>Scaevola aemula</i> (SA)	Fairy Fan Flower	Tube
<i>Persicaria decipiens</i> (PD)	Slender knot weed	Tube

DC2 UPPER BANK PLANTING

SCIENTIFIC NAME	COMMON NAME	POT
<i>Carex appressa</i> (CA)	Tussock Grass	Tube
<i>Carex longebrachiata</i> (CL)	Drooping Sedge	Tube
<i>Chorizandra cymbaria</i> (CC)	Heron Bristle Sedge	Tube
<i>Juncus usitatis</i> (JU)	Common Rush	Tube
<i>Persicaria decipiens</i> (PD)	Slender knot weed	Tube

DC3 OVERBANK DENSE PLANTING

SCIENTIFIC NAME	COMMON NAME	POT
<i>Carex appressa</i> (CA)	Drooping Sedge	Tube
<i>Cymbopogon refractus</i> (CR)	Barbed Wire Grass	Tube
<i>Dianella caerulea</i> (DC)	Blue Flax Lily	Tube
<i>Dianella revoulti</i> (DR)	Flax Lily	Tube
<i>Hardenbergia violacea</i> (HV)	Happy Wanderer	Tube
<i>Themeda australis</i> (TA)	Kangaroo Grass	Tube
<i>Panicum simile</i> (PS)	Two Colour Panic	Tube
<i>Pratia purpurascens</i> (PP)	White Root	Tube
<i>Poa affinis</i> (PA)	Tussock Grass	Tube
<i>Scaevola aemula</i> (SA)	Fairy Fan Flower	Tube

DC4 OVERBANK MODERATE PLANTING

SCIENTIFIC NAME	COMMON NAME	POT
<i>Dianella caerulea</i> (DC)	Blue Flax Lily	Tube
<i>Dianella revoulti</i> (DR)	Flax Lily	Tube
<i>Hardenbergia violacea</i> (HV)	Happy Wanderer	Tube
<i>Lomandra longifolia</i> (LLom)	Spiny Headed Mat Rush	Tube
<i>Lomandra hystrix</i> (LH)	Lucky Stripe	Tube
<i>Themeda australis</i> (TA)	Kangaroo Grass	Tube
<i>Panicum simile</i> (PS)	Two Colour Panic	Tube
<i>Pratia purpurascens</i> (PP)	White Root	Tube
<i>Myoporum parvifolium</i> (MP)	Creeping Boobialla	Tube
<i>Poa affinis</i> (PA)	Tussock Grass	Tube

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APPROVED:	DATE:	COMPANY:
PG	01/07/22	AURECON

TITLE:		SR00039B	
DARK CREEK STORMWATER CHANNEL - MAIN CHANNEL		PLANTING LAYOUT AND SPECIES	
SIZE:	SCALE:	INDEX No.	DRAWING No.
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SHEET	REV No.		
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## APPENDIX B

### Clause 171(2) factors and matters of national environmental significance

#### Clause 171(2) checklist

The following factors listed in section 171(2) of the *Environmental Planning and Assessment Regulation 2021* have been considered to assess the likely impacts of the proposal on the environment.

Factor	Impact
<p><b>(a) the environmental impact on a community?</b></p> <p>There would be potential for short-term negative impacts on the community during construction of the Proposal including noise, air and minor visual impacts. Potential visual amenity impact during construction would include the placement and movement of construction vehicles and stockpile areas within the Proposal site.</p> <p>Construction noise would be generated from construction activities and vehicles. Air quality impacts would result from dust and vehicle emissions. These impacts would likely occur for the duration of construction.</p> <p>Measures have been proposed to minimise these potential impacts (refer to Section 6.1).</p>	Short-term negative
<p><b>(b) the transformation of a locality?</b></p> <p>Construction of the Proposal would temporarily impact the existing locality, predominantly through a negative visual, noise and air quality impacts, associated with the placement and movement of construction plant and equipment and ancillary facilities.</p> <p>The Proposal would result in improved amenity for the stormwater system by replacing the concrete channel banks with natural materials and providing planting, thus increasing the value of the waterway and encouraging more recreational activity by the local community.</p>	Short-term, minor, negative  Long-term, minor, positive
<p><b>(c) the environmental impact on the ecosystems of a locality?</b></p> <p>The Proposal would not result in the removal of any vegetation or impact on the ecosystems of a locality.</p>	Nil
<p><b>(d) reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?</b></p> <p>During construction, the Proposal would have the potential to create a reduction in the overall aesthetic and recreational quality of the immediate Proposal site due to the equipment associated with construction, dust and noise generation. However, impacts would be minimised as far as practicable through the implementation of safeguards outlined in Section 6.1. No scientific or other qualities of the Proposal site are anticipated to be impacted during the construction or operation of the proposal.</p> <p>The Proposal would improve the aesthetic and recreational quality and value of the environment through naturalisation of the stormwater system and plantings, providing longer-term beneficial outcomes to the local community.</p>	Short-term, minor, negative  Long-term, minor, positive

Factor	Impact
<p><b>(e) the effects on a locality, place or building that has –</b></p> <ul style="list-style-type: none"> <li><b>i. aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance</b></li> <li><b>ii. other special value for present or future generations</b></li> </ul> <p>The Proposal would not have any effect on locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historic, scientific or social significance or other special values.</p>	Nil
<p><b>(f) impact on habitat of any protected animals (within the meaning of the <i>Biodiversity Conservation Act 2016</i>)?</b></p> <p>The Proposal is not anticipated to endanger any species of animal, plant or other form of life. Any potential biodiversity impacts associated with the Proposal would be mitigated through the implementation of safeguards outlined in Section 6.1. The Proposal would not impact any habitat of any protected animals within the meaning of the BC Act.</p>	Nil
<p><b>(g) the endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?</b></p> <p>The Proposal is not anticipated to endanger any species of animal, plant or other form of life. There are no biodiversity impacts anticipated from the Proposal. Any potential impacts will be mitigated through the implementation of mitigation measures outlined in Section 6.1.</p>	Nil
<p><b>(h) long-term effects on the environment?</b></p> <p>There would be a positive long-term impact on the environment through the creek naturalisation and creekside planting. This would create a more natural ecosystem and may encourage fauna and aquatic vegetation to establish in the area.</p>	Long-term, positive
<p><b>(i) degradation of the quality of the environment?</b></p> <p>The Proposal has the potential to degrade the quality of the environment through accidental spills and erosion and sediment impacts during construction. Soil and erosion impacts associated with the Proposal would be minor and short-term, and mitigated through the implementation of mitigation measures outlined in Section 6.1.</p>	Short-term, minor, negative
<p><b>(j) risk to the safety of the environment?</b></p> <p>There would be a minor risk to the safety of the environment during construction of the Proposal in the event of an accidental release of sediment to the environment.</p>	Short-term, minor, negative
<p><b>(k) reduction in the range of beneficial uses of the environment?</b></p> <p>Beneficial uses of the environment would increase in the long-term due to the Proposal. Improving the amenity of the stormwater system will increase the value of the waterway and encourage more recreational activity by the community.</p>	Long-term, positive
<p><b>(l) pollution of the environment?</b></p> <p>The Proposal would have the potential to result in some minor negative short-term water pollution risks including from sediments, soil nutrients, concrete, and waste. Management of water quality impacts would be carried out in accordance with the safeguards and management measures outlined in Section 6.</p> <p>Short-term noise and air quality impacts (dust and exhaust emissions) would be expected during the construction of the Proposal. Management</p>	Short-term, minor, negative

Factor	Impact
<p>of noise and air quality impacts would be carried out in accordance with the safeguards and management measures summarised in Section 6.</p> <p>The operation of the Proposal would not alter the air quality from the existing conditions.</p>	
<p><b>(m) environmental problems associated with the disposal of waste?</b></p> <p>Waste associated with the Proposal would be managed in accordance with the <i>Waste Avoidance and Resource Recovery Act 2001</i> and recycled where possible or disposed of by a license contractor at a license facility.</p> <p>Issues associated with the disposal of waste are not expected.</p>	Nil
<p><b>(n) increased demands on resources, natural or otherwise which are, or are likely to become, in short supply?</b></p> <p>The Proposal would not result in an increase in demand for resources which are, or are likely to become, short in supply.</p>	Nil
<p><b>(o) the cumulative environmental effect with other existing or likely future activities?</b></p> <p>Given the minor nature and duration of the Proposal, cumulative impacts would not be expected with identified developments.</p>	Nil
<p><b>(p) the impact on coastal processes and coastal hazards, including those under projected climate change conditions?</b></p> <p>The Proposal is not located within a coastal area and would not result in any impact on coastal processes and coastal hazards.</p>	Nil
<p><b>(q) applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1</b></p> <p>The expected outcomes of the Proposal following the amenity improvement works around the stormwater channel align with the objectives of the Hunter Regional Plan 2036. The Proposal enhances quality of life within the local community by creating attractive public spaces.</p>	Long-term, positive
<p><b>(r) other relevant environmental factors</b></p> <p>No other relevant environmental factors.</p>	Nil

## Matters of National Environmental Significance

The following matters of national environmental significance have been considered as required by the environmental assessment provisions of the EPBC Act. This review assists in determining whether the proposal should be referred to the Australian Government Department of the Environment and Energy.

Environmental factor	Impact
<p><b>Any impact on a World Heritage property?</b> There would be no impact to World Heritage properties by the Proposal.</p>	Nil
<p><b>Any impact on a National Heritage place?</b> There would be no impact to National Heritage places by the Proposal.</p>	Nil
<p><b>Any impact on a wetland of international importance (often called 'Ramsar' wetlands)?</b> There would be no impact to wetlands of international importance by the Proposal.</p>	Nil
<p><b>Any impact on nationally threatened species, ecological communities or migratory species?</b> The Proposal would not impact any nationally threatened species, ecological communities or listed migratory species.</p>	Nil
<p><b>Any impact on a Commonwealth marine area?</b> There would be no impact to Commonwealth marine areas by the Proposal.</p>	Nil
<p><b>Does the proposal involve a nuclear action (including uranium mining)?</b> The Proposal does not involve a nuclear action (including uranium mining).</p>	Nil
<p><b>Any impact on a water resource, in relation to coal seam gas development and large coal mining development?</b> The Proposal would not impact on a water resource, in relation to coal.</p>	Nil
<p><b>Additionally, any impact (direct or indirect) on the environment of Commonwealth land?</b> The Proposal does not involve any impact on Commonwealth land.</p>	Nil

## APPENDIX C

### Consultation Records





Hunter Water Corporation  
ABN 46 228 513 446

PO Box 5171  
HRMC NSW 2310  
36 Honeysuckle Drive  
NEWCASTLE NSW 2300  
hunterwater.com.au  
1300 657 657 (T)  
enquiries@hunterwater.com.au

12 April 2022

Our Ref: HW2018-1118/8/10.003

Joanne Rigby  
Director of Infrastructure and Property  
Newcastle City Council  
PO Box 489  
Newcastle NSW 2300

Dear Joanne,

**Consultation regarding proposed stormwater amenity improvement at one of Hunter Water's stormwater systems, Dark Creek, located within Heaton Park, Jesmond**

Hunter Water Corporation (Hunter Water) is currently preparing a Review of Environmental Factors (REF) for proposed stormwater amenity works along 280m of the Dark Creek stormwater channel within Heaton Park in Jesmond (the Proposal). The Dark Creek stormwater channel is located within land zoned as 'RE1 Public Recreation' under the *Newcastle Local Environment Plan 2012*.

In accordance with the *State Environmental Planning Policy (Transport and Infrastructure) 2021 (ISEPP)*, Hunter Water wishes to notify Newcastle City Council (Council) of its intentions to carry out works associated with the Proposal. Hunter Water are required to consult with Council under clause 2.10(1)(a) due to impacts on council stormwater management services, and under clause 2.12(1) due to the proposed developments impacting flood liable land.

Hunter Water's proposed scope of works are illustrated in Figures 1-5 and include:

- Replacement of concrete channel banks with natural (rock rip rap planted out with native plants) materials on the western bank of Dark Creek adjacent to Blue Gum Road and southern bank of Dark Creek adjacent to the future shared user path in Heaton Park;
- Slight widening of the existing concrete channel base;
- Two metres of plantings and a concrete management edge provided at the top of the bank; and
- A fence proposed at the edge of the future shared user path planned by Council.

Hunter Water is currently preparing a REF in accordance with Part 5 of the *Environmental Planning & Assessment Act 1979* with Hunter Water as the determining authority. The proposed works are expected to commence in November 2022 and be completed by June 2024. The REF would identify a range of measures to mitigate potential environmental risks and these would form the basis of a Construction Environmental Management Plan to be implemented during the proposed works.

As can be seen in Figures 1-5, the proposed works are limited to the extent of Heaton Park. At this stage anticipated impacts to vegetation for the Proposal include the likely removal of one mature native tree.

A key design requirement for the works is that the works will not adversely affect channel conveyance or result in increased flooding. An initial assessment has been completed in the concept design and extensive flood modelling will be completed in detail design to confirm this.

The purpose of this letter is to make Council aware of the proposal and to invite your comment for consideration in the REF. It would be appreciated if you could provide any comments about this proposal by 3 May 2022.

Note that Hunter Water has consulted with Council during the initial planning phase, and also throughout the subsequent concept design phase of this project completed between August 2021 and December 2021. During the concept design phase Council has reviewed and provided input on the proposed works. Our Council contact to date has been Luke Jones, Integrated Water Cycle Engineer, who is familiar with the history of Council involvement and the currently proposed works. We have recently commenced detail design and plan for continued involvement and collaboration with Council during final development of the design that is planned for completion in July 2022.

Hunter Water would be pleased to provide further information if required. In this regard please contact Shaun Murphy, [shaun.murphy@hunterwater.com.au](mailto:shaun.murphy@hunterwater.com.au).

Yours faithfully,

A handwritten signature in blue ink, appearing to read 'S. Murphy', with a horizontal line underneath.

Shaun Murphy  
Project Manager  
Asset Solutions – Hunter Water Corporation  
[shaun.murphy@hunterwater.com.au](mailto:shaun.murphy@hunterwater.com.au)



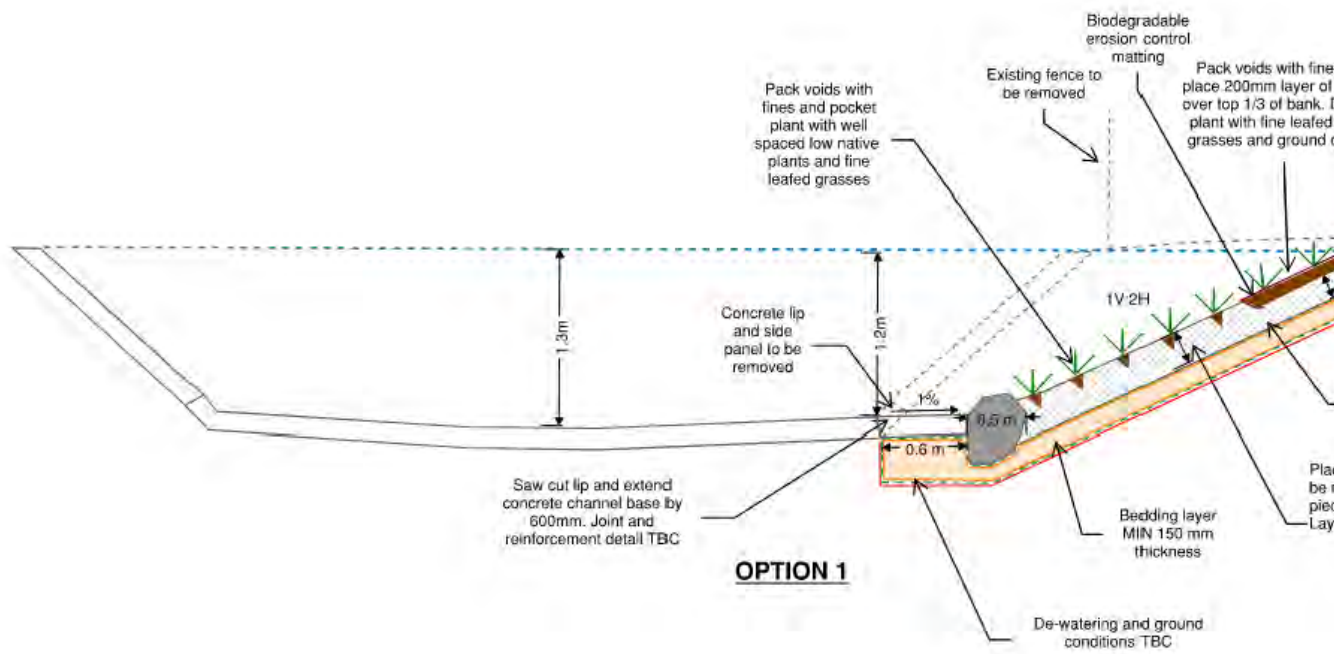


Figure 1 Site Overview – Dark Creek, Jesmond

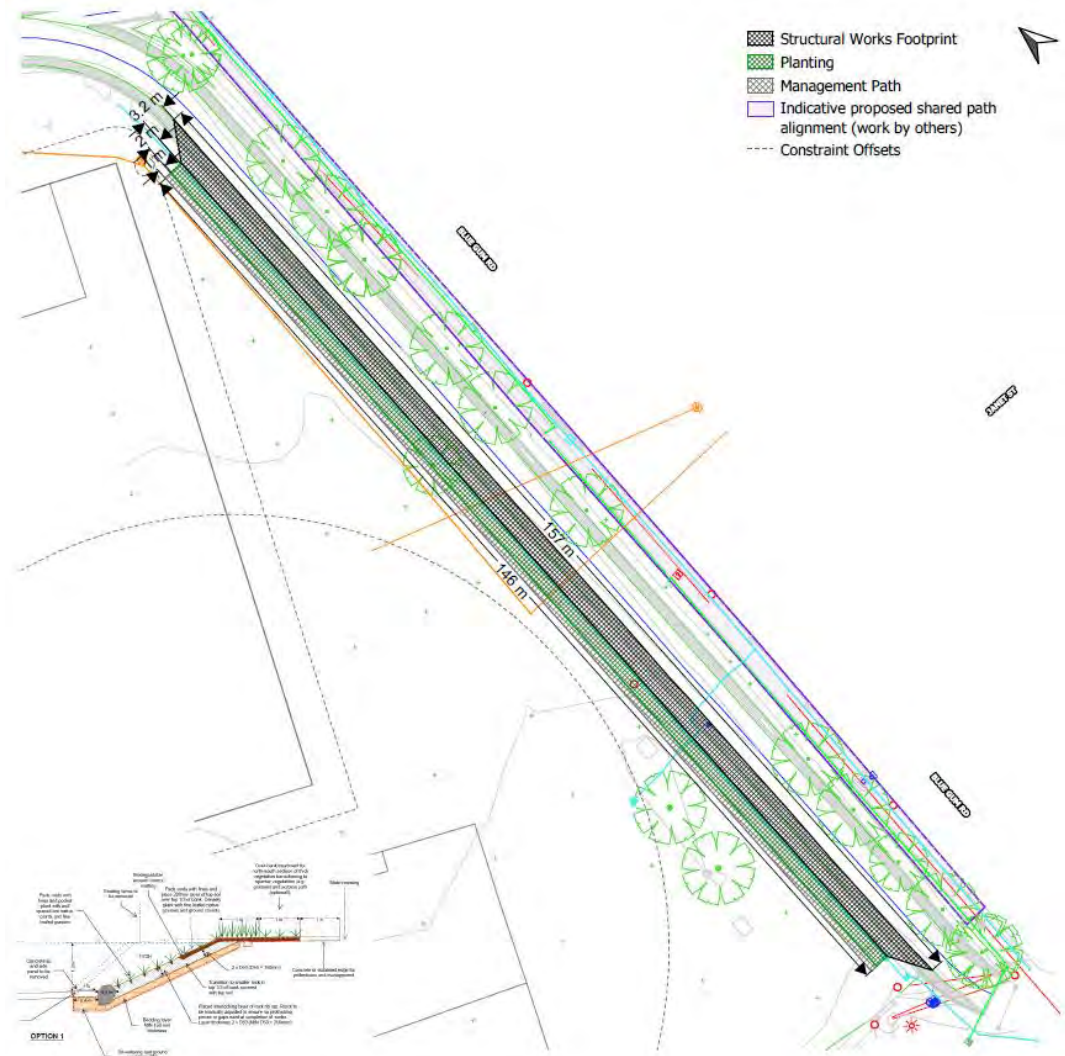


Figure 2 Upstream Section – Extent of Works



Figure 3 Upstream Section – Extent of Works



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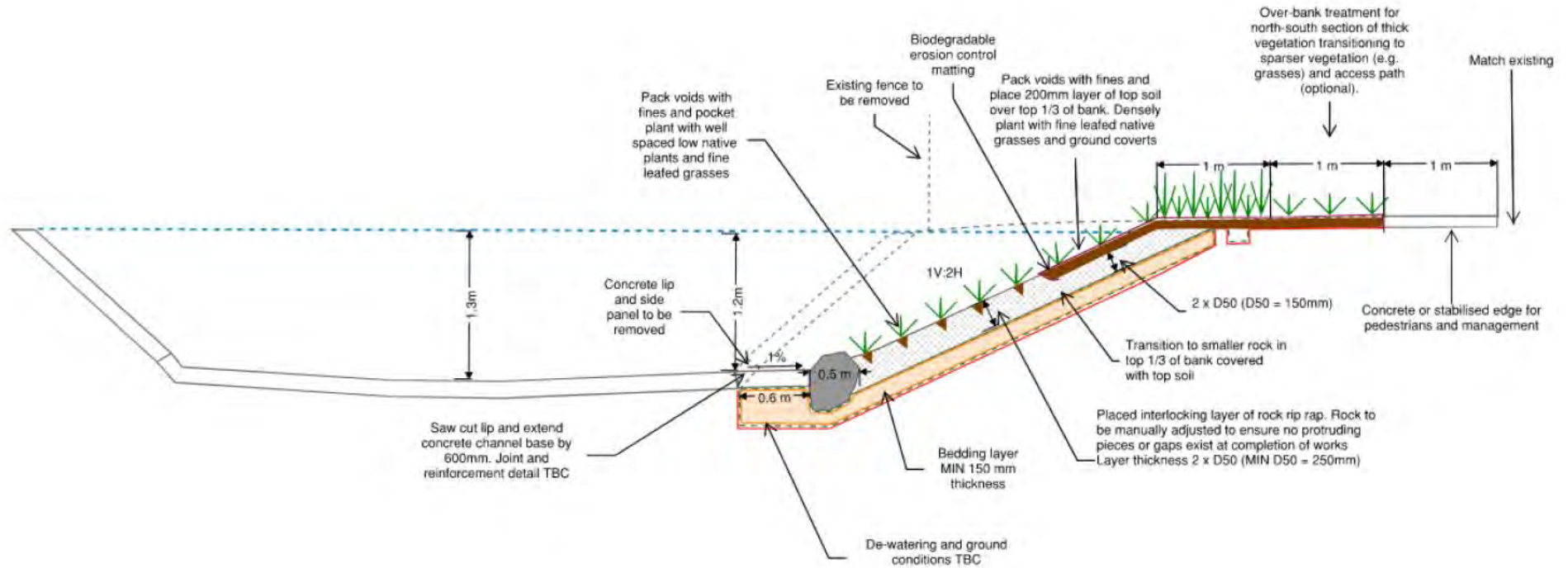


Figure 4 Structural Works - Upstream Section

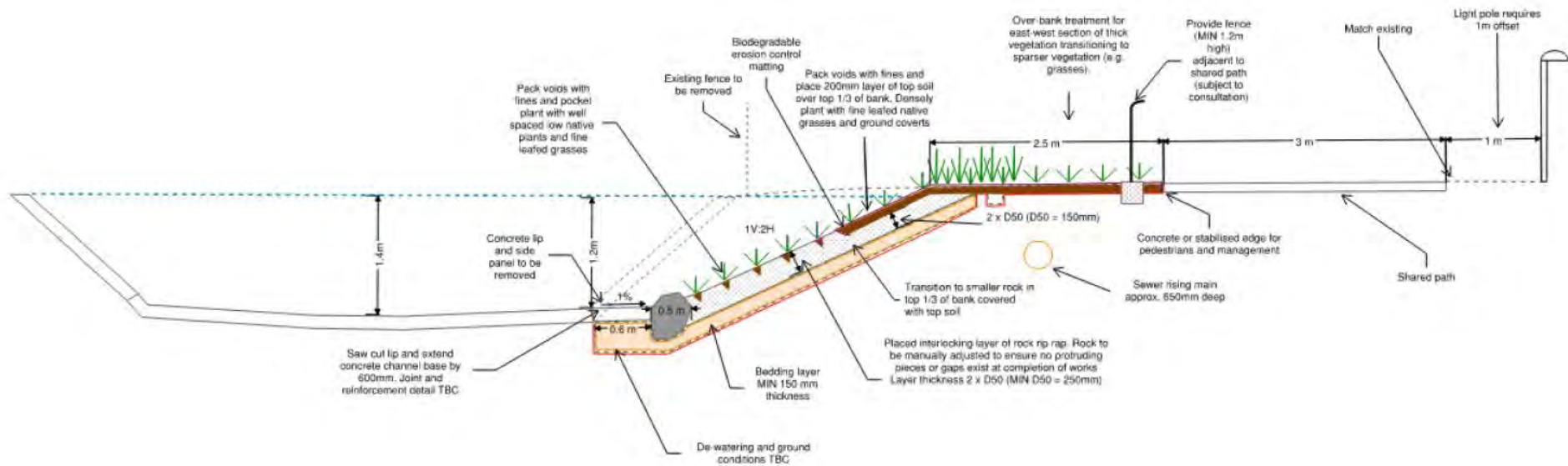


Figure 5 Structural Works - Downstream Section





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enquiries@hunterwater.com.au

12 April 2022

Our Ref: HW2018-1118/8/10.008

PO BOX 6126  
WOLLONGONG NSW 2500  
State Emergency Services New South Wales

To whom it may concern,

**Consultation regarding proposed stormwater amenity improvement at one of Hunter Water's stormwater systems, Dark Creek, located within Heaton Park, Jesmond**

Hunter Water Corporation (Hunter Water) is currently preparing a Review of Environmental Factors (REF) for proposed stormwater amenity works along 280m of the Dark Creek stormwater channel within Heaton Park in Jesmond (the Proposal). The Dark Creek stormwater channel is located within land zoned as 'RE1 Public Recreation' under the *Newcastle Local Environment Plan 2012*.

In accordance with the *State Environmental Planning Policy (Transport and Infrastructure) 2021* (ISEPP), Hunter Water wishes to notify the State Emergency Service (SES) of its intentions to carry out works associated with the Proposal. Under clause 2.13(1), Hunter Water are required to consult with SES due to the proposed developments on flood liable land.

Hunter Water's proposed scope of works are illustrated in Figures 1-5 and include:

- Replacement of concrete channel banks with natural (rock rip rap planted out with native plants) materials on the western bank of Dark Creek adjacent to Blue Gum Road and southern bank of Dark Creek adjacent to the future shared user path in Heaton Park;
- Slight widening of the existing concrete channel base;
- Two metres of plantings and a concrete management edge provided at the top of the bank; and
- A fence proposed at the edge of the future shared user path planned by Council.

Hunter Water is currently preparing a REF in accordance with Part 5 of the *Environmental Planning & Assessment Act 1979* with Hunter Water as the determining authority. The proposed works are expected to commence in November 2022 and be completed by June 2024. The REF would identify a range of measures to mitigate potential environmental risks and these would form the basis of a Construction Environmental Management Plan to be implemented during the proposed works.

As can be seen in Figures 1-5, the proposed works are limited to the extent of Heaton Park. At this stage anticipated impacts to vegetation for the Proposal include the likely removal of one mature native tree.

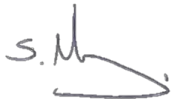
A key design requirement for the works is that the works will not adversely affect channel conveyance or result in increased flooding. An initial assessment has been completed in

the concept design and extensive flood modelling will be completed in detail design to confirm this.

The purpose of this letter is to make SES aware of the proposal and to invite your comment for consideration in the REF. It would be appreciated if you could provide any comments about this proposal by 3 May 2022.

Hunter Water would be pleased to provide further information if required. In this regard please contact Shaun Murphy, [shaun.murphy@hunterwater.com.au](mailto:shaun.murphy@hunterwater.com.au).

Yours faithfully,

A handwritten signature in black ink, appearing to read 'S. Murphy', with a stylized flourish at the end.

Shaun Murphy  
Project Manager  
Asset Solutions – Hunter Water Corporation  
[shaun.murphy@hunterwater.com.au](mailto:shaun.murphy@hunterwater.com.au)



Figure 1 Site Overview – Dark Creek, Jesmond

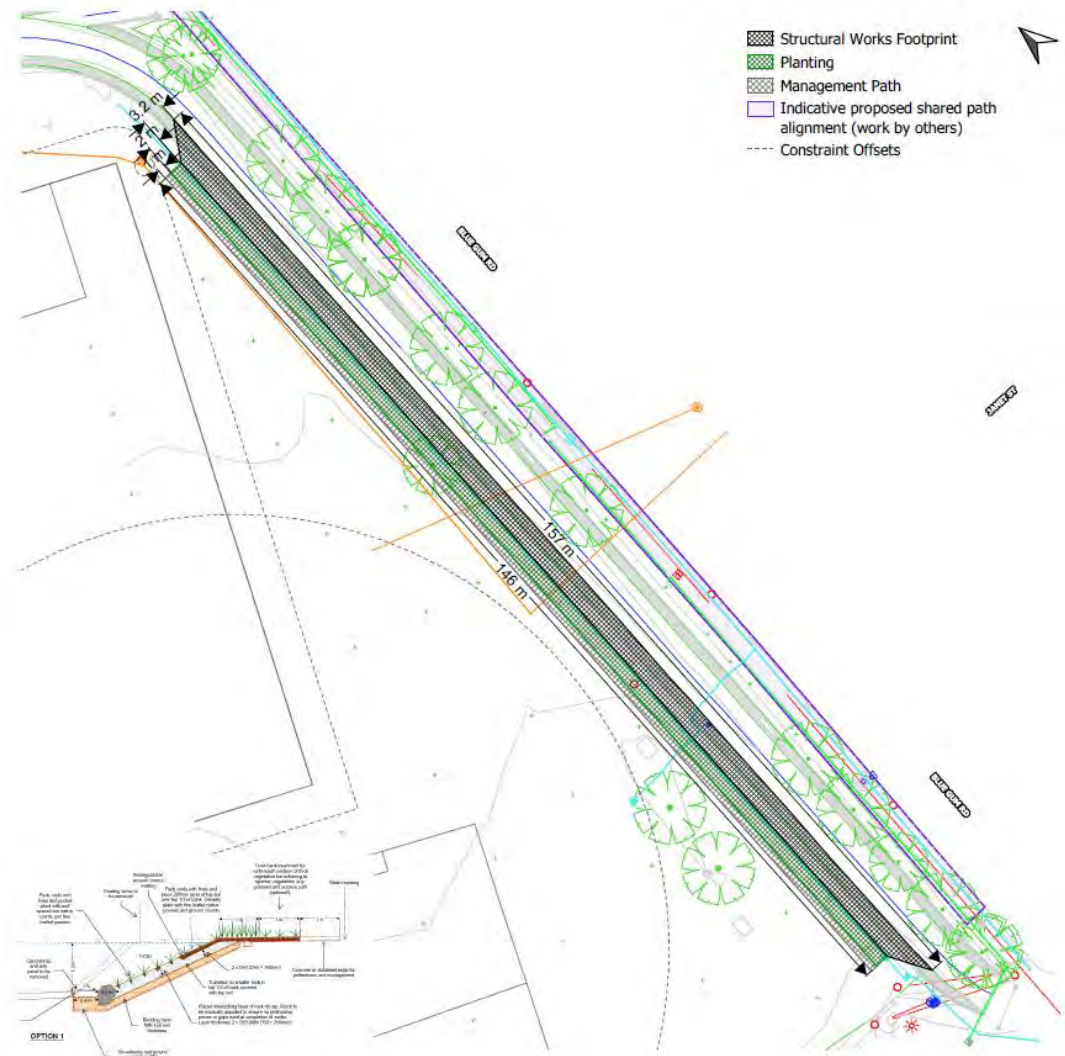


Figure 2 Upstream Section – Extent of Works



Figure 3 Upstream Section – Extent of Works



Hunter Water Corporation  
ABN 46 228 513 446

PO Box 5171  
HRMC NSW 2310  
36 Honeysuckle Drive  
NEWCASTLE NSW 2300  
hunterwater.com.au  
1300 657 657 (T)  
enquiries@hunterwater.com.au

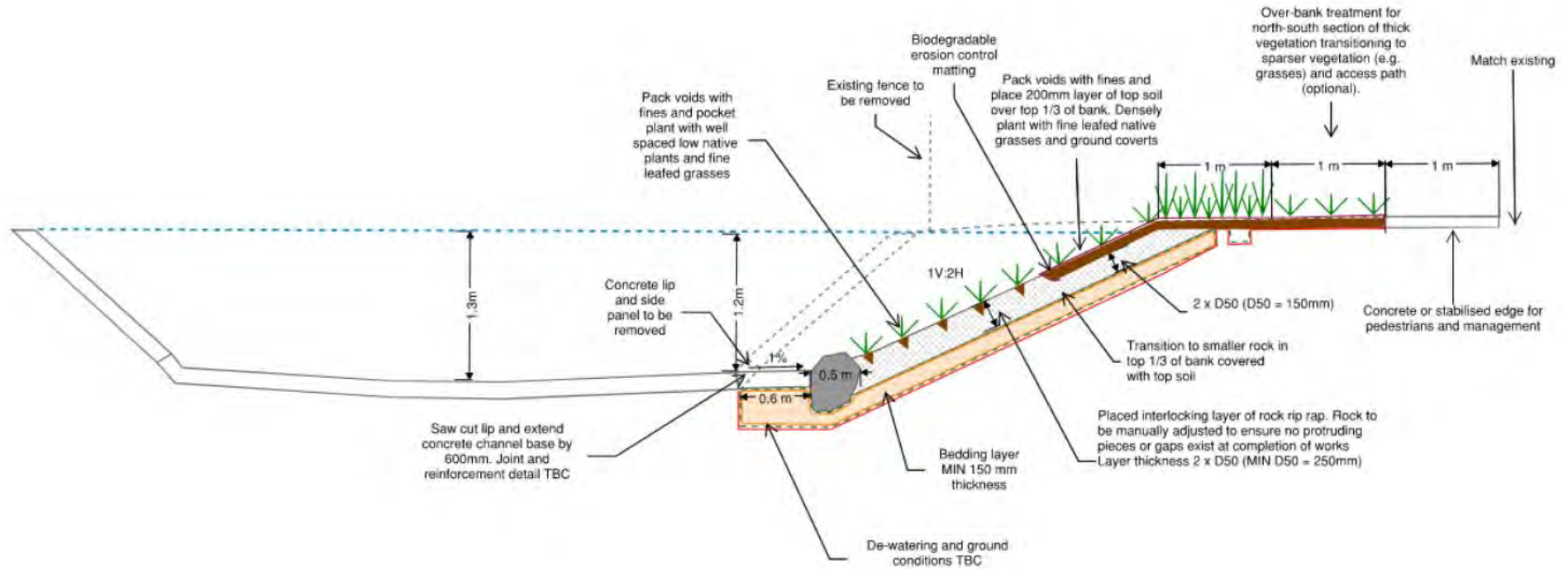


Figure 4 Structural Works - Upstream Section

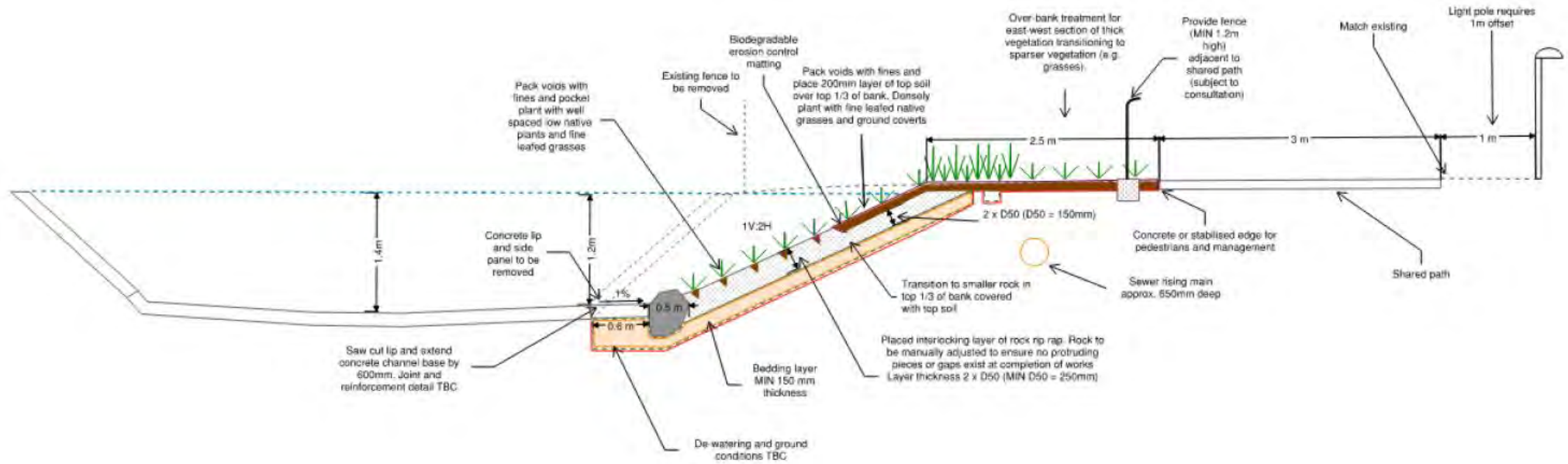


Figure 5 Structural Works - Downstream Section

9 May 2022

Shaun Murphy  
Project Manager  
Asset Solutions – Hunter Water Corporation

Email: [shaun.murphy@hunterwater.com.au](mailto:shaun.murphy@hunterwater.com.au)

Dear Shaun

## **CONSULTATION ON STORMWATER AMENITY IMPROVEMENT**

I refer to your correspondence dated 12 April 2022 regarding consultation on the Review of Environmental Factors (REF) for proposed stormwater amenity works. along Throsby Creek stormwater channel within Litchfield Park in Mayfield, and along Dark Creek stormwater channel in Heaton Park in Jesmond.

CN notes any cycleway fence must be designed and constructed in accordance with Austroads Guide to Road Design Part 6A Pedestrian and Cyclist Paths (i.e. fence 1.4m high) and Council Standard Drawings A3503 and A3504. This applies in the instance the cycleway is constructed prior to the amenity project at Heaton Park. However, CN believes this is unlikely to be the case.

Hunter Water's REF should consider flood impact across the sites through a suitably prepared flood impact assessment. The assessment should show negligible impact across the private properties adjoining Heaton and Litchfield Park. The flood impact shall not introduce over floor flooding as part of the allowance of negligible impact. Impacts to flood depth and velocity isolated to CN property may be acceptable in optimising multi criteria outcomes for the project, this should be discussed to the satisfaction of CN. The flood impact must also consider flood hazard changes as part of its assessment. These considerations have been communicated to Hunter Water in previous consultation.

CN notes the likely removal of one mature tree at the Heaton Park site and none for the Litchfield Park site. For all CN owned trees, CN requires preparation and submission of an Arboricultural Impact Assessment (AIA) and Tree Protection Plan (TPP) in accordance with AS4970:2009 Protection of trees on development sites. This is to be completed by a minimum AQF 5 Arborist with relevant experience. These assessments should form part of the REF for each site.

The AIA must:

- (i) detail all construction activities that are likely to impact trees; this is to include the location of site compounds, facilities, temporary services installations, vehicle access points and storage areas during the construction phase; and
- (ii) describe design modifications and construction methodologies to minimise these impacts; and
- (iii) detail all options from point (ii) above that have been explored and exhausted to retain trees, prior to recommending tree removal.




The TPP must:

- clearly identify all trees that are to be retained on the site and their TPZs and SRZs; and
- include types and locations of tree protection and identify areas where arboriculturally supervision is required; and
- include an inspection schedule that highlights milestone activities and inspection frequencies for the Project Arborist.

Hunter Water's REF for the Litchfield Park site should also consider the Crime Prevention Through Environmental Design (CPTED) impact of any erected or screened structure on the opposite bank. This assessment should be an extension of the ongoing consultation with the residents adjoining the structure.

Should you require any further information on this matter please contact City of Newcastle's Integrated Water Cycle Engineer, Luke Jones on 4974 6118 or [ljones@ncc.nsw.gov.au](mailto:ljones@ncc.nsw.gov.au).

Yours faithfully



Robert Dudgeon

**ACTING MANAGER ASSETS AND PROJECTS**

Our Ref: ID 1606  
Your Ref: HW2018-1118/8/10.008

20 April 2022

Mr Shaun Murphy  
Hunter Water Corporation  
PO Box 5171  
HRMC NSW 2310

Via email: [shaun.murphy@hunterwater.com.au](mailto:shaun.murphy@hunterwater.com.au)  
[sarah.saunders@hunterwater.com.au](mailto:sarah.saunders@hunterwater.com.au)

Dear Mr Murphy,

**Notification under section 2.13 of the State Environmental Planning Policy (Transport and Infrastructure) 2021 in relation to the proposed Dark Creek Upgrade**

Thank you for the notification under section 2.13 of the *State Environmental Planning Policy (Transport and Infrastructure) 2021* in relation to the proposed stormwater amenity improvement at Dark Creek, Heaton Park, Jesmond.

The NSW State Emergency Service (NSW SES) has reviewed the proposed upgrade using the information provided with the proposal and the flood risk information (e.g. local flood Plan, flood studies etc.) available to the NSW SES. Based on this review the proposed works appear to have minimal impact to NSW SES response operations.

Please feel free to contact me via email at [rra@ses.nsw.gov.au](mailto:rra@ses.nsw.gov.au) should you wish to discuss any of the matters raised in this correspondence.

Yours sincerely,



Nicholas Kuster  
Manager Emergency Planning  
**NSW State Emergency Service**

## APPENDIX D

### Database searches

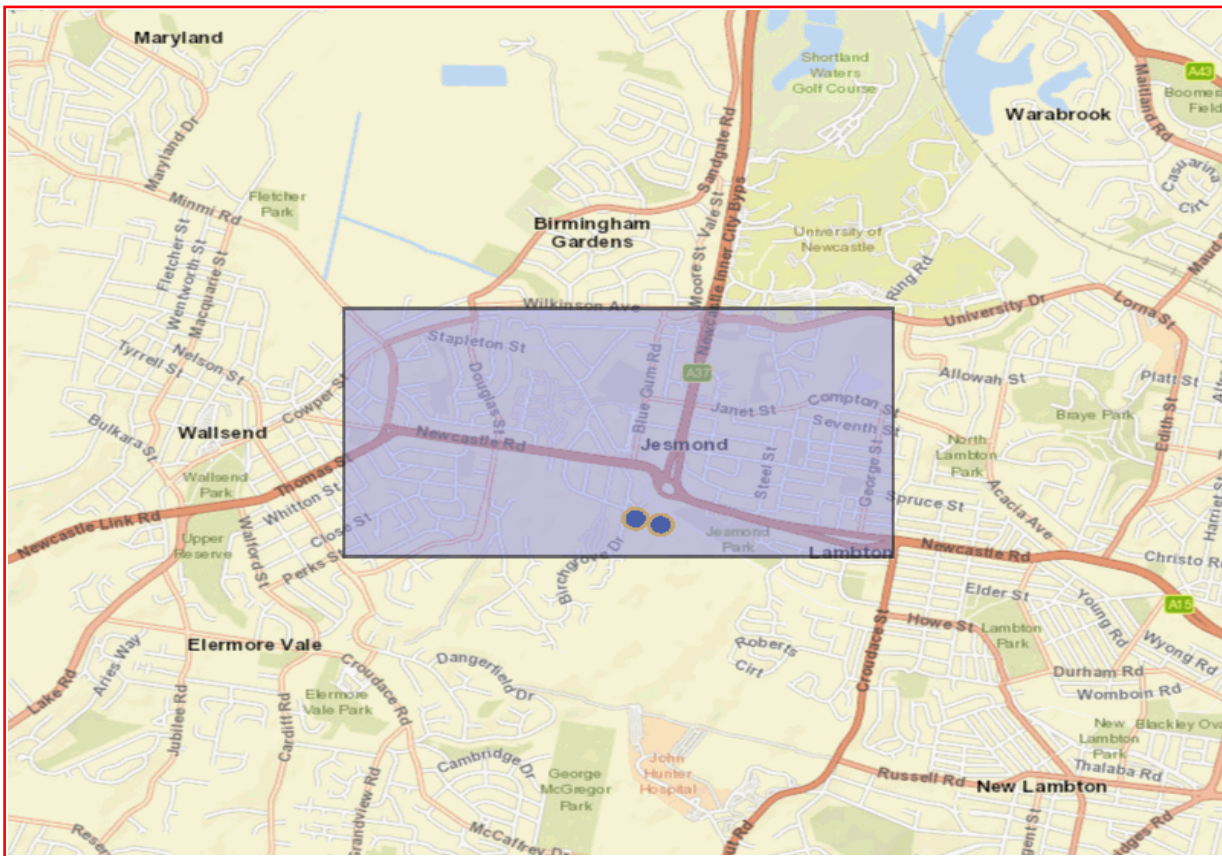
Sajana Athukorala  
4 Roe Court  
Mount Waverley Victoria 3149  
Attention: Sajana Athukorala  
Email: sajana.athukorala@aurecongroup.com

Date: 22 June 2022

Dear Sir or Madam:

**AHIMS Web Service search for the following area at Lat, Long From : -32.91, 151.6743 - Lat, Long To : -32.8962, 151.7052, conducted by Sajana Athukorala on 22 June 2022.**

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of Heritage NSW AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

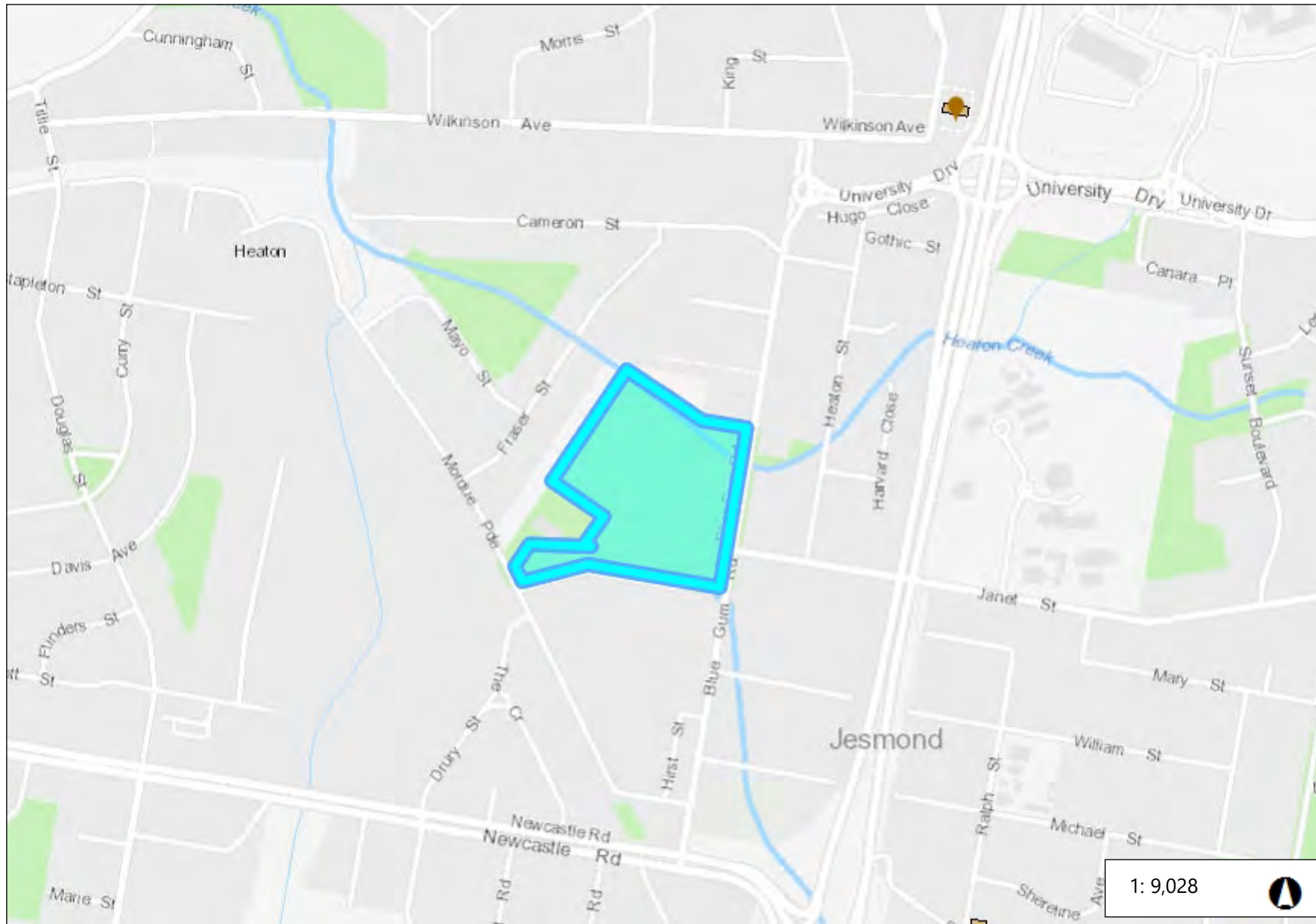
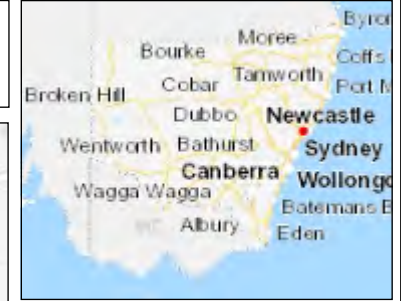
<b>2</b>	<b>Aboriginal sites are recorded in or near the above location.</b>
<b>0</b>	<b>Aboriginal places have been declared in or near the above location. *</b>

### **If your search shows Aboriginal sites or places what should you do?**

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the [NSW Government Gazette \(https://www.legislation.nsw.gov.au/gazette\)](https://www.legislation.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Heritage NSW upon request

### **Important information about your AHIMS search**

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not to be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Heritage NSW and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date. Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.



Legend

- State Heritage Register
- Aboriginal Place
- Local Environmental Plan**
  - Aboriginal Place
  - Conservation Area - General
  - Conservation Area - Landscape
  - Heritage Conservation Area
- Item - Aboriginal
- Item - Archaeological
- Item - General
- Item - Landscape
- Local Environmental Plan
  - Cluster (label denotes number)
- State Heritage Register
  - Cluster (label denotes number)
- Aboriginal Place
  - Cluster (label denotes number)
- Interim Heritage Order
  - Cluster (label denotes number)

1: 9,028

458.6 0 229.31 458.6 Meters

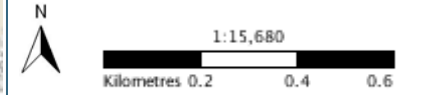
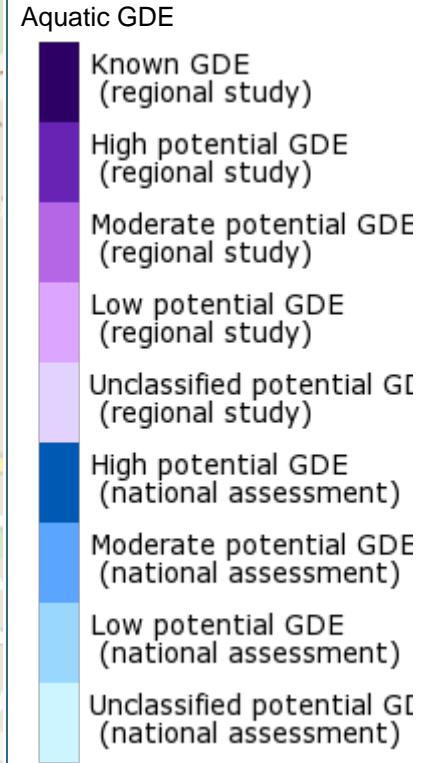
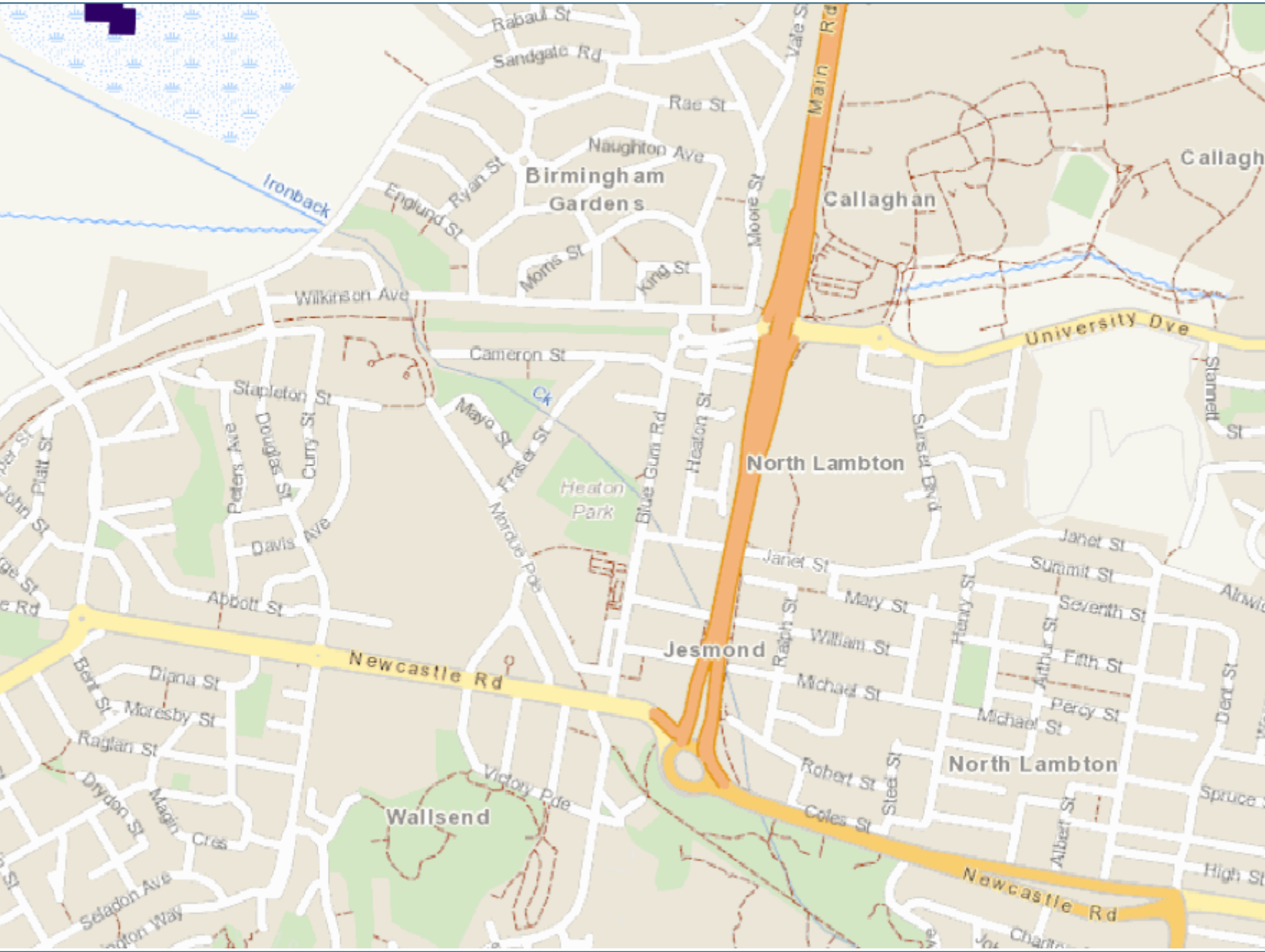
Notes

Number	Name	Location	Type	Status	Issued
11246	ACCESS TRADING COMPANY PTY. LIMITED	53 WEAKLEYS DRIVE, BERESFIELD, NSW	POEO licence	Surrendered	29-Dec-00
12192	AERO LOGISTICS PTY LIMITED	10 Laurio Place, MAYFIELD WEST, NSW 2304	POEO licence	Issued	25-Oct-04
20997	AERO LOGISTICS PTY LIMITED	45 Fitzroy Street, CARRINGTON, NSW 2294	POEO licence	Issued	19-Oct-17
20909	AIR LIQUIDE AUSTRALIA LIMITED	via 15 Greenleaf Road, KOORAGANG, NSW 2304	POEO licence	Issued	8-Jun-17
5430	AMEROPA AUSTRALIA PTY LTD	107 GREENLEAF ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	1-Sep-00
452	AMPOL AUSTRALIA PETROLEUM PTY LTD	156 HANNELL STREET, WICKHAM, NSW	POEO licence	Issued	17-May-00
1266	ASTRO BOY HOLDINGS PTY LTD	10 OLD MAITLAND ROAD, SANDGATE, NSW 2304	POEO licence	Issued	14-Jun-00
20400	AURIZON OPERATIONS LIMITED	Off Woodlands Close and parallel to Industrial Drive, HEXHAM, NSW 2322	POEO licence	Surrendered	28-Jul-14
21379	AURIZON OPERATIONS LIMITED	ROLLING STOCK OPERATED ON A LICENSED RAIL NETWORK, MAYFIELD, NSW 2304	POEO licence	Issued	5-Aug-20
1431	AURIZON PORT SERVICES NSW PTY LTD	DYKE NO. 2 BERTH, CARRINGTON, NSW	POEO licence	Issued	6-Apr-00
11984	AUSGRID	80 Abbott St, WALLSEND, NSW 2287	POEO licence	Surrendered	18-Aug-04
12876	AUSTPAC RESOURCES N.L.	PART OF 240 CORMORANT ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	10-Jun-08
527	AUSTRALIAN TERMINAL OPERATIONS MANAGEMENT PTY LTD	CORNER OF HANNELL & ELIZABETH STREETS, CARRINGTON, NSW 2294	POEO licence	Issued	1-Mar-00
12665	AUSTUBE MILLS PTY LTD	51 INDUSTRIAL DRIVE, MAYFIELD NORTH, NSW 2304	POEO licence	Issued	9-Mar-07
1329	BARTTER ENTERPRISES PTY. LIMITED	HAWTHORNE STREET, BERESFIELD, NSW	POEO licence	Issued	24-Oct-00
20771	BENEDICT RECYCLING PTY LIMITED	1A MCINTOSH DRIVE, MAYFIELD WEST, NSW 2304	POEO licence	Issued	25-May-16
10667	BERENDSEN FLUID POWER PTY LIMITED	9-11 BROADMEADOW RD, BROADMEADOW, NSW 2292	POEO licence	Surrendered	27-Apr-00
7354	BERESFORD PARK NURSERY SUPPLIES PTY LTD	80 ENTERPRISE DRIVE, BERESFIELD, NSW 2322	POEO licence	Surrendered	12-Apr-00
12054	BHP BILLITON INNOVATION PTY. LTD.	Off Vale Street, SHORTLAND, NSW 2307	POEO licence	Surrendered	6-Feb-04
6436	BHP BILLITON LIMITED	INDUSTRIAL DRIVE, MAYFIELD WEST, NSW 2304	POEO licence	Surrendered	3-Apr-00
1708	BHP BILLITON LIMITED	INDUSTRIAL DRIVE, MAYFIELD, NSW 2304	POEO licence	Surrendered	22-Aug-00
13046	BHP BILLITON LIMITED	Cormorant Road, KOORAGANG, NSW 2304	POEO licence	Surrendered	22-Oct-09
2566	BITUPAVE LTD	LENAGHANS DRIVE, BLACK HILL, NSW 2322	POEO licence	No longer in force	2-Mar-00
7	BITUPAVE LTD	1 GROSS STREET, CARRINGTON, NSW 2294	POEO licence	No longer in force	9-Mar-00
21003	BITUPAVE LTD	24 Gross Street, CARRINGTON, NSW 2294	POEO licence	Issued	23-Aug-18
2090	BOC LIMITED	73A ELIZABETH STREET, TIGHES HILL, NSW 2297	POEO licence	Surrendered	31-Mar-00
20165	BOC LIMITED	9 Egret Street, KOORAGANG, NSW 2304	POEO licence	Issued	5-Oct-12
1094	BORAL CEMENT LIMITED	100 Cormorant Road, KOORAGANG, NSW 2304	POEO licence	Issued	19-Jun-00
11968	BORAL RECYCLING PTY LIMITED	1/24 EGRET STREET, KOORAGANG, NSW	POEO licence	Issued	16-Sep-03
995	BORAL RESOURCES (COUNTRY) PTY.	MORDUE PARADE, JESMOND, NSW 2299	POEO licence	No longer in force	2-Mar-00
12497	BORAL RESOURCES (COUNTRY) PTY. LIMITED	72 ENTERPRISE DRIVE, BERESFIELD, NSW 2322	POEO licence	No longer in force	11-Aug-06
1134	BORAL RESOURCES (NSW) PTY LTD	OFF INDUSTRIAL DRIVE, MAYFIELD, NSW 2304	POEO licence	Surrendered	8-Aug-00
1419	BORAL TIMBER FIBRE EXPORTS PTY LTD	16 HERON ROAD, KOORAGANG, NSW 2304	POEO licence	Surrendered	15-Jun-00
10037	BULBECK ENVIRO PTY LTD	36 WYONG ROAD, LAMBTON, NSW 2299	POEO licence	Surrendered	26-Oct-99
13206	BULBECK ENVIRO PTY LTD	4 CHANNEL ROAD, MAYFIELD WEST, NSW 2304	POEO licence	Issued	13-Jan-10
5810	CARGILL AUSTRALIA LIMITED	51 RAVEN STREET, KOORAGANG, NSW 2304	POEO licence	Issued	23-May-01
4193	CEMENT AUSTRALIA HOLDINGS PTY LTD	KOORAGANG NO. 2 BERTH, HERON ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	25-May-00
6124	CLEANAWAY OPERATIONS PTY LTD	Raven Street, KOORAGANG, NSW 2304	POEO licence	Issued	17-Jul-00
12367	CLEANAWAY PTY LTD	19 Egret Street, KOORAGANG, NSW 2304	POEO licence	Surrendered	28-Sep-05
21289	CLEANAWAY PTY LTD	2 BALBU CLOSE, BERESFIELD, NSW 2322	POEO licence	Issued	17-May-20
12331	CMG CONCRETE PTY LIMITED	118 Garden Grove Parade, ADAMSTOWN, NSW 2289	POEO licence	No longer in force	25-Jul-05
822	COMMONWEALTH STEEL COMPANY PTY LIMITED	2 MAUD STREET, MAYFIELD WEST, NSW 2304	POEO licence	Issued	6-Jun-00
13214	COMMONWEALTH STEEL COMPANY PTY LIMITED	George Bishop Drive, MAYFIELD NORTH, NSW 2304	POEO licence	Issued	30-Dec-09
1676	COMMUNITY ASSOCIATION IN DP 270447	230 OLD MAITLAND ROAD, HEXHAM, NSW 2322	POEO licence	Issued	22-Aug-00
20333	CPB CONTRACTORS PTY LIMITED	Within and Adjacent to the Rail Corridor from the Tarro interchange to rail track chainage 172.500, HEXHAM, NSW 2322	POEO licence	Surrendered	5-Dec-13
20295	CRAWFORDS FREIGHTLINES PTY LTD	158 MAITLAND ROAD, SANDGATE, NSW	POEO licence	Issued	18-Jul-13
20151	CREI INDUSTRIAL NOMINEES NO 2 PTY LTD	16 GALLEGHAN STREET, HEXHAM, NSW	POEO licence	Issued	30-Nov-12
10887	CUMMINS SOUTH PACIFIC PTY. LTD.	21 GALLEGHAN STREET, HEXHAM, NSW	POEO licence	Surrendered	29-Sep-00
3278	DELTA EMD AUSTRALIA PTY LIMITED	80 TOURLE STREET, MAYFIELD, NSW 2304	POEO licence	Surrendered	20-Apr-00
6001	DONAU PTY LTD	81 DENISON ST, CARRINGTON, NSW 2294	POEO licence	Surrendered	16-May-00
6609	DONAU PTY LTD	50 FITZROY ST, CARRINGTON, NSW 2294	POEO licence	Surrendered	12-Oct-00
21130	DOWNER EDI WORKS PTY LTD	Parts of Lot 118 DP1078271 and Lot 103 DP1188890, SYDNEY, NSW 2000	POEO licence	Surrendered	10-Oct-18

20484	EASTERN BASIN PTY LTD	OFF BOURKE STREET, CARRINGTON, NSW 2294	POEO licence	Issued	14-Aug-14
1215	ELECTRIC LAMP MANUFACTURERS (AUSTRALIA) PTY LTD	54 CLYDE STREET, HAMILTON, NSW 2303	POEO licence	Revoked	23-Jun-00
11422	FAIRFAX REGIONAL PRINTERS PTY LIMITED	7 Enterprise Drive Holmwood Business Park, BERESFIELD, NSW 2322	POEO licence	Surrendered	2-Jul-01
10181	FUCHS LUBRICANTS (AUSTRALASIA) PTY LTD	2 HOLLAND STREET, WICKHAM, NSW 2293	POEO licence	Issued	5-Nov-99
20862	FUCHS LUBRICANTS (AUSTRALASIA) PTY LTD	40 Elwell Close, BERESFIELD, NSW 2322	POEO licence	Issued	20-Jul-17
1296	GRAINCORP OPERATIONS LIMITED	150 DENISON STREET, CARRINGTON, NSW 2294	POEO licence	Issued	18-Aug-00
1259	HANSON CONSTRUCTION MATERIALS PTY LTD	29 CARBINE CLOSE, WALLSEND, NSW 2287	POEO licence	No longer in force	27-Apr-00
1261	HANSON CONSTRUCTION MATERIALS PTY LTD	CNR FLETCHER & GOW STREETS, ADAMSTOWN, NSW 2289	POEO licence	No longer in force	1-May-00
11727	HCOA OPERATIONS (AUSTRALIA) PTY	219 CHRISTO ROAD, WARATAH, NSW 2298	POEO licence	Surrendered	27-Feb-03
11729	HEALTH CARE LINGARD PTY LTD	23 MEREWETHER STREET, MEREWETHER, NSW 2291	POEO licence	No longer in force	27-Feb-03
1586	HEXHAM BOWLING CLUB CO-OPERATIVE LIMITED	290 OLD MAITLAND ROAD, HEXHAM, NSW 2322	POEO licence	Issued	31-Oct-00
816	HEXHAM MANUFACTURING PTY LTD	189 MAITLAND ROAD, HEXHAM, NSW 2322	POEO licence	Issued	24-May-00
1017	HOLCIM (AUSTRALIA) PTY LTD	340 INDUSTRIAL DRIVE, TIGHES HILL, NSW 2297	POEO licence	No longer in force	15-Mar-00
6437	HUNTER & CENTRAL COAST DEVELOPMENT CORPORATION	CORMORANT DRIVE, KOORAGANG, NSW 2304	POEO licence	Surrendered	8-Mar-01
10023	HUNTER AND NEW ENGLAND AREA HEALTH SERVICE	Lookout Road, NEW LAMBTON HEIGHTS, NSW 2305	POEO licence	No longer in force	2-Aug-00
10036	HUNTER AND NEW ENGLAND AREA HEALTH SERVICE	Watt Street, NEWCASTLE, NSW 2300	POEO licence	No longer in force	22-Aug-00
11487	HUNTER AND NEW ENGLAND AREA HEALTH SERVICE	1 KING STREET, NEWCASTLE, NSW 2300	POEO licence	No longer in force	2-Jul-02
1683	HUNTER WATER CORPORATION	OFF SCENIC DRIVE, MEREWETHER, NSW 2295	POEO licence	Issued	29-Sep-99
232	HUNTER WATER CORPORATION	OFF FULLERTON STREET, STOCKTON, NSW 2295	POEO licence	Surrendered	29-Sep-99
3385	HUNTER WATER CORPORATION	McInnes Street, MINMI, NSW 2287	POEO licence	Surrendered	4-Jan-00
6114	HUNTER WATER CORPORATION	OFF ADEN ST, SHORTLAND, NSW 2307	POEO licence	No longer in force	27-Mar-00
111	HYMIX AUSTRALIA PTY LIMITED	CNR. TOURLE STREET & INDUSTRIAL DRIVE, MAYFIELD, NSW 2304	POEO licence	No longer in force	15-Oct-99
11781	INCITEC PIVOT LIMITED	HERON ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	10-Jun-03
2177	INDUSTRIAL GALVANIZERS CORPORATION PTY LTD	47 GRIFFITHS ROAD, LAMBTON, NSW 2299	POEO licence	Surrendered	20-Jan-00
505	INDUSTRIAL GALVANIZERS CORPORATION PTY LTD	312 PACIFIC HIGHWAY, HEXHAM, NSW 2322	POEO licence	Issued	17-Nov-00
11149	INFRABUILD WIRE PTY LIMITED	INGALL STREET, MAYFIELD NORTH, NSW 2304	POEO licence	Issued	18-Jul-00
12147	JUICE TERMINALS PTY LIMITED	OFF DENISON STREET, CARRINGTON, NSW 2294	POEO licence	Issued	9-Jun-04
2367	KOORAGANG BULK FACILITIES PTY LTD	48 HERON ROAD, KOORAGANG ISLAND, KOORAGANG, NSW 2304	POEO licence	Issued	7-Sep-00
2156	KOPPERS CARBON MATERIALS & CHEMICALS PTY LTD	133 WOODSTOCK STREET, MAYFIELD NORTH, NSW 2304	POEO licence	Issued	9-May-00
20514	LAING O'ROURKE AUSTRALIA CONSTRUCTION PTY LTD	Railway Corridor from west of Beaumont Street Hamilton to Stewart Avenue Wickham, WICKHAM, NSW 2293	POEO licence	Surrendered	31-Oct-14
12521	LINX LOGISTICS PTY LTD	240 CORMORANT ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	22-Dec-06
13059	LMS ENERGY PTY LTD	141 Minmi Road, WALLSEND, NSW 2287	POEO licence	Issued	31-Mar-09
11549	MAYFIELD INDUSTRIAL ESTATE ASSOCIATION INCORPORATED	Closure Area of Former BHP Steelworks, off Selwyn Street, MAYFIELD NORTH, NSW 2304	POEO licence	Issued	22-Nov-01
329	MCDONALD'S AUSTRALIA LIMITED	23 MAITLAND ROAD, HEXHAM, NSW 2322	POEO licence	Issued	19-Sep-01
11485	MEDIREST (AUSTRALIA) PTY LTD	Edith Street, WARATAH, NSW 2298	POEO licence	No longer in force	5-Nov-01
7434	MED-X PTY LTD	25 SANDPIPER CLOSE, KOORAGANG, NSW 2304	POEO licence	Issued	21-Jun-00
21238	MINION ENTERPRISES PTY LTD	28 Parker Street, CARRINGTON, NSW 2294	POEO licence	Issued	20-May-19
13261	MTX AUSTRALIA PTY LTD	-, CARRINGTON, NSW 2294	POEO licence	Surrendered	1-Jun-10
20116	NEWCASTLE AGRI TERMINAL PTY LTD	38 ROBERTSON STREET, CARRINGTON, NSW 2294	POEO licence	Issued	5-Jul-12
5583	NEWCASTLE CITY COUNCIL	-, NEWCASTLE, NSW 2300	POEO licence	Issued	28-Jun-00
5897	NEWCASTLE CITY COUNCIL	141 MINMI RD, WALLSEND, NSW 2287	POEO licence	Issued	11-Aug-00
12693	NEWCASTLE COAL INFRASTRUCTURE GROUP PTY LTD	CORMORANT ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	26-Oct-07
12740	NEWCASTLE COAL INFRASTRUCTURE GROUP PTY LTD	Cormorant Road, KOORAGANG, NSW 2304	POEO licence	Surrendered	26-Oct-07
11396	NEWCASTLE CRUISING YACHT CLUB LIMITED	91 & 95 HANNELL STREET, WICKHAM, NSW 2293	POEO licence	Issued	24-Apr-01
10772	NEWCASTLE PORT CORPORATION	DYKE POINT, CARRINGTON, NSW 2294	POEO licence	Issued	15-Jun-00
11357	NEWCASTLE PRIVATE HOSPITAL PTY LTD	2 Lookout Road, NEW LAMBTON HEIGHTS, NSW 2305	POEO licence	No longer in force	24-Jan-01
2286	NEWCASTLE WOODCHIPPING PTY LTD	6 SANDPIPER CLOSE, KOORAGANG, NSW 2304	POEO licence	Surrendered	22-Aug-00
10730	NONFERRAL PTY LIMITED	116 Newcastle Rd, WALLSEND, NSW 2287	POEO licence	Surrendered	3-May-00



21368	ONE RAIL AUSTRALIA PTY LTD	ROLLING STOCK OPERATED ON A LICENSED RAIL NETWORK, MAYFIELD WEST, NSW	POEO licence	Issued	5-Aug-20
5345	ONESTEEL RECYCLING PTY LIMITED	14 SPARKE STREET, HEXHAM, NSW 2322	POEO licence	Issued	31-Mar-00
1763	ONESTEEL TRADING PTY LIMITED	51 INDUSTRIAL DRIVE, MAYFIELD, NSW	POEO licence	Surrendered	9-Feb-00
828	ORICA AUSTRALIA PTY LTD	15 GREENLEAF ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	14-Nov-00
20081	ORIGIN ENERGY LPG LIMITED	100 Cormorant Road, KOORAGANG, NSW 2304	POEO licence	Issued	17-May-12
6104	PACIFIC NATIONAL (NSW) PTY LTD	SELWYN STREET, TIGHES HILL, NSW 2297	POEO licence	No longer in force	10-Jan-00
12977	PARK PTY LTD	18-28 GREENLEAF ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	12-Feb-09
1967	PORT OF NEWCASTLE OPERATIONS PTY LIMITED	HERON ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	23-Feb-00
4688	PORT OF NEWCASTLE OPERATIONS PTY LIMITED	Off Bourke Street, CARRINGTON, NSW 2294	POEO licence	Surrendered	6-Jul-00
4687	PORT OF NEWCASTLE OPERATIONS PTY LIMITED	KOORAGANG NO. 3 BERTH, HERON ROAD, KOORAGANG, NSW 2304	POEO licence	Surrendered	6-Jul-00
3373	PORT OF NEWCASTLE OPERATIONS PTY LIMITED	Port of Newcastle , NEWCASTLE, NSW 2300	POEO licence	Surrendered	11-Aug-00
13181	PORT OF NEWCASTLE OPERATIONS PTY LIMITED	OFF SELWYN STREET, MAYFIELD NORTH, NSW 2304	POEO licence	Issued	4-Nov-09
601	PORT WARATAH COAL SERVICES LTD	PORT WARATAH DRIVE, CARRINGTON, NSW 2294	POEO licence	Issued	20-Apr-00
1552	PORT WARATAH COAL SERVICES LTD	CURLEW STREET, KOORAGANG, NSW 2304	POEO licence	Issued	14-Jul-00
7675	PORT WARATAH COAL SERVICES LTD	CORMORANT ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	21-Feb-01
5022	PORT WARATAH COAL SERVICES LTD	KOORAGANG, NSW 2304	POEO licence	Issued	20-Jun-01
13022	PORT WARATAH COAL SERVICES LTD	Curlew Street, KOORAGANG, NSW 2304	POEO licence	Surrendered	2-Dec-09
10	PREMIER CONCRETE (N.S.W.) PTY. LIMITED	5 CARBINE CLOSE, WALLSEND, NSW 2287	POEO licence	No longer in force	19-Oct-99
11749	PROTECH STEEL PTY LTD	CORMORANT ROAD, KOORAGANG, NSW 2304	POEO licence	Surrendered	18-Sep-02
20493	QUBE PORTS PTY LTD	HERON ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	24-Oct-14
10996	RAIL CORPORATION NEW SOUTH WALES	BROWN ROAD, BROADMEADOW, NSW 2292	POEO licence	No longer in force	19-Jun-00
1638	SANCHEZ GROUP PROPERTY PTY LIMITED	16 GALLEGHAN STREET, HEXHAM, NSW	POEO licence	Surrendered	29-Dec-00
12764	SCE RESOURCES PTY LTD	151 Ingall Street, MAYFIELD, NSW 2304	POEO licence	Issued	2-Jun-08
12238	SHORTLAND WETLAND CENTRE LTD	Sandgate Road, SHORTLAND, NSW 2307	POEO licence	Surrendered	10-Dec-04
1999	SIBELCO AUSTRALIA LIMITED	ELIZABETH STREET, CARRINGTON, NSW	POEO licence	Surrendered	14-Jun-00
11264	SIMS GROUP AUSTRALIA HOLDINGS LIMITED	CORMORANT ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	14-Mar-01
13073	SLATTERY AUCTIONS AUSTRALIA PTY LTD	230 Old Maitland Road, HEXHAM, NSW 2322	POEO licence	Surrendered	12-Oct-09
6281	STATE OF NEW SOUTH WALES (OFFICE OF ENVIRONMENT AND HERITAGE)	Hunter Region of the NSW National Parks & Wildlife Service, NEWCASTLE, NSW 2300	POEO licence	Surrendered	18-Sep-00
10051	STATE TRANSIT AUTHORITY OF NSW	91 DENISON STREET, HAMILTON, NSW 2303	POEO licence	Surrendered	22-Dec-99
20193	STOLTHAVEN AUSTRALIA PTY LTD	103 SELWYN STREET, MAYFIELD NORTH, NSW 2304	POEO licence	Issued	11-Oct-13
20716	STOLTHAVEN AUSTRALIA PTY LTD	Mayfield No. 7 Berth, MAYFIELD NORTH, NSW 2304	POEO licence	Surrendered	26-Feb-16
20881	SUEZ RECYCLING & RECOVERY PTY LTD	UNITS 2 AND 4, 122 WOODSTOCK STREET, MAYFIELD NORTH, NSW 2304	POEO licence	Issued	29-Nov-18
20757	SUEZ WATER PTY LTD	15 - 19 Channel Road, MAYFIELD WEST, NSW 2304	POEO licence	Issued	6-Sep-16
21004	THALES AUSTRALIA LIMITED	50 Fitzroy Street, CARRINGTON, NSW 2294	POEO licence	Issued	20-Jun-18
11926	THE HUNTER VALLEY PRIVATE HOSPITAL PTY LTD	20 MAWSON STREET, SHORTLAND, NSW 2307	POEO licence	No longer in force	21-Jul-03
548	THE NEWCASTLE WALLSEND COAL CO PTY	BULKARA ST, WALLSEND, NSW 2287	POEO licence	Surrendered	16-Feb-00
13264	THIESS PTY LTD	HW 23 - Newcastle Inner City Bypass , NEWCASTLE, NSW 2300	POEO licence	Surrendered	6-May-10
6808	UGL RAIL SERVICES PTY LIMITED	16 BROADMEADOW ROAD, BROADMEADOW, NSW 2292	POEO licence	No longer in force	26-Jun-00
369	VIVA ENERGY AUSTRALIA PTY LTD	5 CHATHAM RD, HAMILTON, NSW 2303	POEO licence	Surrendered	27-Jul-00
20512	VUE AUSTRALIA PTY. LTD.	21 HERON ROAD, KOORAGANG, NSW 2304	POEO licence	Issued	21-Nov-14
20669	WBHO INFRASTRUCTURE PTY LTD	KOORAGANG, NSW 2304	POEO licence	Surrendered	23-Sep-15



Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: [Click here](#)

Australian Albers GDA94



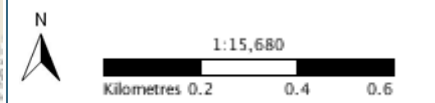


Terrestrial GDE (no data)

No ecosystems analysed

Terrestrial GDE

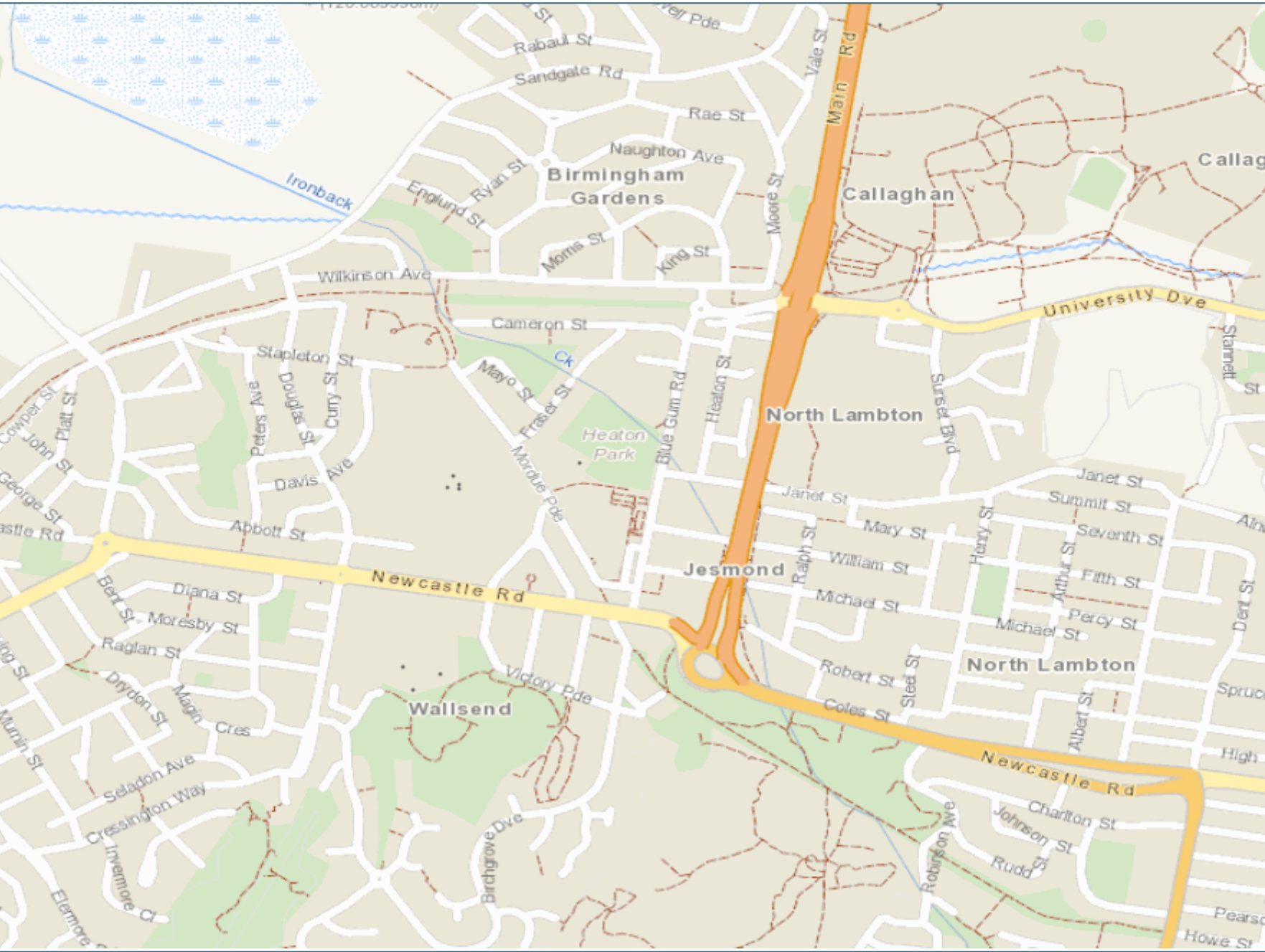
- Known GDE (regional study)
- High potential GDE (regional study)
- Moderate potential GDE (regional study)
- Low potential GDE (regional study)
- Unclassified potential GDE (regional study)
- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)
- Low potential GDE (national assessment)
- Unclassified potential GDE (national assessment)



Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: [Click here](#)

Australian Albers GDA94





All bores

- Bore

All bores

- All bores

Bore density per 25km2

- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 200
- More than 200

Mainland outline

N

1:14,177

Kilometres 0.2 0.4 0.6

Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: [Click here](#)

Australian Albers GDA94

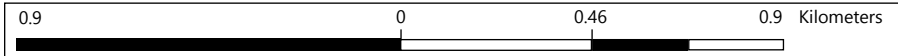




**Legend**

■ Key Fish Habitat - Central River

1: 18,056 



Notes



**Legend**

- Southern Pygmy Perch
- Alpine Redspot Dragonfly
- Australian Grayling
- Darling River Hardyhead
- Darling River Snail
- Eastern Freshwater Cod
- Eel Tailed Catfish
- Fitzroy Falls Spiny Crayfish
- Flathead Galaxias
- Hanleys River Snail
- Macquarie Perch
- Murray Crayfish
- Olive Perchlet
- Oxleyan Pygmy Perch
- Southern Purple Spotted Gudgeon
- River Blackfish
- Silver Perch
- Trout Cod

1: 18,056



0.9 0 0.46 0.9 Kilometers

**Notes**



# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 22-Jun-2022

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)

# Summary

## Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance (Ramsar)</a>	1
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	4
<a href="#">Listed Threatened Species:</a>	48
<a href="#">Listed Migratory Species:</a>	33

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

<a href="#">Commonwealth Lands:</a>	11
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	41
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Australian Marine Parks:</a>	None
<a href="#">Habitat Critical to the Survival of Marine Turtles:</a>	None

## Extra Information

This part of the report provides information that may also be relevant to the area you have

<a href="#">State and Territory Reserves:</a>	1
<a href="#">Regional Forest Agreements:</a>	1
<a href="#">Nationally Important Wetlands:</a>	1
<a href="#">EPBC Act Referrals:</a>	13
<a href="#">Key Ecological Features (Marine):</a>	None
<a href="#">Biologically Important Areas:</a>	None
<a href="#">Bioregional Assessments:</a>	1
<a href="#">Geological and Bioregional Assessments:</a>	None



# Details

## Matters of National Environmental Significance

### Wetlands of International Importance (Ramsar Wetlands) [ Resource Information ]

Ramsar Site Name	Proximity	Buffer Status
<a href="#">Hunter estuary wetlands</a>	Within 10km of Ramsar site	In feature area

### Listed Threatened Ecological Communities [ Resource Information ]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Central Hunter Valley eucalypt forest and woodland</a>	Critically Endangered	Community may occur within area	In feature area
<a href="#">Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community</a>	Endangered	Community likely to occur within area	In feature area
<a href="#">Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland</a>	Endangered	Community likely to occur within area	In feature area
<a href="#">River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria</a>	Critically Endangered	Community likely to occur within area	In feature area

### Listed Threatened Species [ Resource Information ]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.

Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
<b>BIRD</b>			
<a href="#">Anthochaera phrygia</a> Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
<a href="#">Botaurus poiciloptilus</a> Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Calidris canutus</a> Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Calidris tenuirostris</a> Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Callocephalon fimbriatum</a> Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Charadrius leschenaultii</a> Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Charadrius mongolus</a> Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Erythrotriorchis radiatus</a> Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Falco hypoleucos</a> Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area	In feature area
<a href="#">Grantiella picta</a> Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area	In feature area
<a href="#">Lathamus discolor</a> Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Limosa lapponica baueri</a> Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area	In feature area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Pycnoptilus floccosus</a> Pilotbird [525]	Vulnerable	Species or species habitat may occur within area	In feature area
<a href="#">Rostratula australis</a> Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Sternula nereis nereis</a> Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area	In feature area
<b>FROG</b>			
<a href="#">Litoria aurea</a> Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area	In feature area
<a href="#">Mixophyes balbus</a> Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat may occur within area	In feature area
<a href="#">Uperoleia mahonyi</a> Mahony's Toadlet [89189]	Endangered	Species or species habitat may occur within area	In feature area
<b>MAMMAL</b>			
<a href="#">Chalinolobus dwyeri</a> Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Dasyurus maculatus maculatus (SE mainland population)</a> Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area	In feature area
<a href="#">Petauroides volans</a> Greater Glider [254]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Petaurus australis australis</a> Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)</a> Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Potorous tridactylus tridactylus</a> Long-nosed Potoroo (northern) [66645]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Pseudomys novaehollandiae</a> New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Pteropus poliocephalus</a> Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
<b>PLANT</b>			
<a href="#">Angophora inopina</a> Charmhaven Apple [64832]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Caladenia tessellata</a> Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Cryptostylis hunteriana</a> Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Cynanchum elegans</a> White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area	In feature area
<a href="#">Diuris praecox</a> Newcastle Doubletail [55086]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Eucalyptus camfieldii</a> Camfield's Stringybark [15460]	Vulnerable	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Euphrasia arguta</a> [4325]	Critically Endangered	Species or species habitat may occur within area	In feature area
<a href="#">Grevillea parviflora subsp. parviflora</a> Small-flower Grevillea [64910]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Grevillea shiressii</a> [19186]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Melaleuca biconvexa</a> Biconvex Paperbark [5583]	Vulnerable	Species or species habitat may occur within area	In feature area
<a href="#">Persicaria elatior</a> Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Prasophyllum sp. Wybong (C.Phelps ORG 5269)</a> a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area	In feature area
<a href="#">Pterostylis gibbosa</a> Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat may occur within area	In feature area
<a href="#">Rhizanthella slateri</a> Eastern Underground Orchid [11768]	Endangered	Species or species habitat may occur within area	In feature area
<a href="#">Rhodamnia rubescens</a> Scrub Turpentine, Brown Malletwood [15763]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
<a href="#">Rhodomyrtus psidioides</a> Native Guava [19162]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
<a href="#">Rutidosis heterogama</a> Heath Wrinklewort [13132]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Syzygium paniculatum</a> Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat known to occur within area	In feature area
<a href="#">Tetratheca juncea</a> Black-eyed Susan [21407]	Vulnerable	Species or species habitat known to occur within area	In feature area

### Listed Migratory Species [ [Resource Information](#) ]

Scientific Name	Threatened Category	Presence Text	Buffer Status
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#### Migratory Marine Birds

<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
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#### Migratory Terrestrial Species

<a href="#">Cuculus optatus</a> Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
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<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area	In feature area
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<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat known to occur within area	In feature area
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<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat known to occur within area	In feature area
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<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat known to occur within area	In feature area
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<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat known to occur within area	In feature area
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<a href="#">Symposiachrus trivirgatus as Monarcha trivirgatus</a> Spectacled Monarch [83946]		Species or species habitat may occur within area	In feature area
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#### Migratory Wetlands Species

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
<a href="#">Arenaria interpres</a> Ruddy Turnstone [872]		Species or species habitat known to occur within area	In feature area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area
<a href="#">Calidris canutus</a> Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat known to occur within area	In feature area
<a href="#">Calidris ruficollis</a> Red-necked Stint [860]		Species or species habitat known to occur within area	In feature area
<a href="#">Calidris tenuirostris</a> Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Charadrius bicinctus</a> Double-banded Plover [895]		Species or species habitat known to occur within area	In feature area
<a href="#">Charadrius leschenaultii</a> Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Charadrius mongolus</a> Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area	In feature area
<a href="#">Limicola falcinellus</a> Broad-billed Sandpiper [842]		Species or species habitat known to occur within area	In feature area
<a href="#">Limosa lapponica</a> Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In feature area
<a href="#">Limosa limosa</a> Black-tailed Godwit [845]		Species or species habitat known to occur within area	In feature area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Numenius phaeopus</a> Whimbrel [849]		Species or species habitat known to occur within area	In feature area
<a href="#">Pandion haliaetus</a> Osprey [952]		Species or species habitat known to occur within area	In feature area
<a href="#">Philomachus pugnax</a> Ruff (Reeve) [850]		Species or species habitat known to occur within area	In feature area
<a href="#">Pluvialis fulva</a> Pacific Golden Plover [25545]		Species or species habitat known to occur within area	In feature area
<a href="#">Pluvialis squatarola</a> Grey Plover [865]		Species or species habitat known to occur within area	In feature area
<a href="#">Tringa brevipes</a> Grey-tailed Tattler [851]		Species or species habitat known to occur within area	In feature area



Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area	In feature area
<a href="#">Tringa stagnatilis</a> Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area	In feature area
<a href="#">Xenus cinereus</a> Terek Sandpiper [59300]		Species or species habitat known to occur within area	In feature area

## Other Matters Protected by the EPBC Act

### Commonwealth Lands [\[ Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State	Buffer Status
Communications, Information Technology and the Arts - Telstra Corporation Limited Commonwealth Land - Australian Telecommunications Commission [11672]	NSW	In buffer area only
Commonwealth Land - Australian Telecommunications Commission [11671]	NSW	In buffer area only

### Defence

Commonwealth Land - Defence Service Homes Corporation [11698]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [11699]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [11695]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [11694]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [11693]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [11697]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [11696]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [11692]	NSW	In buffer area only
Commonwealth Land - Defence Service Homes Corporation [11691]	NSW	In buffer area only

### Listed Marine Species [\[ Resource Information \]](#)

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
<a href="#">Arenaria interpres</a> Ruddy Turnstone [872]		Species or species habitat known to occur within area	In feature area
<a href="#">Bubulcus ibis as Ardea ibis</a> Cattle Egret [66521]		Breeding likely to occur within area overfly marine area	In feature area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area
<a href="#">Calidris canutus</a> Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Calidris ruficollis</a> Red-necked Stint [860]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Calidris tenuirostris</a> Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Charadrius bicinctus</a> Double-banded Plover [895]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Charadrius leschenaultii</a> Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In feature area
<a href="#">Charadrius mongolus</a> Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Charadrius ruficapillus</a> Red-capped Plover [881]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Haliaeetus leucogaster</a> White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area	In feature area
<a href="#">Himantopus himantopus</a> Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Lathamus discolor</a> Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area
<a href="#">Limicola falcinellus</a> Broad-billed Sandpiper [842]		Species or species habitat known to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Limosa lapponica</a> Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In feature area
<a href="#">Limosa limosa</a> Black-tailed Godwit [845]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Neophema chrysostoma</a> Blue-winged Parrot [726]		Species or species habitat may occur within area overfly marine area	In feature area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area
<a href="#">Numenius phaeopus</a> Whimbrel [849]		Species or species habitat known to occur within area	In feature area
<a href="#">Pandion haliaetus</a> Osprey [952]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Philomachus pugnax</a> Ruff (Reeve) [850]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Pluvialis fulva</a> Pacific Golden Plover [25545]		Species or species habitat known to occur within area	In feature area
<a href="#">Pluvialis squatarola</a> Grey Plover [865]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Recurvirostra novaehollandiae</a> Red-necked Avocet [871]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Rostratula australis as Rostratula benghalensis (sensu lato)</a> Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Symposiachrus trivirgatus as Monarcha trivirgatus</a> Spectacled Monarch [83946]		Species or species habitat may occur within area overfly marine area	In feature area
<a href="#">Tringa brevipes as Heteroscelus brevipes</a> Grey-tailed Tattler [851]		Species or species habitat known to occur within area	In feature area
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area	In feature area
<a href="#">Tringa stagnatilis</a> Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
<a href="#">Xenus cinereus</a> Terek Sandpiper [59300]		Species or species habitat known to occur within area overfly marine area	In feature area

## Extra Information

### State and Territory Reserves [\[ Resource Information \]](#)

Protected Area Name	Reserve Type	State	Buffer Status
Hexham Swamp	NRS Addition - Gazettal in Progress	NSW	In buffer area only

### Regional Forest Agreements [\[ Resource Information \]](#)

Note that all areas with completed RFAs have been included.

RFA Name	State	Buffer Status
<a href="#">North East NSW RFA</a>	New South Wales	In feature area

### Nationally Important Wetlands [\[ Resource Information \]](#)

Wetland Name	State	Buffer Status
<a href="#">Hexham Swamp</a>	NSW	In buffer area only

### EPBC Act Referrals [\[ Resource Information \]](#)

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
<b>Controlled action</b>				
<a href="#">Newcastle inner city bypass Rankin Park to Jesmond NSW</a>	2015/7550	Controlled Action	Post-Approval	In feature area
<a href="#">Port Site and Materials Handling Development</a>	2001/242	Controlled Action	Completed	In feature area
<a href="#">Protech Cold Mill Facility</a>	2001/274	Controlled Action	Post-Approval	In feature area
<a href="#">River Dredging Operations</a>	2001/249	Controlled Action	Completed	In feature area
<b>Not controlled action</b>				
<a href="#">Fort Scratchley refurbishment works</a>	2005/2283	Not Controlled Action	Completed	In buffer area only
<a href="#">Geological exploration and historical research of convict coal mines beneath For</a>	2004/1421	Not Controlled Action	Completed	In buffer area only
<a href="#">Green &amp; Golden Bell Frog Habitat Enhancement Project</a>	2004/1795	Not Controlled Action	Completed	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
<b>Not controlled action</b>				
<a href="#">Hunter Natural Gas Pipeline</a>	2004/1902	Not Controlled Action	Completed	In buffer area only
<a href="#">Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia</a>	2015/7522	Not Controlled Action	Completed	In feature area
<a href="#">Richmond Vale Rail Trail</a>	2019/8568	Not Controlled Action	Completed	In buffer area only
<a href="#">sale of property located at 96, Hunter Street</a>	2003/1097	Not Controlled Action	Completed	In feature area
<a href="#">Sandgate Rail Grade Separation</a>	2005/1948	Not Controlled Action	Completed	In feature area
<b>Not controlled action (particular manner)</b>				
<a href="#">Rehabilitation of Hexham Swamp</a>	2003/1244	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

## Bioregional Assessments

SubRegion	BioRegion	Website	Buffer Status
Hunter	Northern Sydney Basin	<a href="#">BA website</a>	In feature area

# Caveat

## 1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

## 2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

## 3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

## 4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.



# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

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# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 27/08/21 17:19:11

[Summary](#)

[Details](#)

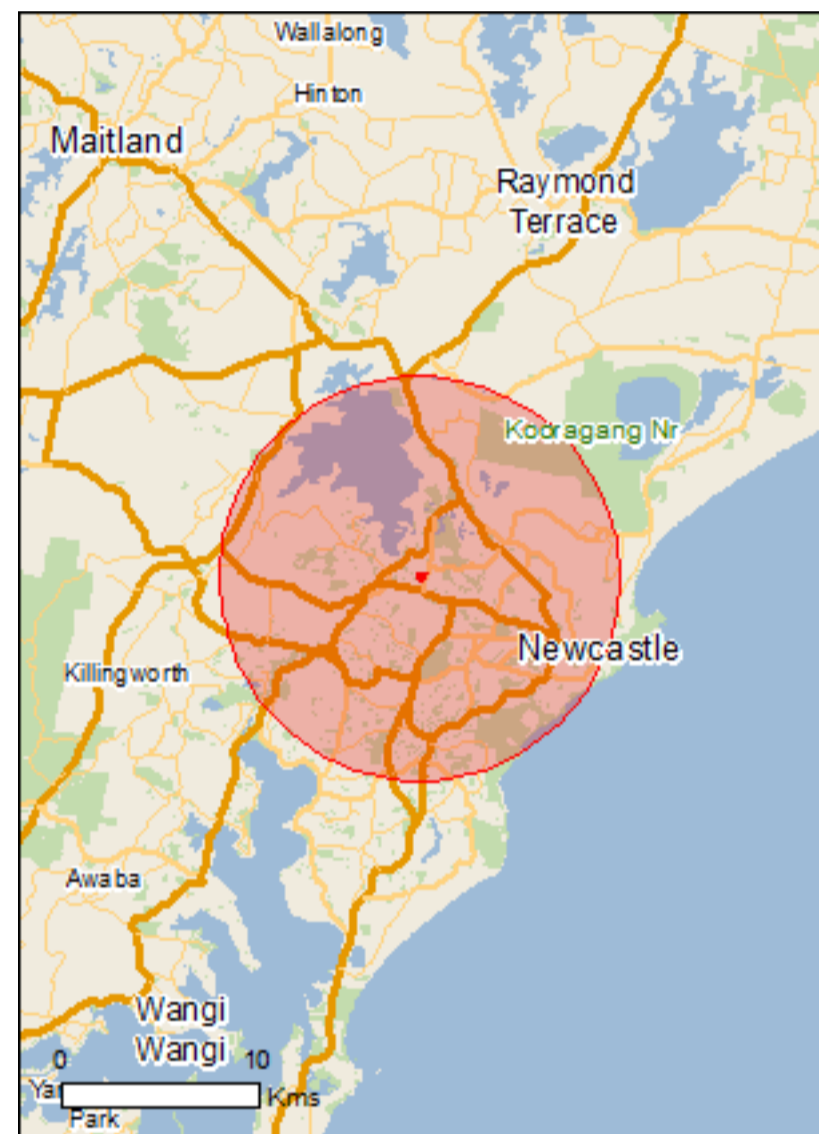
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

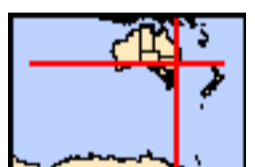
[Acknowledgements](#)



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[Coordinates](#)

[Buffer: 10.0Km](#)



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	1
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	5
<a href="#">Listed Threatened Species:</a>	84
<a href="#">Listed Migratory Species:</a>	75

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

<a href="#">Commonwealth Land:</a>	12
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	97
<a href="#">Whales and Other Cetaceans:</a>	13
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Australian Marine Parks:</a>	None

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

<a href="#">State and Territory Reserves:</a>	6
<a href="#">Regional Forest Agreements:</a>	1
<a href="#">Invasive Species:</a>	45
<a href="#">Nationally Important Wetlands:</a>	4
<a href="#">Key Ecological Features (Marine)</a>	None

# Details

## Matters of National Environmental Significance

### Wetlands of International Importance (Ramsar)

[\[ Resource Information \]](#)

Name	Proximity
<a href="#">Hunter estuary wetlands</a>	Within Ramsar site

### Listed Threatened Ecological Communities

[\[ Resource Information \]](#)

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
<a href="#">Central Hunter Valley eucalypt forest and woodland</a>	Critically Endangered	Community may occur within area
<a href="#">Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community</a>	Endangered	Community likely to occur within area
<a href="#">Lowland Rainforest of Subtropical Australia</a>	Critically Endangered	Community may occur within area
<a href="#">River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria</a>	Critically Endangered	Community likely to occur within area
<a href="#">Subtropical and Temperate Coastal Saltmarsh</a>	Vulnerable	Community likely to occur within area

### Listed Threatened Species

[\[ Resource Information \]](#)

Name	Status	Type of Presence
<b>Birds</b>		
<a href="#">Anthochaera phrygia</a> Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Botaurus poiciloptilus</a> Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
<a href="#">Calidris canutus</a> Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Calidris tenuirostris</a> Great Knot [862]	Critically Endangered	Roosting known to occur within area
<a href="#">Charadrius mongolus</a> Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
<a href="#">Diomedea antipodensis</a> Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea antipodensis gibsoni</a> Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Status	Type of Presence
<a href="#">Diomedea epomophora</a> Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea exulans</a> Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea sanfordi</a> Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Erythrotriorchis radiatus</a> Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Falco hypoleucos</a> Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
<a href="#">Fregetta grallaria grallaria</a> White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Grantiella picta</a> Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Lathamus discolor</a> Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Limosa lapponica baueri</a> Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Macronectes giganteus</a> Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
<a href="#">Macronectes halli</a> Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Pachyptila turtur subantarctica</a> Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Phoebetria fusca</a> Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
<a href="#">Pterodroma leucoptera leucoptera</a> Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
<a href="#">Pterodroma neglecta neglecta</a> Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
<a href="#">Rostratula australis</a> Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
<a href="#">Sternula nereis nereis</a> Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche bulleri</a> Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche bulleri platei</a> Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche cauta</a> Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche eremita</a> Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche impavida</a> Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche melanophris</a> Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche salvini</a> Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche steadi</a> White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thinornis cucullatus cucullatus</a> Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat likely to occur within area
<b>Fish</b>		
<a href="#">Epinephelus daemeli</a> Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Hippocampus whitei</a> White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat likely to occur within area
<b>Frogs</b>		
<a href="#">Heleioporus australiacus</a> Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat may occur within area
<a href="#">Litoria aurea</a> Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Mixophyes balbus</a> Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat may occur within area
<a href="#">Uperoleia mahonyi</a> Mahony's Toadlet [89189]	Endangered	Species or species habitat may occur within area
<b>Mammals</b>		
<a href="#">Balaenoptera musculus</a> Blue Whale [36]	Endangered	Species or species habitat may occur within area
<a href="#">Chalinolobus dwyeri</a> Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
<a href="#">Dasyurus maculatus maculatus (SE mainland population)</a>		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
<a href="#">Eubalaena australis</a>		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
<a href="#">Megaptera novaeangliae</a>		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Petauroides volans</a>		
Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Petrogale penicillata</a>		
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)</a>		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Potorous tridactylus tridactylus</a>		
Long-nosed Potoroo (SE Mainland) [66645]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Pseudomys novaehollandiae</a>		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pteropus poliocephalus</a>		
Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
<b>Plants</b>		
<a href="#">Angophora inopina</a>		
Charmhaven Apple [64832]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Caladenia tessellata</a>		
Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Commersonia prostrata</a>		
Dwarf Kerrawang [87152]	Endangered	Species or species habitat likely to occur within area
<a href="#">Cryptostylis hunteriana</a>		
Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Cynanchum elegans</a>		
White-flowered Wax Plant [12533]	Endangered	Species or species habitat known to occur within area
<a href="#">Diuris praecox</a>		
Newcastle Doubletail [55086]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Eucalyptus camfieldii</a>		
Camfield's Stringybark [15460]	Vulnerable	Species or species habitat may occur within area
<a href="#">Eucalyptus parramattensis subsp. decadens</a>		
Earp's Gum, Earp's Dirty Gum [56148]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Euphrasia arguta</a>		
[4325]	Critically Endangered	Species or species habitat may occur within



Name	Status	Type of Presence area
<a href="#">Grevillea parviflora subsp. parviflora</a> Small-flower Grevillea [64910]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Grevillea shiressii</a> [19186]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Melaleuca biconvexa</a> Biconvex Paperbark [5583]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Persicaria elatior</a> Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Phaius australis</a> Lesser Swamp-orchid [5872]	Endangered	Species or species habitat may occur within area
<a href="#">Pomaderris brunnea</a> Rufous Pomaderris, Brown Pomaderris [16845]	Vulnerable	Species or species habitat may occur within area
<a href="#">Prasophyllum sp. Wybong (C.Phelps ORG 5269)</a> a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Pterostylis gibbosa</a> Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat may occur within area
<a href="#">Rhizanthella slateri</a> Eastern Underground Orchid [11768]	Endangered	Species or species habitat may occur within area
<a href="#">Rhodamnia rubescens</a> Scrub Turpentine, Brown Malletwood [15763]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Rhodomyrtus psidioides</a> Native Guava [19162]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Rutidosis heterogama</a> Heath Wrinklewort [13132]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Syzygium paniculatum</a> Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Tetradlea juncea</a> Black-eyed Susan [21407]	Vulnerable	Species or species habitat known to occur within area
<b>Reptiles</b>		
<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known

Name	Status	Type of Presence
<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	to occur within area Foraging, feeding or related behaviour known to occur within area
<b>Sharks</b>		
<a href="#">Carcharias taurus (east coast population)</a> Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Carcharodon carcharias</a> White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Rhincodon typus</a> Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
<b>Listed Migratory Species</b>		<b>[ Resource Information ]</b>
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
<b>Migratory Marine Birds</b>		
<a href="#">Anous stolidus</a> Common Noddy [825]		Species or species habitat likely to occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardenna carneipes</a> Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
<a href="#">Ardenna grisea</a> Sooty Shearwater [82651]		Species or species habitat likely to occur within area
<a href="#">Calonectris leucomelas</a> Streaked Shearwater [1077]		Species or species habitat known to occur within area
<a href="#">Diomedea antipodensis</a> Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea epomophora</a> Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea exulans</a> Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea sanfordi</a> Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Fregata ariel</a> Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
<a href="#">Fregata minor</a> Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
<a href="#">Macronectes giganteus</a> Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
<a href="#">Macronectes halli</a> Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
<a href="#">Phoebetria fusca</a> Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
<a href="#">Sternula albifrons</a> Little Tern [82849]		Species or species habitat may occur within area
<a href="#">Thalassarche bulleri</a> Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche cauta</a> Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche eremita</a> Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche impavida</a> Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche melanophris</a> Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche salvini</a> Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche steadi</a> White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<b>Migratory Marine Species</b>		
<a href="#">Balaena glacialis australis</a> Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
<a href="#">Balaenoptera edeni</a> Bryde's Whale [35]		Species or species habitat may occur within area
<a href="#">Balaenoptera musculus</a> Blue Whale [36]	Endangered	Species or species habitat may occur within area
<a href="#">Caperea marginata</a> Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
<a href="#">Carcharhinus longimanus</a> Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
<a href="#">Carcharodon carcharias</a> White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
<a href="#">Dugong dugon</a> Dugong [28]		Species or species habitat may occur within area
<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
<a href="#">Lamna nasus</a> Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
<a href="#">Manta alfredi</a> Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
<a href="#">Manta birostris</a> Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
<a href="#">Orcinus orca</a> Killer Whale, Orca [46]		Species or species habitat may occur within area
<a href="#">Rhincodon typus</a> Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
<a href="#">Sousa chinensis</a> Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
<b>Migratory Terrestrial Species</b>		
<a href="#">Cuculus optatus</a> Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat known to occur within area
<a href="#">Monarcha trivirgatus</a> Spectacled Monarch [610]		Species or species habitat known to occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat known to occur within area
<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat known to occur within area
<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
<b>Migratory Wetlands Species</b>		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat known to occur within area
<a href="#">Arenaria interpres</a> Ruddy Turnstone [872]		Roosting known to occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Roosting known to occur within area
<a href="#">Calidris canutus</a> Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat known to occur within area
<a href="#">Calidris ruficollis</a> Red-necked Stint [860]		Roosting known to occur within area
<a href="#">Calidris tenuirostris</a> Great Knot [862]	Critically Endangered	Roosting known to occur within area
<a href="#">Charadrius bicinctus</a> Double-banded Plover [895]		Roosting known to occur within area
<a href="#">Charadrius mongolus</a> Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
<a href="#">Gallinago megala</a> Swinhoe's Snipe [864]		Roosting likely to occur within area
<a href="#">Gallinago stenura</a> Pin-tailed Snipe [841]		Roosting likely to occur within area
<a href="#">Limicola falcinellus</a> Broad-billed Sandpiper [842]		Roosting known to occur within area
<a href="#">Limosa lapponica</a> Bar-tailed Godwit [844]		Species or species habitat known to occur within area
<a href="#">Limosa limosa</a> Black-tailed Godwit [845]		Roosting known to occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Numenius minutus</a> Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
<a href="#">Numenius phaeopus</a> Whimbrel [849]		Roosting known to occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Species or species habitat known to occur within area
<a href="#">Philomachus pugnax</a> Ruff (Reeve) [850]		Roosting known to occur within area

Name	Threatened	Type of Presence
<a href="#">Pluvialis fulva</a> Pacific Golden Plover [25545]		Roosting known to occur within area
<a href="#">Pluvialis squatarola</a> Grey Plover [865]		Roosting known to occur within area
<a href="#">Tringa brevipes</a> Grey-tailed Tattler [851]		Roosting known to occur within area
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
<a href="#">Tringa stagnatilis</a> Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
<a href="#">Xenus cinereus</a> Terek Sandpiper [59300]		Roosting known to occur within area

## Other Matters Protected by the EPBC Act

### Commonwealth Land [\[ Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Commonwealth Land - Australian & Overseas Telecommunications Corporation Commonwealth Land - Australian Broadcasting Corporation Commonwealth Land - Australian Postal Commission Commonwealth Land - Australian Postal Corporation Commonwealth Land - Australian Telecommunications Commission Commonwealth Land - Commonwealth Trading Bank of Australia Commonwealth Land - Defence Housing Authority Commonwealth Land - Defence Service Homes Corporation Commonwealth Land - Director of War Service Homes Commonwealth Land - Telstra Corporation Limited Defence - ADF CAREERS REFERENCE CENTRE

### Listed Marine Species [\[ Resource Information \]](#)

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Birds</b>		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat known to occur within area
<a href="#">Anous stolidus</a> Common Noddy [825]		Species or species habitat likely to occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Breeding likely to occur within area
<a href="#">Arenaria interpres</a> Ruddy Turnstone [872]		Roosting known to occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Roosting known to occur within area

Name	Threatened	Type of Presence
<a href="#">Calidris canutus</a> Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat known to occur within area
<a href="#">Calidris ruficollis</a> Red-necked Stint [860]		Roosting known to occur within area
<a href="#">Calidris tenuirostris</a> Great Knot [862]	Critically Endangered	Roosting known to occur within area
<a href="#">Calonectris leucomelas</a> Streaked Shearwater [1077]		Species or species habitat known to occur within area
<a href="#">Charadrius bicinctus</a> Double-banded Plover [895]		Roosting known to occur within area
<a href="#">Charadrius mongolus</a> Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
<a href="#">Charadrius ruficapillus</a> Red-capped Plover [881]		Roosting known to occur within area
<a href="#">Diomedea antipodensis</a> Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea epomophora</a> Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea exulans</a> Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea gibsoni</a> Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Diomedea sanfordi</a> Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Fregata ariel</a> Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
<a href="#">Fregata minor</a> Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
<a href="#">Gallinago megala</a> Swinhoe's Snipe [864]		Roosting likely to occur within area
<a href="#">Gallinago stenura</a> Pin-tailed Snipe [841]		Roosting likely to occur within area
<a href="#">Haliaeetus leucogaster</a> White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
<a href="#">Heteroscelus brevipes</a> Grey-tailed Tattler [59311]		Roosting known to occur within area
<a href="#">Himantopus himantopus</a> Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Lathamus discolor</a> Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Limicola falcinellus</a> Broad-billed Sandpiper [842]		Roosting known to occur within area
<a href="#">Limosa lapponica</a> Bar-tailed Godwit [844]		Species or species habitat known to occur within area
<a href="#">Limosa limosa</a> Black-tailed Godwit [845]		Roosting known to occur within area
<a href="#">Macronectes giganteus</a> Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
<a href="#">Macronectes halli</a> Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat known to occur within area
<a href="#">Monarcha trivirgatus</a> Spectacled Monarch [610]		Species or species habitat known to occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat known to occur within area
<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat known to occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
<a href="#">Numenius minutus</a> Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
<a href="#">Numenius phaeopus</a> Whimbrel [849]		Roosting known to occur within area
<a href="#">Pachyptila turtur</a> Fairy Prion [1066]		Species or species habitat known to occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Species or species habitat known to occur within area
<a href="#">Philomachus pugnax</a> Ruff (Reeve) [850]		Roosting known to occur within area



Name	Threatened	Type of Presence
<a href="#">Phoebetria fusca</a> Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
<a href="#">Pluvialis fulva</a> Pacific Golden Plover [25545]		Roosting known to occur within area
<a href="#">Pluvialis squatarola</a> Grey Plover [865]		Roosting known to occur within area
<a href="#">Puffinus carneipes</a> Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
<a href="#">Puffinus griseus</a> Sooty Shearwater [1024]		Species or species habitat likely to occur within area
<a href="#">Recurvirostra novaehollandiae</a> Red-necked Avocet [871]		Roosting known to occur within area
<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat known to occur within area
<a href="#">Rostratula benghalensis (sensu lato)</a> Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
<a href="#">Sterna albifrons</a> Little Tern [813]		Species or species habitat may occur within area
<a href="#">Thalassarche bulleri</a> Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche cauta</a> Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche eremita</a> Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche impavida</a> Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche melanophris</a> Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
<a href="#">Thalassarche salvini</a> Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thalassarche sp. nov.</a> Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
<a href="#">Thalassarche steadi</a> White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
<a href="#">Thinornis rubricollis rubricollis</a> Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat likely to occur within area
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
<a href="#">Tringa stagnatilis</a> Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
<a href="#">Xenus cinereus</a> Terek Sandpiper [59300]		Roosting known to occur within area
<b>Fish</b>		
<a href="#">Acentronura tentaculata</a> Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
<a href="#">Festucalex cinctus</a> Girdled Pipefish [66214]		Species or species habitat may occur within area
<a href="#">Filicampus tigris</a> Tiger Pipefish [66217]		Species or species habitat may occur within area
<a href="#">Heraldia nocturna</a> Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
<a href="#">Hippichthys penicillus</a> Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
<a href="#">Hippocampus abdominalis</a> Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
<a href="#">Hippocampus whitei</a> White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat likely to occur within area
<a href="#">Histiogamphelus briggsii</a> Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
<a href="#">Lissocampus runa</a> Javelin Pipefish [66251]		Species or species habitat may occur within area
<a href="#">Maroubra perserrata</a> Sawtooth Pipefish [66252]		Species or species habitat may occur within area
<a href="#">Notiocampus ruber</a> Red Pipefish [66265]		Species or species habitat may occur within area
<a href="#">Phyllopteryx taeniolatus</a> Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
<a href="#">Solegnathus spinosissimus</a> Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
<a href="#">Solenostomus cyanopterus</a> Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
<a href="#">Solenostomus paradoxus</a> Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area
<a href="#">Stigmatopora argus</a> Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
<a href="#">Stigmatopora nigra</a> Widebody Pipefish, Wide-bodied Pipefish, Black		Species or species

Name	Threatened	Type of Presence
Pipefish [66277]		habitat may occur within area
<a href="#">Syngnathoides biaculeatus</a> Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
<a href="#">Trachyrhamphus bicoarctatus</a> Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
<a href="#">Urocampus carinirostris</a> Hairy Pipefish [66282]		Species or species habitat may occur within area
<a href="#">Vanacampus margaritifer</a> Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area

## Mammals

<a href="#">Arctocephalus forsteri</a> Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
<a href="#">Arctocephalus pusillus</a> Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
<a href="#">Dugong dugon</a> Dugong [28]		Species or species habitat may occur within area

## Reptiles

<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
<a href="#">Pelamis platurus</a> Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

## Whales and other Cetaceans

Name	Status	Type of Presence
<a href="#">[ Resource Information ]</a>		
<b>Mammals</b>		
<a href="#">Balaenoptera acutorostrata</a> Minke Whale [33]		Species or species habitat may occur within area
<a href="#">Balaenoptera edeni</a> Bryde's Whale [35]		Species or species habitat may occur within area
<a href="#">Balaenoptera musculus</a> Blue Whale [36]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
<a href="#">Caperea marginata</a> Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
<a href="#">Delphinus delphis</a> Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
<a href="#">Eubalaena australis</a> Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
<a href="#">Grampus griseus</a> Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Orcinus orca</a> Killer Whale, Orca [46]		Species or species habitat may occur within area
<a href="#">Sousa chinensis</a> Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
<a href="#">Stenella attenuata</a> Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
<a href="#">Tursiops aduncus</a> Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
<a href="#">Tursiops truncatus s. str.</a> Bottlenose Dolphin [68417]		Species or species habitat may occur within area

## Extra Information

### State and Territory Reserves [\[ Resource Information \]](#)

Name	State
Awabakal	NSW
Blue Gum Hills	NSW
Glenrock	NSW
Hexham Swamp	NSW
Hunter Wetlands	NSW
Pambalong	NSW

### Regional Forest Agreements [\[ Resource Information \]](#)

Note that all areas with completed RFAs have been included.

Name	State
<a href="#">North East NSW RFA</a>	New South Wales

### Invasive Species [\[ Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
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Name	Status	Type of Presence
<b>Birds</b>		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
<b>Frogs</b>		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
<b>Mammals</b>		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species

Name	Status	Type of Presence
<p>Mus musculus House Mouse [120]</p>		<p>habitat likely to occur within area</p> <p>Species or species habitat likely to occur within area</p>
<p>Oryctolagus cuniculus Rabbit, European Rabbit [128]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Rattus norvegicus Brown Rat, Norway Rat [83]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Rattus rattus Black Rat, Ship Rat [84]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Vulpes vulpes Red Fox, Fox [18]</p>		<p>Species or species habitat likely to occur within area</p>
<b>Plants</b>		
<p>Alternanthera philoxeroides Alligator Weed [11620]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Asparagus plumosus Climbing Asparagus-fern [48993]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]</p>		<p>Species or species habitat may occur within area</p>
<p>Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]</p>		<p>Species or species habitat likely to occur within area</p>
<p>Genista sp. X Genista monspessulana Broom [67538]</p>		<p>Species or species</p>

Name	Status	Type of Presence
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892] Opuntia spp. Prickly Pears [82753]		habitat may occur within area  Species or species habitat likely to occur within area  Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area

## Nationally Important Wetlands

[ [Resource Information](#) ]

Name	State
<a href="#">Hexham Swamp</a>	NSW
<a href="#">Jewells Wetland</a>	NSW
<a href="#">Kooragang Nature Reserve</a>	NSW
<a href="#">Shortland Wetlands Centre</a>	NSW

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates

-32.899225 151.689955,-32.899802 151.691328,-32.901748 151.690813



# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- [-Other groups and individuals](#)

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

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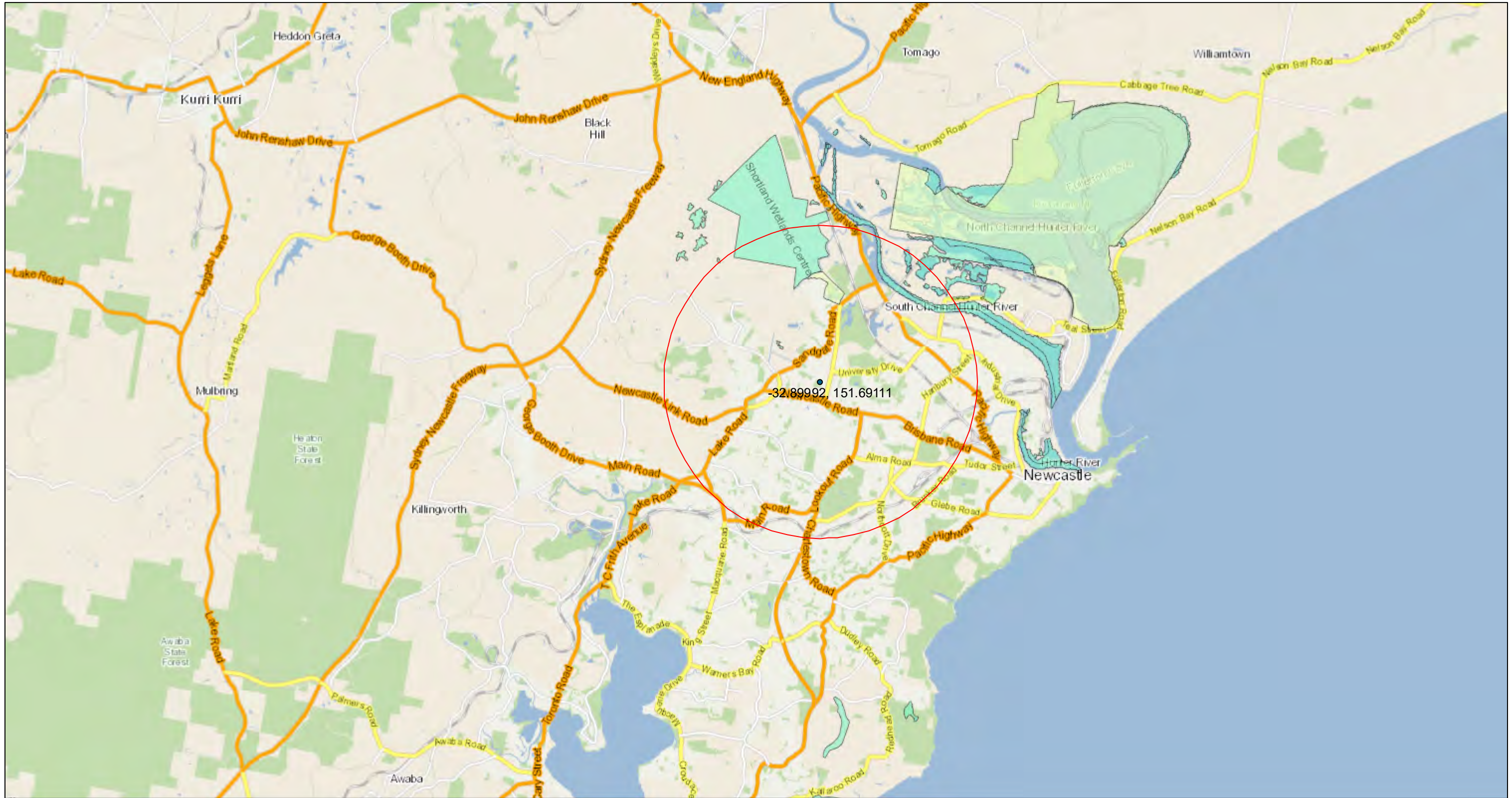
Department of Agriculture Water and the Environment

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+61 2 6274 1111

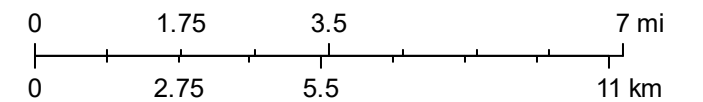
# Protected Wetlands N14 Dark Creek



August 27, 2021

- Ramsar Wetlands
- Nationally Important Wetlands

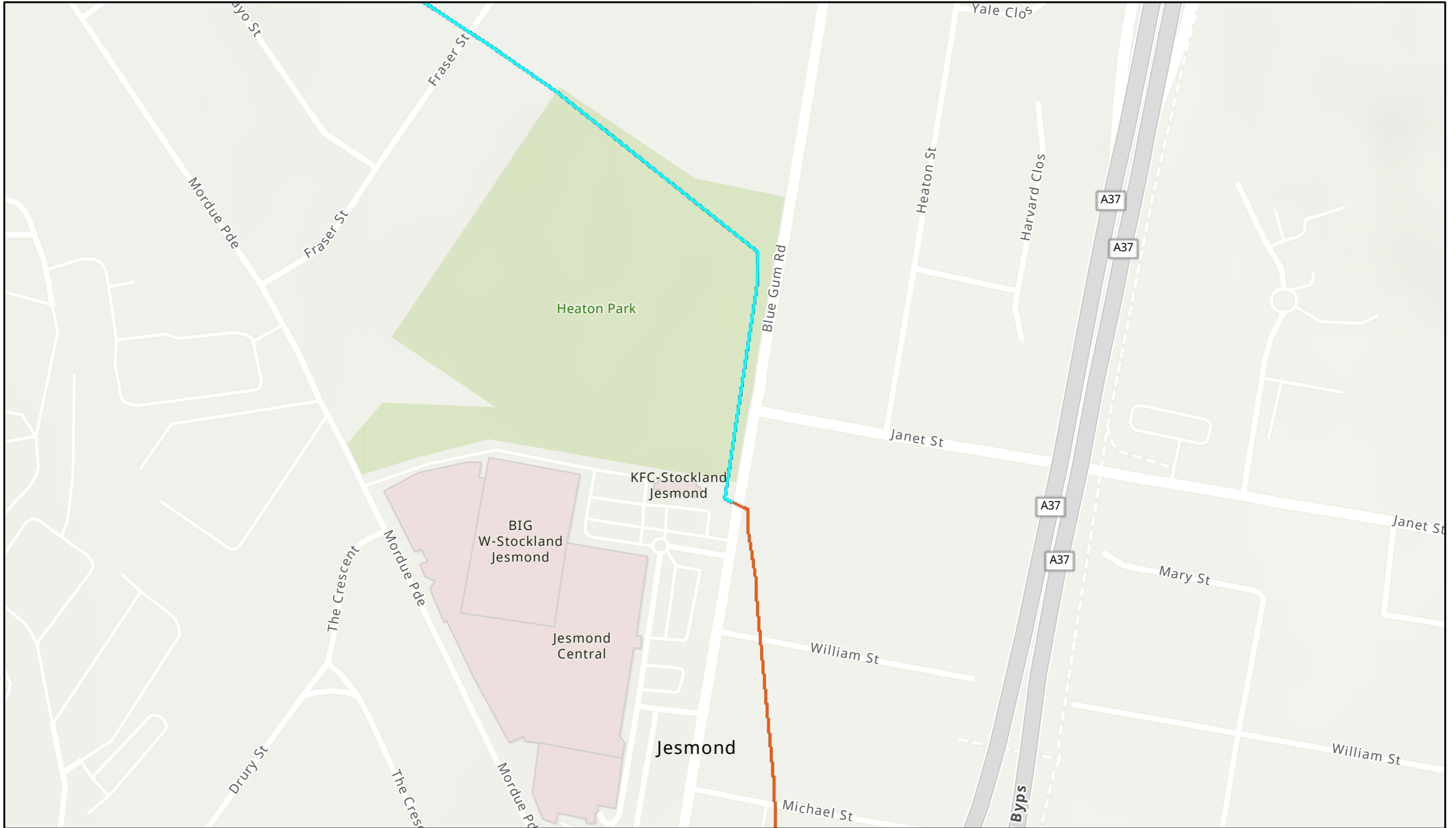
1:144,448



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Map produced by the Department of Agriculture, Water and the Environment.  
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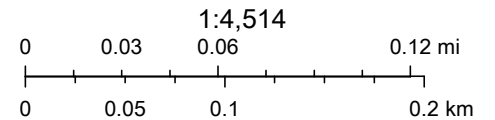
# NSW River Styles



29/08/2021, 21:00:43

## River Styles

- |  |                    |  |        |  |                           |
|--|--------------------|--|--------|--|---------------------------|
|  | CVS                |  | LUV DC |  | PCVS DC                   |
|  | <all other values> |  | CVS T  |  | None                      |
|  | Anthropogenic      |  | LUV CC |  | PCVS                      |
|  |                    |  |        |  | Reference Reach Locations |
|  |                    |  |        |  | SMG                       |



Water - NSW Department of Planning, Industry and Environment, Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Esri Community Maps Contributors, Esri, HERE, Garmin,

be

## BERESFIELD



**Landscape**—undulating low hills and rises on Permian sediments in the East Maitland Hills region. Slope gradients 3–15%, local relief to 50 m, elevation is 20–50 m. Partially cleared tall open-forest.

**Landscape Variant**—*bea*—steeper upper slopes (15–<25%).

**Soils**—moderately deep (<120 cm), moderately well to imperfectly drained Yellow Podzolic Soils (Dy2.21), Brown Podzolic Soils (Db1.21) and brown Soloths (Db2.41) occur on crests with moderately deep (<120 cm), well-drained Red Podzolic Soils (Dr2.21) and red Soloths (Dr2.41) on upper slopes, moderately well to imperfectly drained brown Soloths (Db2.41, Db1.41) and yellow Soloths (Dy3.41) on sideslopes and deep (>200 cm), imperfectly to poorly drained Yellow Podzolic Soils (Dy2.21), yellow Soloths (Dy2.41, Dy3.41) and Gleyed Podzolic Soils (Dg2.41) on lower slopes.

**Qualities and Limitations**—high foundation hazard, water erosion hazard, Mine Subsidence District, seasonal waterlogging and high run-on on localised lower slopes, highly acid soils of low fertility.

## LOCATION

Undulating low hills and rises on Permian sediments in the East Maitland Hills region in the centre-west of the area, including Beresfield and East Maitland. Type location is south-west of Beresfield (Area reference 3 71\*\*\*E, 63 66\*\*\*N).

## LANDSCAPE

### Geology and Regolith

Permian Tomago Coal Measures—shale, mudstone, sandstone, coal, tuff and clay.

Permian Mulbring Siltstone—siltstone, claystone, thin sandstone, and limestone.

Small areas of Permian Waratah Subgroup also occur—cross-laminated grey brown sandstone.

### Topography

Undulating low hills and rises. Local relief is 10–50 m. Elevation is 20–50 m. Slopes are 3–15%. Crests are broad (250–400 m). Sideslopes are long and gently inclined (350–750 m), with some very long footslopes up to 2 000 m long. Occasional short, steep sideslopes occur, with common terracetting. Drainage lines are deeply incised and narrow (2–3 m). Rock outcrop is generally absent.

### Vegetation

Partially cleared tall open-forest comprising *Eucalyptus maculata* (spotted gum), *E. fibrosa* (broad-leaved ironbark), *E. punctata* (grey gum), *E. oblonga* (narrow-leaved stringybark), *E. eugenioides* (thin-leaved stringybark) and *E. paniculata* (grey ironbark). Understorey vegetation contains *Bursaria spinosa* (blackthorn), paperbarks including *Melaleuca nodosa*, and wattles, including *Acacia falcata*.

*Eucalyptus tereticornis* (forest red gum) occurs on some lower slopes.

In drainage lines, *Melaleuca styphelioides*, *Backhousia myrtifolia* (grey myrtle), *Alphitonia excelsa* (red ash) and *Lantana camera* (lantana) are common.

### Land Use

Urban centres occur at East Maitland, Beresfield and some northern suburbs of Newcastle. Small areas have been cleared for grazing or poultry farming.

### Existing Land Degradation

Disturbed areas suffer considerable erosion. Unsealed tracks which are poorly maintained exhibit minor gully erosion. Moderate to severe rill erosion may occur on exposed batters, occasionally batter collapse may occur due to tunnel erosion of subsoils. Moderate sheet erosion occurs where vegetative cover has been removed.

Minor salt scalds occur on some lower slopes.

### Landscape Variants

Areas marked as **bea** on the map have steeper slopes (15–<25%); otherwise, they have similar landscape features to Beresfield soil landscape.

## SOILS

### Dominant Soil Materials

#### be1—Friable brownish black loam (topsoil—A<sub>1</sub> horizon)

**Colour** brownish black (10YR 2/2, 10YR 2/3), occasionally black (10YR 2/1) or dark brown (10YR 3/3)

**Texture** sandy loam to loam fine sandy or silt loam

**Structure** weak, fine (10–20 mm) sub-angular blocky peds which part easily to <2 mm crumb peds

**Fabric** rough ped

**Field pH** moderately acid to neutral (pH 5.5–7.0)

**Exposed condition**

often friable, may be firm when dry

**Permeability**

highly permeable

**Coarse fragments**

gravel-sized platy ironstone and sub-angular sandstone generally few, but may be abundant. Very few fine charcoal fragments may occur

**Roots** common to abundant, in-ped, fine

**Type location** John Renshaw Drive, 200 m ENE of intersection with Minmi Road (Grid Ref. 3 7240\*E, 63 6845\*N). Soil Data System card 33, 0–10 cm

#### be2—Hardsetting dull yellowish brown sandy loam (topsoil—A<sub>2</sub> horizon)

**Colour** dull yellowish brown (10YR 4/3) to dark brown (10YR 3/3, 7.5YR 3/3). Dry colour is often bleached dull yellow orange (10YR 7/2, 10YR 6/3). Few small rusty mottles may occur down root traces

**Texture** ranges from sandy loam through clay loam to fine sandy clay loam

**Structure** massive, rarely a weak to moderate (5–10 mm) sub-angular blocky ped occurs

**Fabric** earthy, rarely rough ped

**Field pH** moderately to slightly acid (pH 5.5–6.0)

**Exposed condition**

massive appearance, hardsetting and brittle when dry

**Permeability**

moderate

**Coarse fragments**

few to common gravel-sized tabular ironstone fragments may occur, occasionally in the form of a stone line at the base of this material. Few to common conglomerate pebbles and very few charcoal fragments may occur

**Roots** few to common, fine

**Type location** John Renshaw Drive, 200 m ENE of intersection with Minmi Road (Grid Ref. 3 7240\*E, 63 6845\*N). Soil Data System card 33, 10–15 cm

#### be3—Pedal brown plastic mottled clay (subsoil—B<sub>2</sub> horizon)

**Colour** brown (7.5YR 4/4, 7.5YR 4/6), dark brown (7.5YR 3/3, 10YR 5/4), bright yellowish brown (10YR 6/6) and yellowish brown (10YR 5/6, 2.5Y 5/3) common, but ranging to greyish yellow brown (10YR 4/2) and dull yellowish brown (10YR 5/3, 10YR 4/3). Few to common red/grey/orange mottles occur

**Texture** dominantly medium clay, ranging from light-medium to heavy plastic clay, occasionally fine sandy clay

**Structure** strong, dense (10–20 mm) angular blocky peds. A 50–100 mm prismatic or angular blocky macrostructure is generally present

**Fabric** smooth ped

**Field pH** moderately to slightly acid (pH 5.0–6.0)

**Exposed condition**

when dry, fine 1–2 mm fragments form on the surface and cracking evident. When wet, a surface mulch is formed slow

**Permeability**

**Coarse fragments**

common to many angular and sub-angular ironstone fragments may occur few, fine, ex-ped

**Roots**

**Type location** John Renshaw Drive, 200 m ENE of intersection with Minmi Road (Grid Ref. 3 7240\*E, 636845\*N). Soil Data System card 33, 15–120 cm

#### be4—Reddish brown plastic pedal clay (subsoil—B<sub>2</sub>, B<sub>3</sub> horizons)

**Colour** reddish brown (5YR 4/6, 2.5YR 4/6), dull reddish brown (5YR 4/4), red/grey mottles may be common

**Texture** medium to heavy plastic clay

**Structure** primary 20–50 mm angular blocky peds which part easily to 10–20 mm angular blocky or polyhedral peds. A 100–200 mm prismatic macrostructure may occur

**Fabric** smooth ped

**Field pH** strongly to slightly acid (pH 4.5–6.0)

**Exposed condition**

when dry, fine (1–2 mm) fragments form on the surface. Cracking 2–5 cm in width common. Upon wetting, a surface mulch forms. Consistence is moderately firm to very firm when dry, weak and labile when moist

**Permeability**

**Coarse fragments**

sub-angular and tabular ironstone fragments may occur and be common to many

**Roots**

few, ex-ped

**Other**

clay skins (cutans) abundant

**Type location** John Renshaw Drive at Black Hill Road turnoff (Grid Ref. 3 6740\*E, 63 6720\*N). Soil Data System card 23, 40–85 cm

**be5—Gleyed “puggy” silty clay (subsoil—B<sub>2</sub>, B<sub>3</sub>, C horizons)**

<b>Colour</b>	dull yellow orange (10YR 7/2, 10YR 6/4), light grey (10YR 7/1), light yellow (2.5YR 7/3) occur. Red/orange/grey mottling may occur and be common
<b>Texture</b>	commonly silty clay, but ranging from sandy clay to light-medium clay
<b>Structure</b>	large (100–200 mm) prismatic ped part easily to 20–50 mm angular blocky or sub-angular blocky ped. Structure strong when dry, but massive when wet
<b>Fabric</b>	smooth ped
<b>Field pH</b>	moderately acid to neutral (pH 5.0–7.0)
<b>Exposed condition</b>	1–2 mm surface fragments form. When abundant tabular ironstones are present, surface condition is gravelly
<b>Permeability</b>	slow
<b>Coarse fragments</b>	few to abundant gravel-sized sub-angular tabular ironstone fragments, which may be stratified
<b>Roots</b>	few to absent, fine (<2 mm)
<b>Type location</b>	John Renshaw Drive at Black Hill Rd turnoff (Grid Ref. 3 674**E, 63 672**N). Soil Data System card 23, 85– 144 cm

**Occurrence and Relationships**

**Moderately well-drained crests.** 5–15 cm friable brownish black loam (**be1**) overlies 5–30 cm of hardsetting dull yellowish brown sandy clay loam (**be2**), which in turn overlies 40–105 cm pedal brown plastic mottled clay (**be3**). Soil boundaries are clear to sharp. Total soil depth is <120 cm [moderately well-drained Yellow Podzolic Soils (Dy2.21) and Brown Podzolic Soils (Db1.21, Db2.41)].

**Sideslopes.** 5–10 cm **be1** overlies 10–30 cm **be2** and commonly 16–65 cm **be3**. These materials may in turn be underlain by 25–80 cm of reddish brown plastic pedal clay (**be4**) and, in turn, often >200 cm gleyed “puggy” silty clay (**be5**). Where disturbed, **be1** has often been lost to erosion and **be2** is exposed at the surface. Soil boundaries are clear to abrupt. Total soil depth is >200 cm [moderately well-drained brown Soloths (Db2.41, Db1.41), some yellow Soloths (Dy3.41)].

**On better drained upper slopes.** Up to 10 cm **be1** overlies 10–35 cm **be2**, then 35–>80 cm **be4**, which in turn overlies <115 cm **be5**. Soil boundaries are abrupt to clear. Total soil depth is >120 cm [well-drained Red Podzolic Soils (Dr2.21) and some red Soloths (Dr2.41)].

**On some lower slopes and more poorly drained flat low crests.** Up to 10 cm **be1** overlies 10–30 cm **be2** which is underlain by 140–>400 cm **be5**. Soil boundaries are abrupt. Total soil depth is >200 cm [imperfectly drained Yellow Podzolic Soils (Dy2.21), yellow Soloths (Dy2.41, Dy3.41) and some poorly drained Gleyed Podzolic Soils (Dg2.41)].

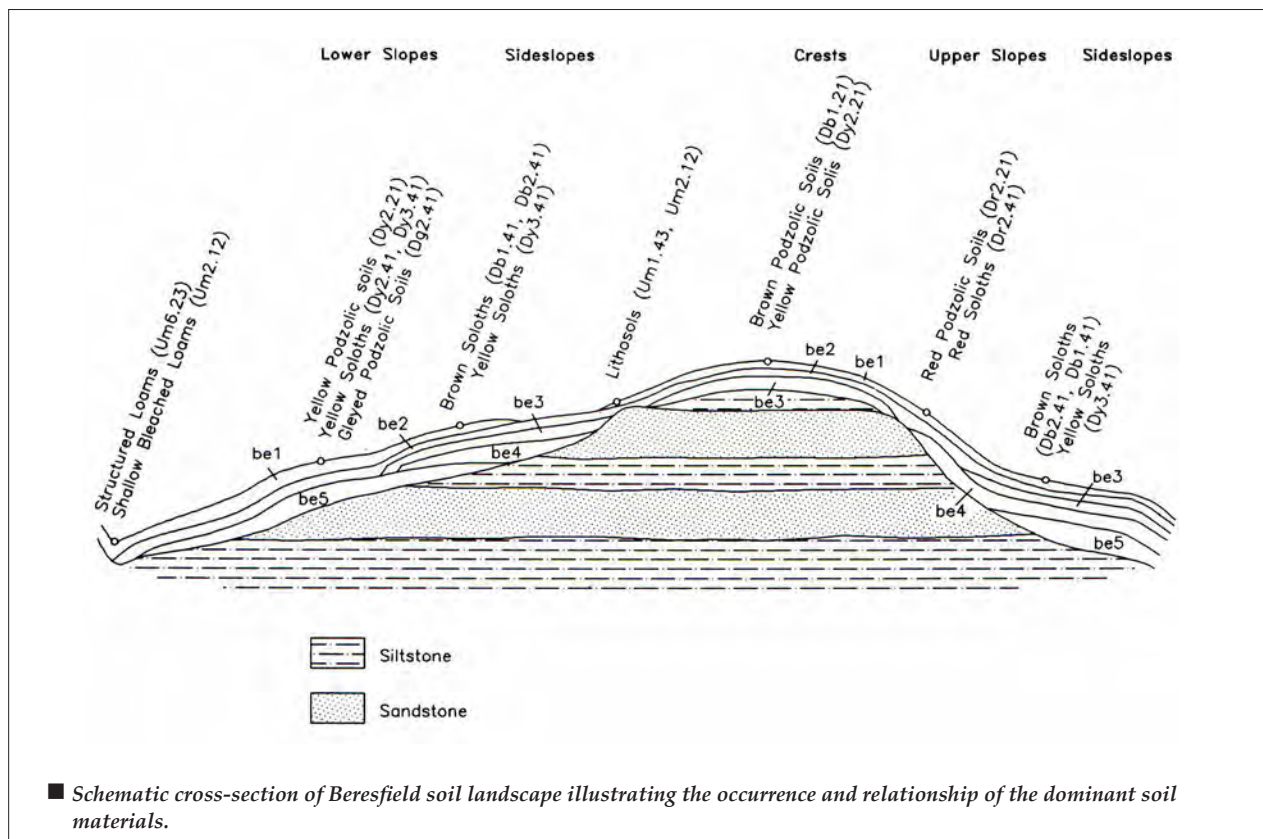
**Drainage lines.** 15–>180 cm **be1** occurs [imperfectly drained Structured Loams (Um6.23), some Earthy Loams (Um5.52)]. Occasionally, **be1** is underlain by 15 cm **be2**. Soil boundaries are clear. Total soil depth is 30–>180 cm [poorly drained Bleached Loams (Um2.12)].

**Where sandstone outcrops occur.** Up to 10 cm **be1** overlies 18–30 cm **be2**. Boundaries are clear. Total soil depth is <100 cm [rapidly drained Lithosols (Um1.43, Um2.12)].

**QUALITIES AND LIMITATIONS**

**Landscape Limitations**

- Foundation hazard
- Steep slopes (localised)
- High run-on (localised)



Water erosion hazard  
 Seasonal waterlogging (localised, lower slopes)  
 Rock outcrop (localised)  
 Mine Subsidence District

#### Landscape Limitations – bea

Steep slopes (localised)  
 Mass movement hazard  
 High foundation hazard  
 Water erosion hazard  
 Mine Subsidence District  
 High run-on

#### Soil Limitations

- be1** Very strong acidity  
 High potential aluminium toxicity  
 Stoniness (localised)  
 High erodibility  
 Low fertility
- be2** Hardsetting surface  
 Strong acidity  
 High potential aluminium toxicity  
 Stoniness  
 Low fertility
- be3** High plasticity  
 Moderate shrink-swell potential  
 Low permeability  
 Very strong acidity  
 High aluminium toxicity potential  
 Low fertility  
 Stoniness (localised)
- be4** High plasticity  
 Very strong acidity  
 Very high potential aluminium toxicity  
 Low permeability  
 Moderate shrink-swell potential  
 Sodicity/dispersion  
 Stoniness (localised)  
 Low fertility
- be5** High erodibility  
 Low wet bearing strength  
 Very strong acidity  
 High potential aluminium toxicity  
 Low fertility  
 Stoniness (localised)  
 Very low permeability  
 High sodicity/dispersion  
 High salinity

#### Fertility

**Soil Materials as Plant Growth Media.** Soil material suitability as growth media is moderate (**be1**) to low (**be2**, **be3**, **be4**, **be5**). All soil materials are strongly to very strongly acid, with high potential aluminium toxicity. Topsoil **be1** is friable when moist and has moderate organic matter, but high phosphorus sorption.

**Soil Profile Fertility.** Soil profile suitability as a plant growth medium is low. Soil volumes available for root penetration are moderate.

#### Erodibility

	K factor	Non-concentrated flows	Concentrated flows	Wind
<b>be1</b>	0.028	moderate	high	V low
<b>be2</b>	0.033	moderate	moderate	V low
<b>be3</b>	0.017	low	high	V low
<b>be4</b>	0.018	low	moderate	V low
<b>be5</b>	0.048	high	high	V low

#### Erosion Hazard

	Non-concentrated flows	Concentrated flows	Wind
<b>grazing</b>	low	mod-high	slight
<b>cultivation</b>	high	extreme	low-mod
<b>urban</b>	mod-high	high	slight

#### Foundation Hazard

Generally high foundation hazard due to moderate to high shrink-swell (reactive) and highly plastic subsoils. Topsoil depth is 5–50 cm. Total soil depth is <120–>200 cm.

#### Urban Capability

Generally moderate limitations for urban development due to high foundation hazard.

#### Rural Capability

Generally moderate limitations for cultivation and low limitations for grazing.

#### Sustainable Land Management Recommendations

Care should be taken that topsoil loss is minimised by maintaining a permanent protective ground cover. If exposure of the hardsetting **be2** occurs, increased runoff and erosion will result. Incorporation of organic matter, and fertilisers, including phosphorus and lime, may be beneficial for pasture establishment. Areas of salt scalding should be fenced off to exclude stock and sown with salt tolerant grass species. Drainage or diversion of surface water may also be required. The Department (SCS) can provide advice on the management of areas effected by land degradation.

#### Soil Conservation Earthworks

Generally moderate limitations for earthworks due to high shrink-swell subsoils (**be4**) and highly aggregated subsoils (**be3**). Localised limitations include shallow soils and imperfectly drained soils. Soils tested have earthworks categories J for **be1**, B for **be2** and **be5**, C for **be3** and G for **be4**. Soils are often highly dispersible and further testing is recommended prior to undertaking earthworks.

ki

## KILLINGWORTH



**Landscape**—undulating to rolling hills and low hills on the Newcastle Coal Measures of the Awaba Hills region. Elevation 50–160 m, local relief 30–100 m, slopes are 3–20%. Predominantly uncleared tall open-forest.

**Landscape Variant—kia**—rolling to steep hills, slopes are >20%.

**Soils**—shallow (<60 cm) to moderately deep (<150 cm), well to imperfectly drained Yellow Podzolic Soils (Dy3.21, Dy5.11, Dy2.11), yellow Soloths (Dy3.41, Dy2.41), Gleyed Podzolic Soils (Dg1.41) and gleyed Soloths (Dg2.41, Dg3.41) on crests and hillslopes, with shallow (<60 cm) well-drained Structured Loams (Um6.32, Um6.22), Bleached Loams (Um2.12, Um1.41) and Lithosols (Um4.4, Uc1.21, Uc2.21) on some crests.

**Qualities and Limitations**—high water erosion hazard, Mine Subsidence District, foundation hazard (localised), shallow soils (localised), seasonal waterlogging (localised), sodic/dispersible soils of low wet strength, very strongly acid soils of low fertility.

## LOCATION

Undulating to rolling hills and low hills on sediments of the Newcastle Coal Measures in the Awaba Hills region in the south of the area. Includes the easterly facing slopes and foothills of the Sugarloaf Range. Typical locations include Killingworth, Wakefield and the rolling hills around Minmi (Area reference 3 65\*\*\*E, 63 55\*\*\*N).

## LANDSCAPE

### Geology and Regolith

Permian Newcastle Coal Measures—Moon Island Beach, Boolaroo and Lambton Subgroups—coal, tuff, conglomerate, sandstone and shale.

## Topography

Rolling low hills to hills. Slope gradients 3–20%, local relief is 30–100 m, elevation 50–160 m. Crests are generally broad (250 m), sideslopes are long (>500 m) and grade into narrow (<3 m) drainage lines. Drainage plains are long (>500 m) and gently inclined. Short, steep (>20%) lower slopes often lead to gullies. Rock outcrop occurs occasionally in the upper catchment.

## Vegetation

Largely uncleared open-forest, with some open woodland. Dominant species are *Eucalyptus maculata* (spotted gum), *E. eugenoides* (thin-leaved stringybark), *E. umbra* (bastard mahogany), *E. fibrosa* (broad-leaved ironbark) and *E. paniculata* (grey ironbark). Understorey species include *Themeda australis* (kangaroo grass), *Leptospermum* spp. (tea-tree) and *Xanthorrhoea* spp. (grass tree).

*Eucalyptus gummifera* (red bloodwood) and *Angophora costata* (smooth-barked apple) occur on well-drained sandstone crests.

*Melaleuca styphelioides* (prickly-leaved paperbark) occurs within the understorey in poorly drained areas.

*Eucalyptus punctata* (grey gum), *E. propinqua* (small-fruited grey gum), *E. maculata* (spotted gum) and *E. globoidea* (white stringybark) are common on upper slopes.

*E. capitellata* (brown stringybark) and *E. haemastoma* (scribbly gum) occur in the southern extent of the landscape (e.g., Wakefield area). *Syncarpia glomulifera* (turpentine) and occasional *E. piperita* (sydney peppermint) occur on sheltered upper slopes.

## Land Use

Predominantly uncleared bushland with some urban development (e.g., West Wallsend) and coal mining at Killingworth, Wakefield and west of Wallsend.



**Existing Land Degradation**

Moderate sheet erosion occurs in areas which have been cleared of vegetation and are poorly maintained. Topsoil has often been completely removed.

Minor to moderate gully erosion occurs along poorly maintained unsealed tracks and in other disturbed areas. Exposed batters suffer from slumping and rill erosion.

**Included Soil Landscapes**

Small areas of Awaba (**aw**) soil landscape have been included but are too small and irregular to map.

**Landscape Variants**

The areas marked as **ki** on the map have steeper slopes (20–25%), but otherwise similar landscape features to Killingworth (**ki**) soil landscape.

**SOILS****Dominant Soil Materials****ki1—Brownish black pedal loam (topsoil)**

<b>Colour</b>	brownish black (10YR 3/1, 10YR 2/3, 10YR 3/2) or dark brown (10YR 3/3, 10YR 3/4)
<b>Texture</b>	commonly sandy loam or silt loam, but may vary depending on the parent material from loamy sand to clay loam
<b>Structure</b>	weak to moderate, 20–50 mm polyhedral and sub-angular blocky peds, which part easily to 2–5 mm crumb or polyhedral peds. Occasionally, lighter textured soils are massive
<b>Fabric</b>	rough ped, porous, rarely earthy
<b>Field pH</b>	strongly to slightly acid (pH 4.5–6.5)
<b>Exposed condition</b>	often hardsetting when dry but may be friable when moderately moist
<b>Permeability</b>	moderately to highly permeable, depending upon texture
<b>Coarse fragments</b>	gravel fragments range from very few to common, very few charcoal fragments commonly occur, very few ironstones may occur
<b>Roots</b>	few to many, in-ped
<b>Type location</b>	Wakefield Road 1 km NE of Wakefield (Grid Ref. 3 652**E, 63 527**N). Lake Macquarie Catchment Soil Survey Soil Data System card 7, 0–15 cm

**ki2—Bleached hardsetting loamy sand to sandy clay loam (topsoil—A<sub>2</sub> horizon)**

<b>Colour</b>	greyish yellow brown (10YR 6/2, 10YR 5/2, 10YR 4/2), yellowish grey (2.5YR 5/1, 2.5YR 6/1), dull yellow (2.5YR 6/4) or light yellow (2.5YR 7/3), rarely brownish black (10YR 2/3). Common small rusty mottles may occur down root traces. When dry, this material is a bleached dull yellow orange (10YR 7/2) or light grey (10YR 7/1)
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<b>Texture</b>	commonly loamy sand, but ranging through silt loam to sand clay loam
<b>Structure</b>	massive, rarely weak, 50–100 mm sub-angular blocky structure is apparent
<b>Fabric</b>	earthy, rarely rough ped
<b>Field pH</b>	strongly to slightly acid (pH 4.5–6.0)
<b>Exposed condition</b>	hardsetting when dry, with a moderately firm brittle consistence
<b>Permeability</b>	moderate to slow
<b>Coarse fragments</b>	gravel-sized stones are commonly present, ranging from few to abundant. Charcoal fragments may be few to common
<b>Roots</b>	few to common, fine
<b>Type location</b>	1 km N of Killingworth on Holmesville Road (Grid Ref. 3 654**E, 63 561**N). Lake Macquarie Catchment Soil Survey Soil Data System card 67, 0–14 cm

**ki3—Pedal yellowish brown clay (subsoil—B<sub>2</sub> horizon)**

<b>Colour</b>	yellowish brown (2.5YR 5/6, 10YR 5/6), dull yellowish brown (7.5YR 5/4, 10YR 5/4, 10YR 5/3), greyish yellow brown (10YR 6/2, 10YR 5/2), light yellow (2.5YR 7/3), dull yellow orange (10YR 6/3, 10YR 7/3), light grey (10YR 7/1, 2.5YR 8/1) most common, with small orange red mottles, few to abundant
<b>Texture</b>	sandy clay through silty clay to occasionally heavy clay
<b>Structure</b>	moderate to strong, 20–50 mm sub-angular blocky and polyhedral peds, often with a 50–100 mm or 100–200 mm prismatic macrostructure
<b>Fabric</b>	smooth ped, clay skins may be common, occasionally rough ped
<b>Field pH</b>	strongly to slightly acid (pH 4.0–6.0)
<b>Exposed condition</b>	massive appearance, with a very tough dry consistence, or material may weather to form easily transportable (<5 mm) aggregates. Cracks at 5–10 mm width may occur
<b>Permeability</b>	slow
<b>Coarse fragments</b>	few siltstone sandstone or ironstone fragments commonly occur
<b>Roots</b>	few, in- and ex-ped
<b>Type location</b>	1 km N of Killingworth on the Holmesville Road (Grid Ref. 3 654**E, 63 561**N). Lake Macquarie Catchment Soil Survey Soil Data System card 67, 14–95 cm

**Associated Soil Materials**

**Earthy, yellowish brown sandy clay loam.** A sandy clay loam to sandy clay which is massive and earthy or has a weak, porous structure with rough ped fabric. This material may occur as a subsoil (B horizon) on sandstone parent material.

## Occurrence and Relationships

The parent materials present give rise to two distinct soil types. Soils may change quickly, depending on the thickness of sandstone/tuff/mudstone interbeds.

**Soils on siltstone and sideslopes on tuff.** 5–25 cm brownish black pedal loam (**ki1**) overlies 10–45 cm bleached, hardsetting loamy sand to sandy clay loam (**ki2**) and 16–>128 cm pedal yellowish brown clay (**ki3**). Soil boundaries are sharp to clear [well to imperfectly drained yellow Soloths (Dy3.41, Dy2.41) and some Yellow Podzolic Soils (Dy3.21), also some gleyed Soloths (Dy2.41) and Gleyed Podzolic Soils (Dg1.41)]. Total soil depth ranges from shallow (<60 cm) on crests to moderately deep (60–<150 cm) on lower slopes. Often **ki1** has been lost to erosion, and **ki2** is exposed at the surface.

**Well-drained upper slopes on siltstone.** 5–22 cm **ki1** directly overlies >115 cm **ki3**. Boundaries are clear. Total soil depth is >120 cm [well-drained Yellow Podzolic Soils (Dy5.11, Dy2.11)].

**Sandstone parent material and crests on tuff.** Commonly, 10–20 cm **ki2** underlies **ki1**, boundaries are clear [well to imperfectly drained Shallow Bleached Loams (Um2.12, Um1.41) and rapidly drained Lithosols (Uc1.21, Uc2.12)].

Occasionally, 17–55 cm **ki1** may directly overlie bedrock [well-drained Structured Loams (Um6.32, Um6.22) and Lithosols (Um4.4)].

**Occasionally, on sandstone.** 4–10 cm **ki1** overlies 10–30 cm **ki2** and <100 cm earthy yellowish brown sandy clay loam. Boundaries are clear [well-drained Bleached Loams (Um2.21, Um2.22)] and, occasionally, gradual [Yellow Earths (Gn2.74)].

**In drainage lines.** Up to 20 cm **ki1** overlies >50 cm **ki2**. Boundaries are clear to gradual [imperfectly to poorly drained Bleached Loams (Um2.12)].

## QUALITIES AND LIMITATIONS

### Landscape Limitations

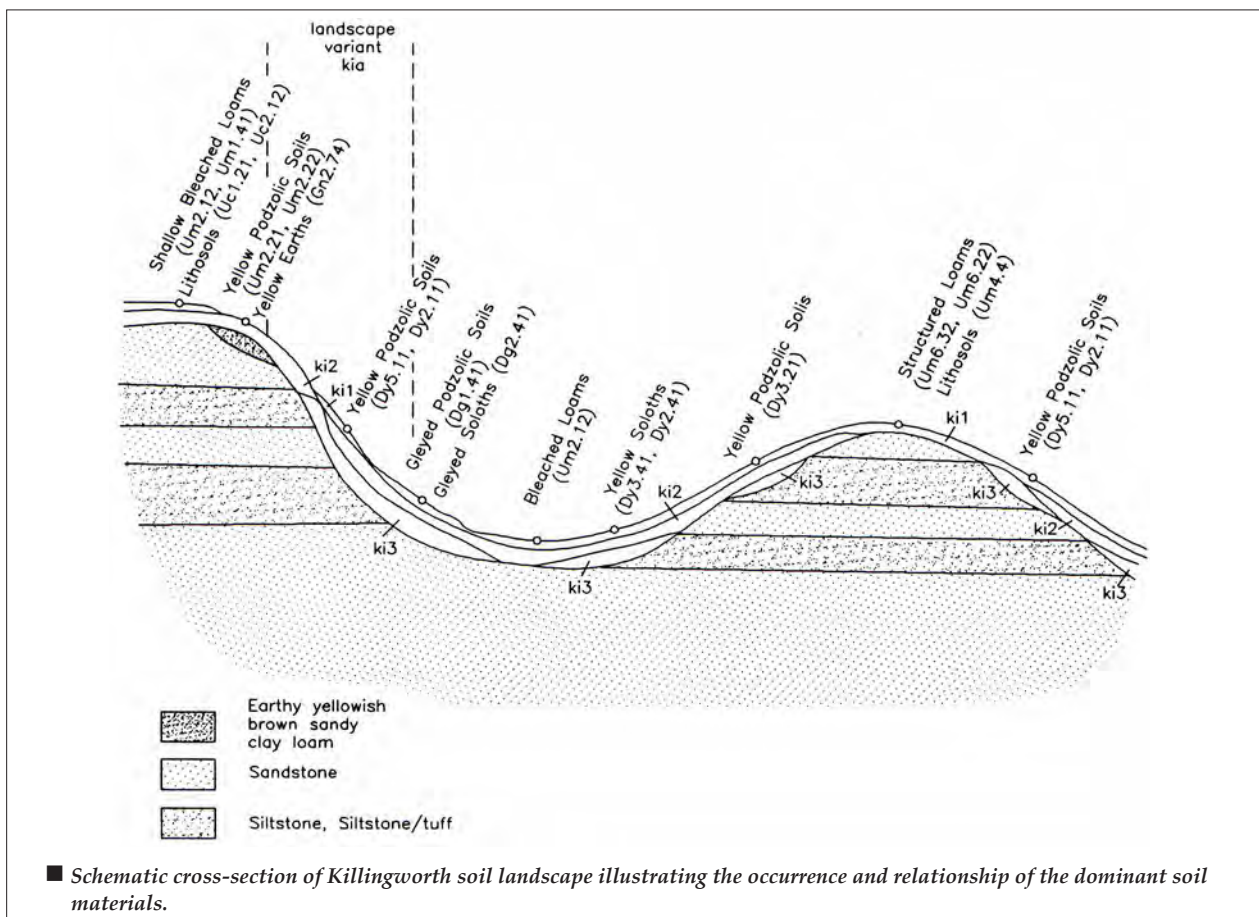
Water erosion hazard  
High run-on (localised)  
Seasonal waterlogging (lower slopes)  
Foundation hazard (localised, deeper soils)  
Mine Subsidence District  
Shallow soils (localised, on sandstone)  
Rock outcrop (localised)

### Landscape Limitations—kia

Water erosion hazard  
High run-on (localised)  
Steep slopes (localised)  
Mass movement hazard (localised)  
Shallow soils (localised)  
Mine Subsidence District  
Rock outcrop (localised)  
Foundation hazard (localised)

### Soil Limitations

**ki1** High erodibility  
Very strong acidity  
Very high potential aluminium toxicity  
Low fertility



- ki2** Low wet bearing strength  
Stoniness (localised)  
Hardsetting surfaces  
Very strong acidity  
Very low fertility  
Very high potential aluminium toxicity
- ki3** Low wet bearing strength  
Sodicity/dispersion  
High erodibility  
Very strong acidity  
Very high potential aluminium toxicity  
Shrink-swell (localised)  
Low fertility

### Fertility

**Soil Materials as Plant Growth Media.** Soil material suitability for use as growth media is very low. Although topsoil **ki1** is moderately well structured with moderate water-holding capacity and high organic matter content, it has a very low nutrient storage capacity and low to very low exchangeable cations. All soil materials are very strongly acid, with high potential aluminium toxicity, low phosphorus and high phosphorus sorption. Exchangeable magnesium is very low and potassium is high. All soil materials have moderate pH buffer capacity. Soil materials **ki1** and **ki2** have very low nutrient storage capacities.

**Soil Profile Fertility.** Suitability as a growth medium is low for shallow to moderately deep, well to imperfectly drained Soloths, Lithosols and Bleached Loams. Soil volumes available for root penetration are low. Suitability is moderate for moderately deep, well-drained Yellow Podzolic Soils.

### Erodibility

	K Factor	Non-concentrated flows	Concentrated flows	Wind
<b>ki1</b>	0.027	moderate	moderate	low
<b>ki2</b>	0.036	moderate	moderate	low
<b>ki3</b>	0.036	moderate	high	low

### Erosion hazard

	Non-concentrated flows	Concentrated flows	Wind
<b>grazing</b>	slight	moderate	slight
<b>cultivation</b>	moderate	high	slight
<b>urban</b>	moderate	high	slight

### Foundation hazard

Generally low foundation hazard; however, a localised moderate foundation hazard occurs where high shrink-swell subsoils occur. Other localised limitations include mass movement potential, which may occur on the landscape variant marked **kia** on the map, and seasonal waterlogging on lower slopes and drainage lines. Topsoil depth is 5–60 cm. Total soil depth is 60–>150 cm.

### Urban Capability

Moderate limitations for urban development. High limitations for **kia** due to steep slopes.

### Rural Capability

High limitations for cultivation, moderate limitations for grazing.

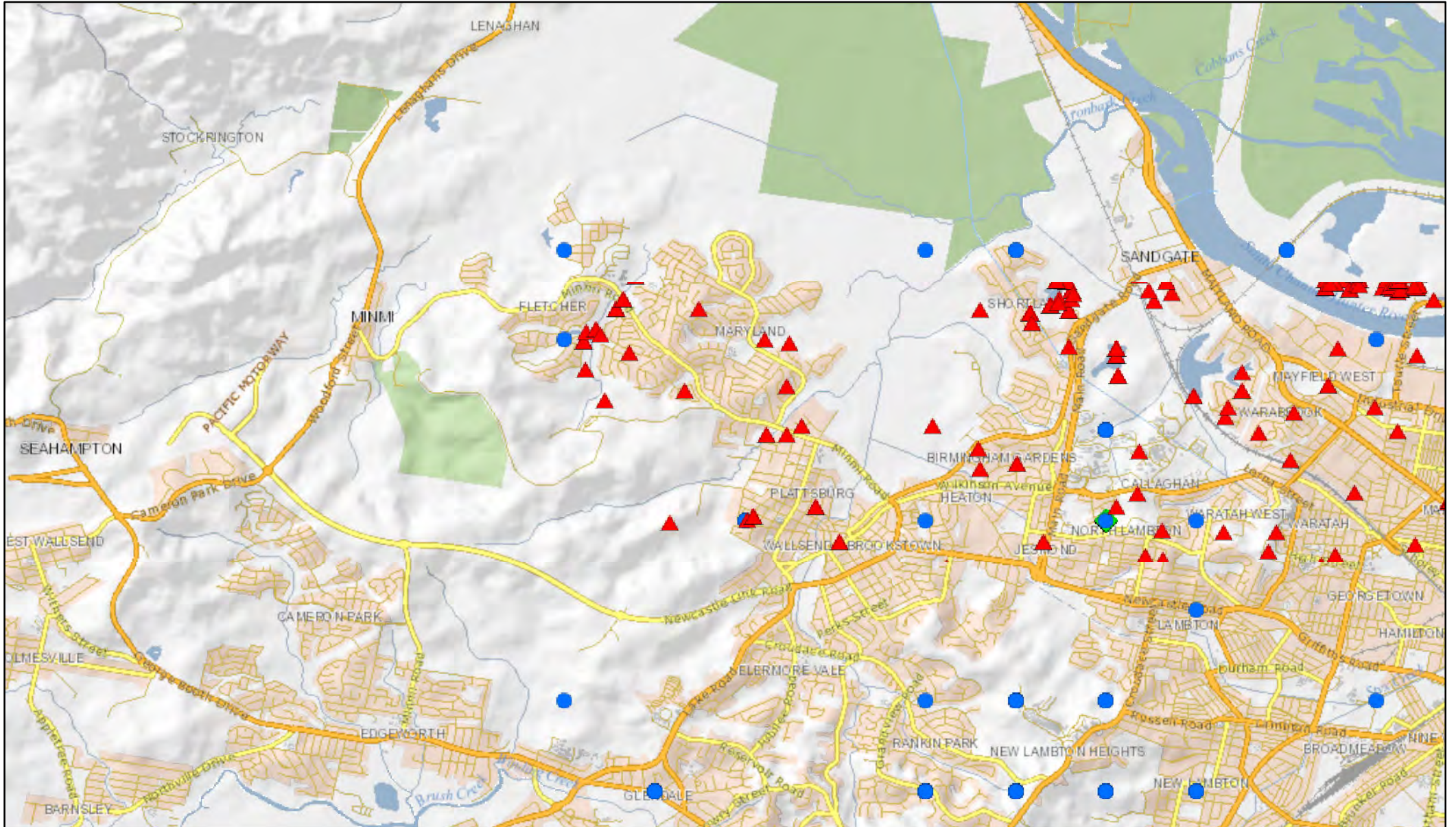
### Sustainable Land Management Recommendations

This soil landscape is best retained under native vegetation. Clearing of ground cover will result in a high erosion hazard. Potential fertility is very low. Areas under pasture are sustainable only if a permanent protective ground cover (>75%) is maintained.

### Soil Conservation Earthworks

Moderate to high limitations for earthworks due to shallow soils and highly dispersible subsoils with localised high shrink-swell. Lower slope areas may be seasonally too wet for earthworks construction. Soils tested have earthworks categories J for topsoils (**ki1**, **ki2**) and D for subsoil (**ki3**).

# Atlas Map

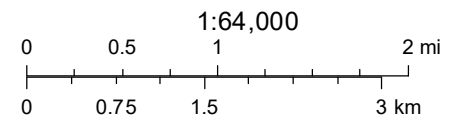


June 22, 2022

**drawGraphics\_poly** ◆ spc3

— Override 1

● spc2



Data from the BioNet Atlas website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°C; ^^ rounded to 0.01°C. Copyright the State of NSW through the Department of Planning, Industry and Environment. Search criteria : Public Report of all Valid Records of Threatened (listed on BC Act 2016) or Commonwealth listed Entities in selected area [North: -32.85 West: 151.64 East: 151.74 South: -32.95] returned a total of 11,857 records of 58 species.  
Report generated on 3/09/2021 2:25 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records	Info
Animalia	Amphibia	Hylidae	3166	<i>Litoria aurea</i>		Green and Golden Bell Frog	E1,P	V	7729	
Animalia	Aves	Anseranatidae	0199	<i>Anseranas semipalmata</i>		Magpie Goose	V,P		72	
Animalia	Aves	Anatidae	0216	<i>Oxyura australis</i>		Blue-billed Duck	V,P		4	
Animalia	Aves	Anatidae	0214	<i>Stictonetta naevosa</i>		Freckled Duck	V,P		11	
Animalia	Aves	Columbidae	0025	<i>Ptilinopus magnificus</i>		Wompoo Fruit-Dove	V,P		3	
Animalia	Aves	Columbidae	0021	<i>Ptilinopus regina</i>		Rose-crowned Fruit-Dove	V,P		4	
Animalia	Aves	Columbidae	0023	<i>Ptilinopus superbus</i>		Superb Fruit-Dove	V,P		4	
Animalia	Aves	Apodidae	0334	<i>Hirundapus caudacutus</i>		White-throated Needletail	P	V,C,J,K	2	
Animalia	Aves	Procellariidae	0971	<i>Pterodroma solandri</i>		Providence Petrel	V,P		1	
Animalia	Aves	Ciconiidae	0183	<i>Ephippiorhynchus asiaticus</i>		Black-necked Stork	E1,P		63	
Animalia	Aves	Ardeidae	0197	<i>Botaurus poiciloptilus</i>		Australasian Bittern	E1,P	E	19	
Animalia	Aves	Ardeidae	0196	<i>Ixobrychus flavicollis</i>		Black Bittern	V,P		1	
Animalia	Aves	Accipitridae	0218	<i>Circus assimilis</i>		Spotted Harrier	V,P		4	
Animalia	Aves	Accipitridae	0226	<i>Haliaeetus leucogaster</i>		White-bellied Sea-Eagle	V,P		20	
Animalia	Aves	Accipitridae	0225	<i>Hieraaetus morphnoides</i>		Little Eagle	V,P		7	
Animalia	Aves	Accipitridae	0230	^^ <i>Lophoictinia isura</i>		Square-tailed Kite	V,P,3		1	
Animalia	Aves	Accipitridae	8739	^^ <i>Pandion cristatus</i>		Eastern Osprey	V,P,3		2	
Animalia	Aves	Jacaniidae	0171	<i>Irediparra gallinacea</i>		Comb-crested Jacana	V,P		6	
Animalia	Aves	Rostratulidae	0170	<i>Rostratula australis</i>		Australian Painted Snipe	E1,P	E	1	
Animalia	Aves	Scolopacidae	0161	<i>Calidris ferruginea</i>		Curlew Sandpiper	E1,P	CE,C,J,K	7	
Animalia	Aves	Scolopacidae	0152	<i>Limosa limosa</i>		Black-tailed Godwit	V,P	C,J,K	4	
Animalia	Aves	Scolopacidae	0149	<i>Numenius madagascariensis</i>		Eastern Curlew	P	CE,C,J,K	22	
Animalia	Aves	Cacatuidae	0268	^^ <i>Callocephalon fimbriatum</i>		Gang-gang Cockatoo	V,P,3		1	
Animalia	Aves	Cacatuidae	0265	^ <i>Calyptorhynchus lathami</i>		Glossy Black-Cockatoo	V,P,2		2	
Animalia	Aves	Psittacidae	0260	<i>Glossopsitta pusilla</i>		Little Lorikeet	V,P		3	
Animalia	Aves	Psittacidae	0309	^^ <i>Lathamus discolor</i>		Swift Parrot	E1,P,3	CE	6	
Animalia	Aves	Strigidae	0246	^^ <i>Ninox connivens</i>		Barking Owl	V,P,3		2	
Animalia	Aves	Strigidae	0248	^^ <i>Ninox strenua</i>		Powerful Owl	V,P,3		76	
Animalia	Aves	Tytonidae	0250	^^ <i>Tyto novaehollandiae</i>		Masked Owl	V,P,3		2	
Animalia	Aves	Tytonidae	9924	^^ <i>Tyto tenebricosa</i>		Sooty Owl	V,P,3		1	
Animalia	Aves	Meliphagidae	0603	<i>Anthochaera phrygia</i>		Regent Honeyeater	E4A,P	CE	1	
Animalia	Aves	Meliphagidae	0448	<i>Epthianura albifrons</i>		White-fronted Chat	V,P		22	
Animalia	Aves	Neosittidae	0549	<i>Daphoenositta chrysoptera</i>		Varied Sittella	V,P		4	
Animalia	Aves	Petroicidae	0380	<i>Petroica boodang</i>		Scarlet Robin	V,P		3	
Animalia	Mammalia	Dasyuridae	1008	<i>Dasyurus maculatus</i>		Spotted-tailed Quoll	V,P	E	2	
Animalia	Mammalia	Phascolarctidae	1162	<i>Phascolarctos cinereus</i>		Koala	V,P	V	3	
Animalia	Mammalia	Burramyidae	1150	<i>Cercartetus nanus</i>		Eastern Pygmy-possum	V,P		1	
Animalia	Mammalia	Petauridae	1137	<i>Petaurus norfolcensis</i>		Squirrel Glider	V,P		49	
Animalia	Mammalia	Pteropodidae	1280	<i>Pteropus poliocephalus</i>		Grey-headed Flying-fox	V,P	V	243	
Animalia	Mammalia	Emballonuridae	1321	<i>Saccolaimus flaviventris</i>		Yellow-bellied Sheath-tail-bat	V,P		3	
Animalia	Mammalia	Molossidae	1329	<i>Micronomus norfolkensis</i>		Eastern Coastal Free-tailed Bat	V,P		96	
Animalia	Mammalia	Vespertilionidae	1353	<i>Chalinolobus dwyeri</i>		Large-eared Pied Bat	V,P	V	1	
Animalia	Mammalia	Vespertilionidae	1372	<i>Falsistrellus tasmaniensis</i>		Eastern False Pipistrelle	V,P		8	
Animalia	Mammalia	Vespertilionidae	1357	<i>Myotis macropus</i>		Southern Myotis	V,P		31	
Animalia	Mammalia	Vespertilionidae	1361	<i>Scoteanax rueppellii</i>		Greater Broad-nosed Bat	V,P		16	
Animalia	Mammalia	Miniopteridae	1346	<i>Miniopterus australis</i>		Little Bent-winged Bat	V,P		88	
Animalia	Mammalia	Miniopteridae	3330	<i>Miniopterus orianae oceanensis</i>		Large Bent-winged Bat	V,P		51	
Plantae	Flora	Elaeocarpaceae	6205	<i>Tetratheca glandulosa</i>			V		1	
Plantae	Flora	Elaeocarpaceae	6206	<i>Tetratheca juncea</i>		Black-eyed Susan	V	V	2212	
Plantae	Flora	Myrtaceae	4007	^^ <i>Callistemon linearifolius</i>		Netted Bottle Brush	V,3		2	
Plantae	Flora	Myrtaceae	6809	<i>Melaleuca biconvexa</i>		Biconvex Paperbark	V	V	9	
Plantae	Flora	Myrtaceae	4283	<i>Rhodamnia rubescens</i>		Scrub Turpentine	E4A		7	
Plantae	Flora	Myrtaceae	4284	<i>Rhodomyrtus psidioides</i>		Native Guava	E4A		1	
Plantae	Flora	Myrtaceae	4293	<i>Syzygium paniculatum</i>		Magenta Lilly Pilly	E1	V	3	
Plantae	Flora	Orchidaceae	9027	^ <i>Diuris praecox</i>		Rough Doubletail	V,P,2	V	881	

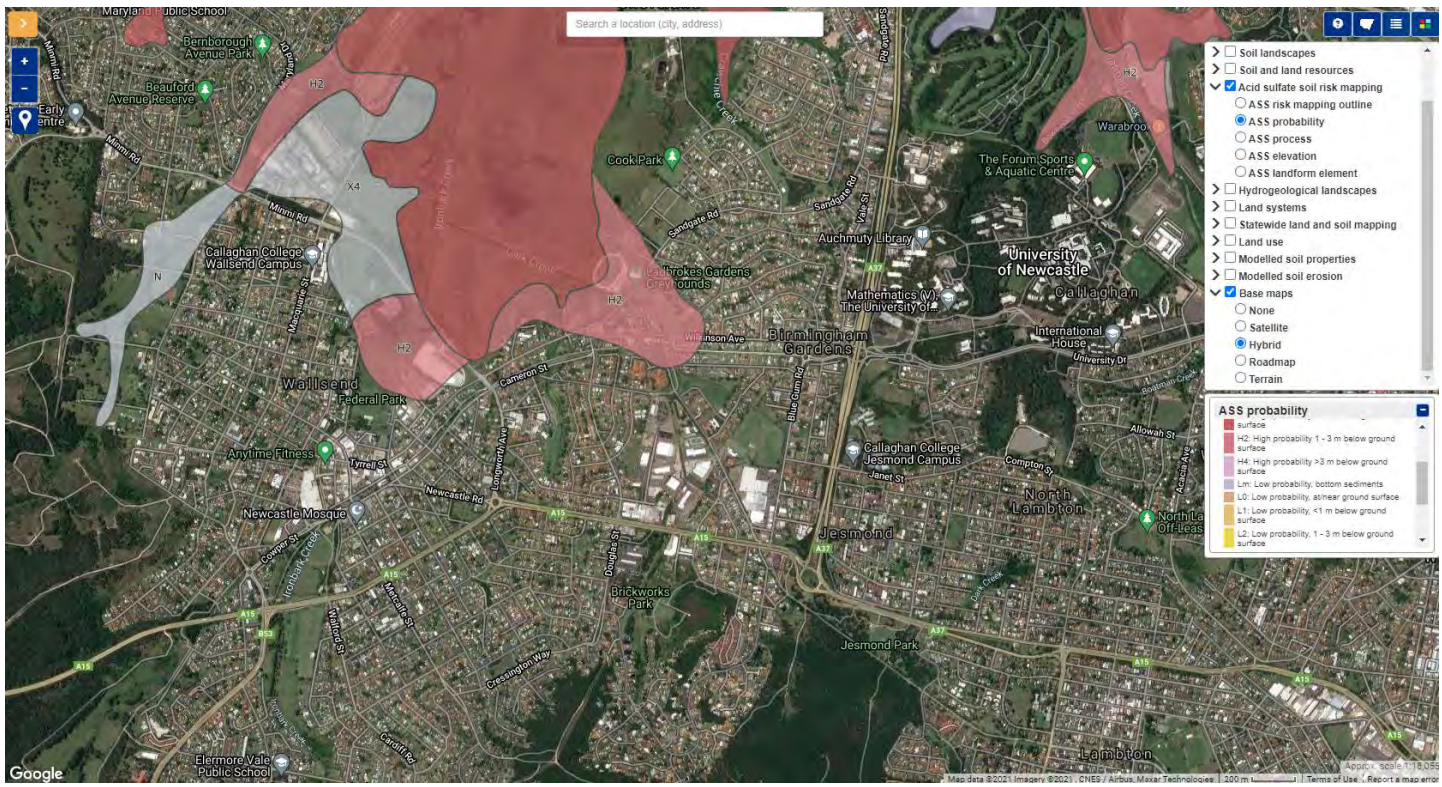
Plantae	Flora	Proteaceae	10009	<i>Grevillea parviflora</i> <i>subsp. parviflora</i>	Small-flower Grevillea	V	V	5	
Plantae	Flora	Proteaceae	5400	<i>Grevillea shiressii</i>		V	V	7	
Plantae	Flora	Zannichelliaceae	6339	<i>Zannichellia palustris</i>		E1		27	

#### NSW Status

<b>1</b> Sensitivity Class 1 (Sensitive Species Data Policy)
<b>2</b> Sensitivity Class 2 (Sensitive Species Data Policy)
<b>3</b> Sensitivity Class 3 (Sensitive Species Data Policy)
<b>CC</b> Collapsed Ecological Community (Biodiversity Conservation Act 2016)
<b>CH</b> Critical Habitat (Biodiversity Conservation Act 2016)
<b>E1</b> Endangered (Biodiversity Conservation Act 2016)
<b>E2</b> Endangered Population (Biodiversity Conservation Act 2016)
<b>E3</b> Endangered Ecological Community (Biodiversity Conservation Act 2016)
<b>E4</b> Presumed Extinct (Biodiversity Conservation Act 2016)
<b>E4A</b> Critically Endangered (Biodiversity Conservation Act 2016)
<b>E4B</b> Critically Endangered Ecological Community (Biodiversity Conservation Act 2016)
<b>EW</b> Extinct in the Wild (Biodiversity Conservation Act 2016)
<b>FCE</b> Critically Endangered Fish (Fisheries Management Act 1994)
<b>FE</b> Endangered Fish (Fisheries Management Act 1994)
<b>FEC</b> Endangered Ecological Community of Fish (Fisheries Management Act 1994)
<b>FEP</b> Endangered Population of Fish (Fisheries Management Act 1994)
<b>FKTP</b> Key Threatening Process of Fish (Fisheries Management Act 1994)
<b>FP</b> Protected Fish (Fisheries Management Act 1994)
<b>FV</b> Vulnerable Fish (Fisheries Management Act 1994)
<b>FX</b> Extinct Fish (Fisheries Management Act 1994)
<b>KTP</b> Key Threatening Process (Biodiversity Conservation Act 2016)
<b>P</b> Protected (National Parks & Wildlife Act 1974)
<b>V</b> Vulnerable (Biodiversity Conservation Act 2016)
<b>V2</b> Vulnerable Ecological Community (Biodiversity Conservation Act 2016)

#### Commonwealth Status

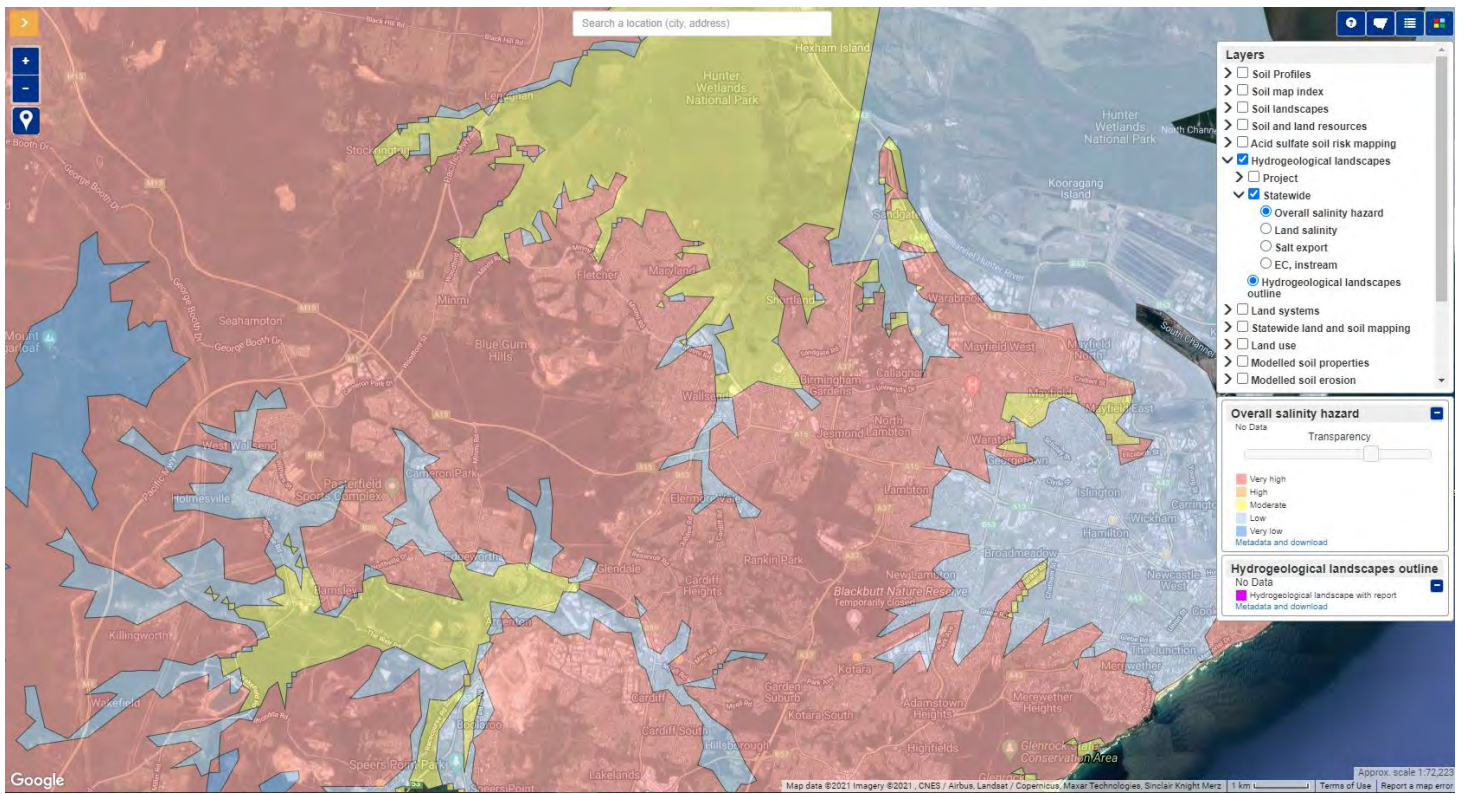
<b>C</b> Listed on China Australia Migratory Bird Agreement
<b>CD</b> Conservation Dependent (Commonwealth EPBC Act 1999)
<b>CE</b> Critically Endangered (Commonwealth EPBC Act 1999)
<b>E</b> Endangered (Commonwealth EPBC Act 1999)
<b>J</b> Listed on Japan Australia Migratory Bird Agreement
<b>K</b> Listed on Republic of Korea Australia Migratory Bird Agreement
<b>KTP</b> Key Threatening Process (Commonwealth EPBC Act 1999)
<b>V</b> Vulnerable (Commonwealth EPBC Act 1999)
<b>X</b> Extinct (Commonwealth EPBC Act 1999)
<b>XW</b> Extinct in the Wild (Commonwealth EPBC Act 1999)



- Soil landscapes
- Soil and land resources
- Acid sulfate soil risk mapping
  - ASS risk mapping outline
  - ASS probability
  - ASS process
  - ASS elevation
  - ASS landform element
- Hydrogeological landscapes
- Land systems
- Statewide land and soil mapping
- Land use
- Modelled soil properties
- Modelled soil erosion
- Base maps
  - None
  - Satellite
  - Hybrid
  - Roadmap
  - Terrain

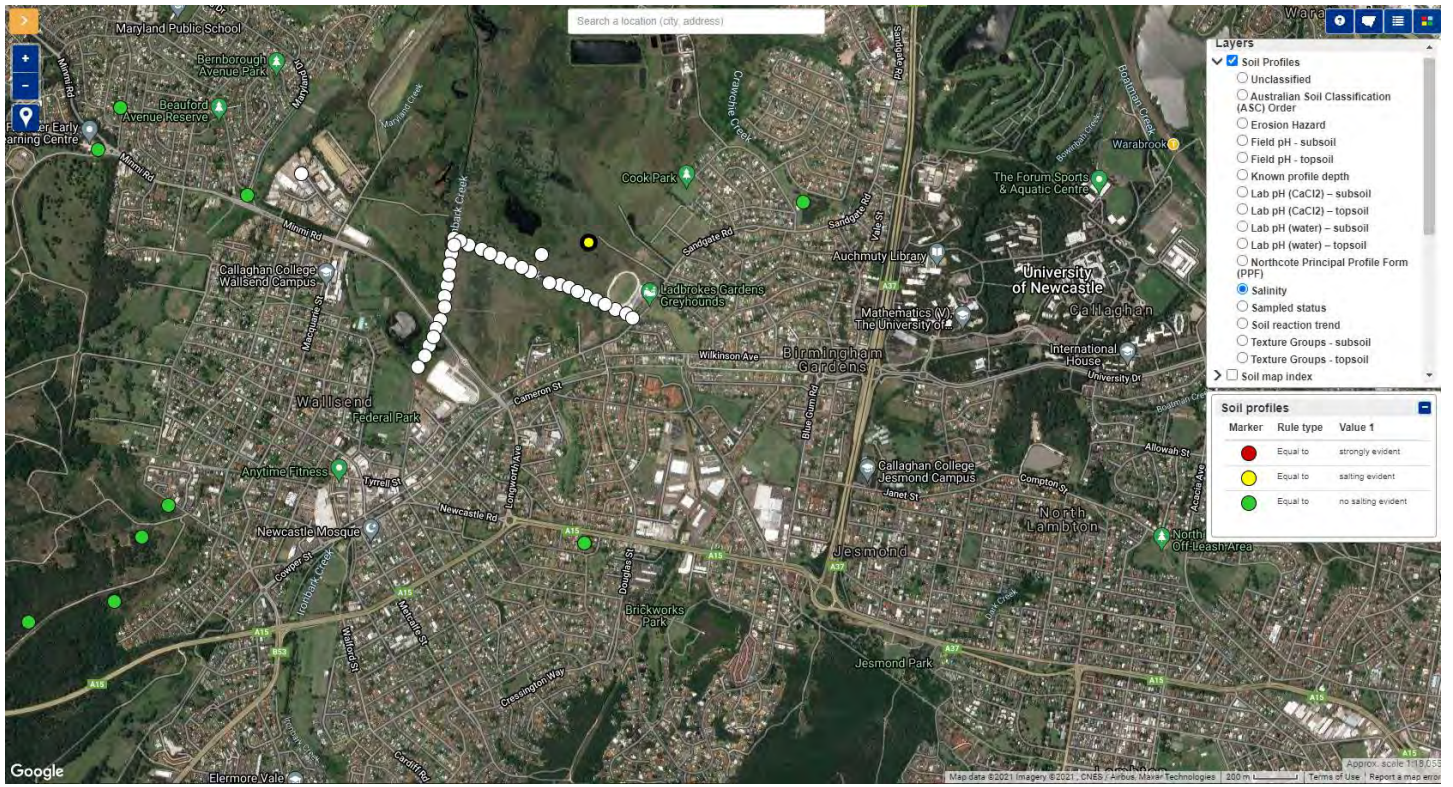
**ASS probability**

- Surface
- H0: high probability 1 - 3 m below ground surface
- H4: High probability >3 m below ground surface
- Lm: Low probability, bottom sediments
- L0: Low probability, at/near ground surface
- L1: Low probability, <1 m below ground surface
- L2: Low probability, 1 - 3 m below ground surface









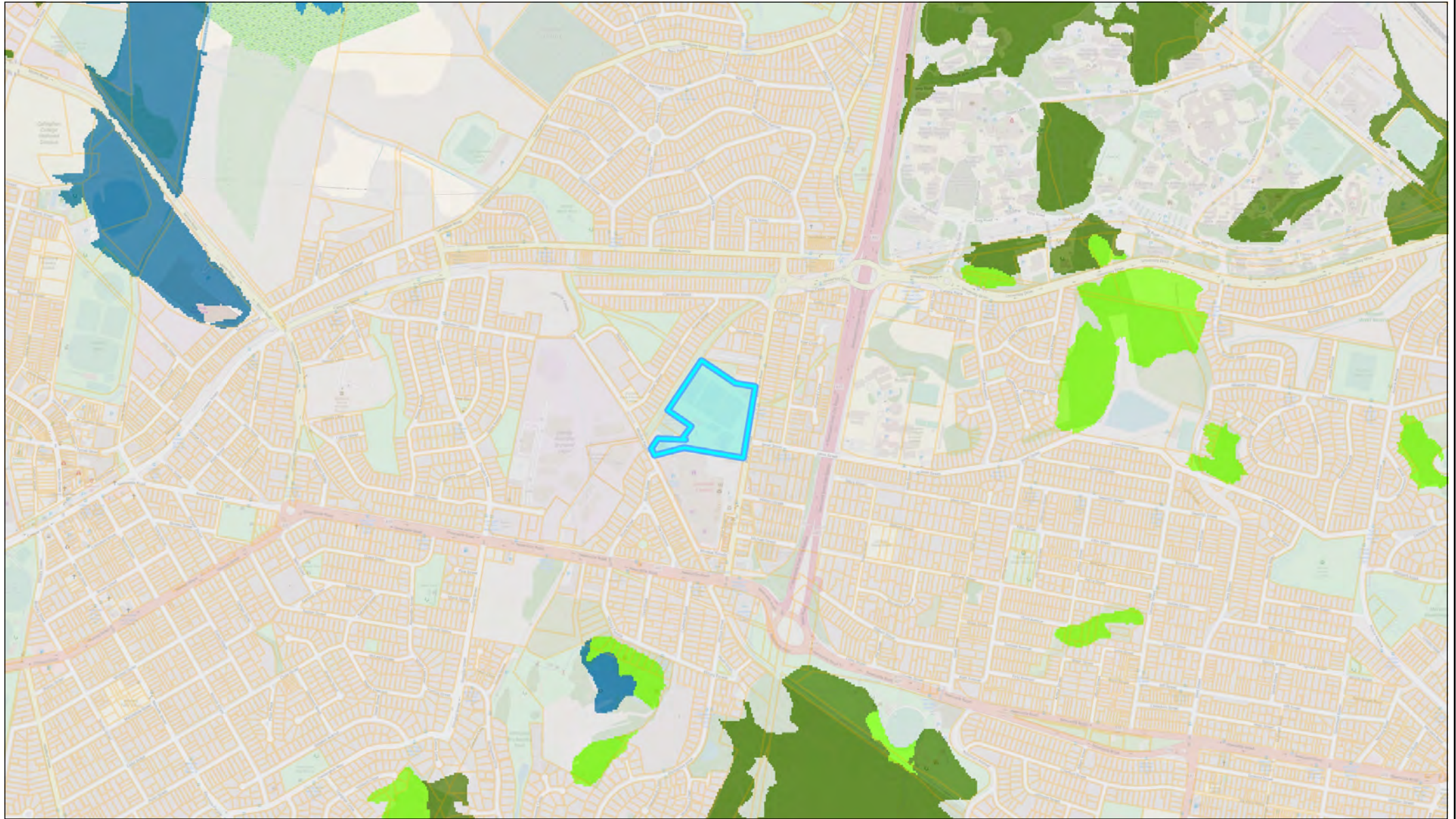


**SEED**

Sharing and Enabling Environmental Data

# Dark Creek Heaton Park

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0.9 0 0.45 0.9 Kilometers

Scale 1: 18,055.95

WGS\_1984\_Web\_Mercator\_Auxiliary\_Sphere

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Generated from SEED web map. Created 7:04 PM 3/9/2021

# Legend

## Keith\_Class

- No equivalent
- Coast and Tableland Riverine Forests
- Coastal Dune Dry Sclerophyll Forests
- Coastal Floodplain Wetlands
- Coastal Freshwater Lagoons
- Coastal Headland Heaths
- Coastal Heath Swamps
- Coastal Swamp Forests
- Coastal Valley Grassy Woodlands
- Cool Temperate Rainforests
- Dry Rainforests
- Eastern Riverine Forests
- Hunter-Macleay Dry Sclerophyll Forests
- Inland Floodplain Woodlands
- Inland Riverine Forests
- Inland Rocky Hill Woodlands
- Littoral Rainforests
- Mangrove Swamps
- Maritime Grasslands
- Montane Bogs and Fens
- New England Dry Sclerophyll Forests
- New England Grassy Woodlands
- North Coast Dry Sclerophyll Forests
- North Coast Wet Sclerophyll Forests
- North-west Slopes Dry Sclerophyll Woodlands
- Northern Escarpment Dry Sclerophyll Forests
- Northern Escarpment Wet Sclerophyll Forests
- Northern Gorge Dry Sclerophyll Forests
- Northern Hinterland Wet Sclerophyll Forests
- Northern Montane Heaths
- Northern Tableland Wet Sclerophyll Forests
- Northern Warm Temperate Rainforests
- Northern Wattle Dry Sclerophyll Forests
- Pilliga Outwash Dry Sclerophyll Forests
- Shoalhaven Plain Woodlands
- Saltmarshes
- South Coast Sands Dry Sclerophyll Forests
- Southern Escarpment Wet Sclerophyll Forests
- Subtropical Rainforests
- Sydney Coastal Dry Sclerophyll Forests
- Sydney Coastal Heaths
- Sydney Hinterland Dry Sclerophyll Forests
- Sydney Montane Dry Sclerophyll Forests
- Sydney Montane Heaths
- Sydney Sand Flats Dry Sclerophyll Forests
- Tableland Clay Grassy Woodlands
- Wallum Sand Heaths
- Western Slopes Dry Sclerophyll Forests
- Western Slopes Grasslands
- Western Slopes Grassy Woodlands
- Western Vine Thickets
- Lot

## APPENDIX E

### Flood Impact Assessment

# Technical Memo

**To:** Shaun Murphy  
Hunter Water

**From:** Peter Gillam  
Aurecon

**CC:**

**Date:** 13/07/2022

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**Subject:** Flood Impact Assessment: Proposed stormwater amenity works for Dark Creek, Jesmond (Final)

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**Author** Shae Jelly

**Reviewer** Peter Gillam

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## 1 Introduction

This memo outlines the methodology and outcomes of the flood impact assessment for the proposed stormwater amenity works on a section of Dark Creek at Heaton Park, Jesmond.

The proposed works extend over two lengths of the channel within Heaton Park as part of the Hunter Water (HW) Stormwater Amenity works program for completion by June 2024.

A flooding investigation has been carried out using a two-dimensional hydraulic model (TUFLOW) to determine:

- Whether the detailed design of amenity works at Dark Creek would cause any adverse impacts to existing flood conditions
- Whether hydraulic conditions along the works area would change flood behaviour downstream
- Typical velocities and bed shear stresses along the works area to inform the stabilisation techniques and sizing of rock rip rap.

## 2 Proposed Amenity Works

The proposed works include planting and creek naturalisation works over two lengths of Dark Creek in Heaton Park as shown in Figure 2-1 and Figure 2-2. Works are within Hunter Water lands and Council land.

The works include:

- Saw cutting and removing sections of vertical concrete channel walls
- Laying back the creek banks at a 1V:2H gradient
- Placing interlocking sandstone rock riprap over the creek banks
- Planting within the rip rap and on overbank areas
- Adding a maintenance edge on the south-north length
- Planting around the bend between the two sections

Increases in floodplain roughness associated with planting and bank works (increase in Manning's  $n$  coefficient) has been offset by increasing the cross-sectional area of the channel to minimise flood afflux.

Hydraulic design (Manning's formula) was undertaken during concept designs development. Detailed flood modelling using a TUFLOW 2D hydraulic model was undertaken to confirm the expected flood impacts of the detailed design and determine the expected velocities and shear stresses across the works area.

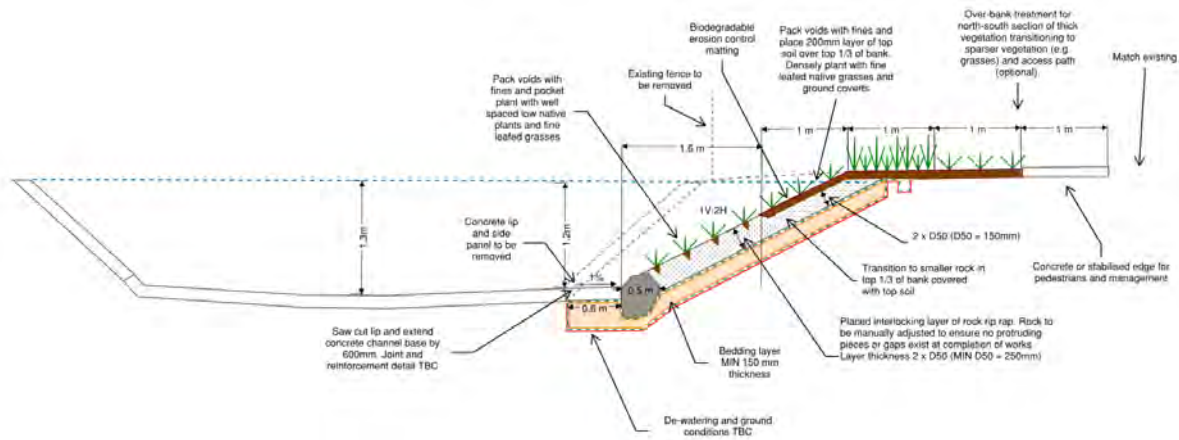


Figure 2-1 Concept design upstream section of creek naturalisation works at Dark Creek, Heaton Park, Jesmond

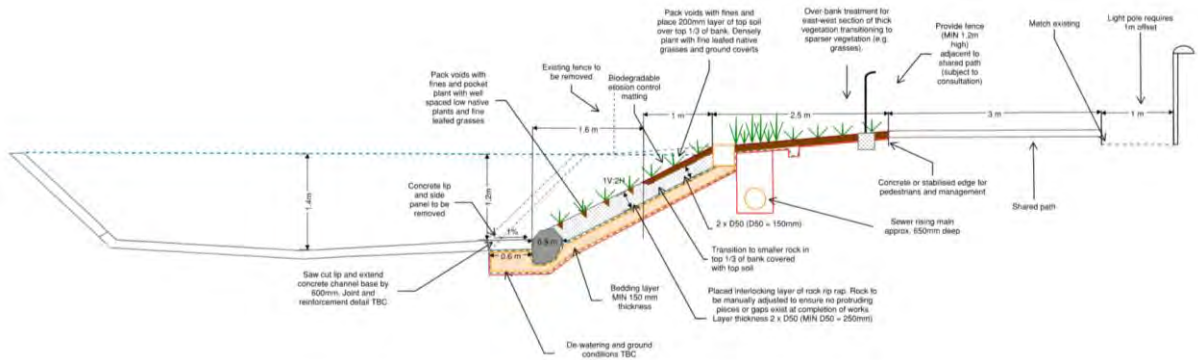


Figure 2-2 Concept design downstream section of creek naturalisation works at Dark Creek, Heaton Park, Jesmond



Figure 2-3 Concept design upstream plan of creek naturalisation works at Dark Creek, Heaton Park, Jesmond

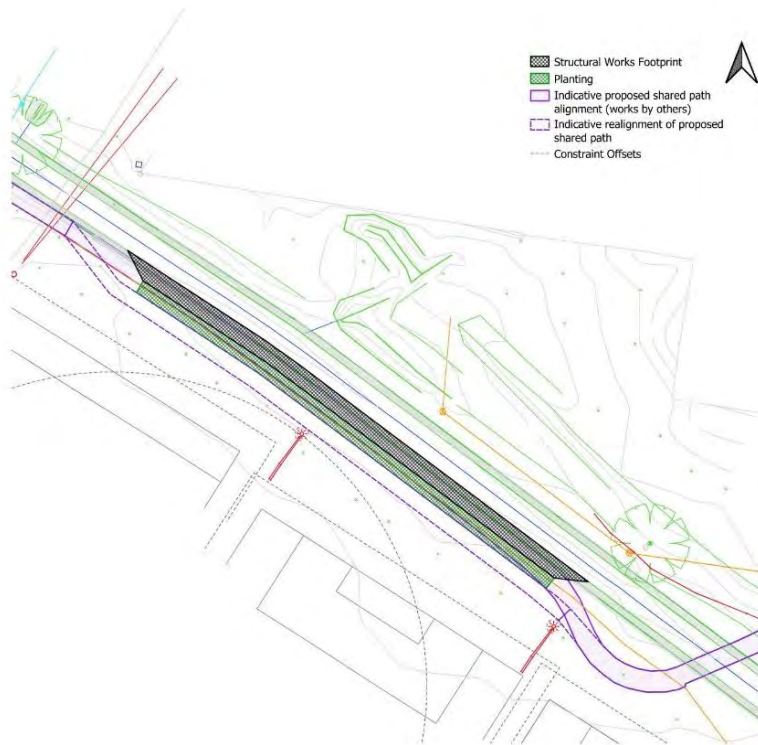


Figure 2-4 Concept design downstream plan of creek naturalisation works at Dark Creek, Heaton Park, Jesmond



### 3 Existing flood modelling data sets held by Council

Flood modelling has previously been undertaken by DHI Water and Environment on behalf of The City of Newcastle (NCC) for the Dark Creek Flood Study (July, 2008).

The NCC Dark Creek MIKE Flood (version 2007) model consisted of the main river channels modelled as 1D elements with the overbank area modelled as 2D. A XP-RAFTS hydrological model was used to determine the inflow hydrographs for use in the MIKE Flood model. The NCC Dark Creek model is calibrated/validated to the 27 April 1988 (Morning) and 27/28 April 1988 (Night) historical flood events.

The results from the NCC Dark Creek MIKE Flood model and some model files were supplied by Council, however it was not confirmed that the model was the final and approved version but is still understood to form a reasonable basis for the current flood impact assessment.

A new TUFLOW model was developed (herein referred to as the HW Dark Creek TUFLOW model) and the NCC Dark Creek MIKE Flood results provided by Council were used to extract design hydrographs to reflect the flood levels modelled in the Dark Creek Flood Study (2008).

### 4 Aurecon modelling methodology

A new model has been established specific for testing the hydraulic design. The model is intended to test the impacts of the detailed design on a range of flow events. The flows selected represent a range of typical flood events of interest as follows:

- Bank full discharge - the design should not affect the level of service provided by the channel
- 10% AEP – the design must have an acceptable impact on local drainage patterns and not worsen the frequency of nuisance flooding
- 1% AEP event flow – the design must not increase flooding on roads or private property or reduce flood immunity for this event and must have an acceptable impact on public lands and roads
- PMF event flows – the design should have an acceptable impact on PMF flood levels

Detailed parameters associated with HW TUFLOW modelling approach and set up of the model are outlined in the following sections.

#### 4.1 Design inflows

The 10% and 1% AEP event and the PMF event were adopted as the design events for this flooding investigation. The hydrographs for these events were extracted directly from the NCC Dark Creek MIKE Flood results using WaterRide at each of the inflow locations of the HW Dark Creek TUFLOW model.

At the site, the critical duration of 6 hours was adopted for the 10% and 1% AEP and the PMF event. Only these critical durations were modelled in the HW Dark Creek model.

The bank-full flow was also considered, which was generated by first running the 10% event and extracting the flow that results in bank-full flow in the HW Dark Creek model. This flow was applied to the model using a synthetic hydrograph of constant flow.

#### 4.2 Hydraulic model parameters

A summary of the hydraulic model and parameters is provided in Table 4-1. The HW Dark Creek TUFLOW model developed for the site was reduced to the area of interest and is shown in Figure 4-3.

The model extent starts upstream of the Blue Gum Road culvert that is upstream of the proposed works and extends past the Fraser Street bridge on the downstream end.

Table 4-1 Hydraulic model parameters

Parameter	Hunter Water Dark Creek TUFLOW Model
Completion date	April 2022
Events/durations assessed	Bank-full flow 10% 360min 1% 360min PMF 360min
Hydrologic modelling	Hydrographs extracted from NCC Dark Creek TUFLOW model (based on hydrology from XP-RAFTS model of ARR1987 hydrology)
Hydraulic model software	TUFLOW quadtree model with version 2020-10-AB-iSP-w64
Grid size	2m cell size within the floodplain with 0.5m nested mesh refinement over the extent of site works
DEM	Refer Figure 4-1 for data coverage. <ul style="list-style-type: none"> <li>• 1m LiDAR – NSW Government LiDAR data set September 2014</li> <li>• Survey data collected by Aurecon in 2021</li> <li>• Design terrain modelling</li> </ul>
Roughness	Refer to section 4.2.2 Previously agreed
Model boundaries	Refer to section 4.2.5
Timesteps	Automatic adaptive time step
Sensitivity case	Refer to section 5.3

### 4.2.1 Terrain

The base terrain data used for this project was the NSW Government 1m LiDAR data from September 2014, and this was then supplemented with detailed site survey. A design TIN has also been created for creek naturalisation structural works and was read into the TUFLOW model in the proposed scenario. The coverage of these datasets can be seen in Figure 4-1.

A terrain modification was made to better represent the hydraulic conveyance in the base model, by smoothing the in-channel transition between the survey data and LiDAR at the downstream end near Fraser Street.

Representation of both the floodplain and channel in the 2D domain and the use of a different modelling software is a significant difference from the existing modelling carried out by DHI. This modelling approach may yield different hydraulic outcomes. However, given the approach of this modelling is to determine the extent of velocities, bed shear stresses and potential for flood afflux, a 2D modelling approach is preferred to representing the channel works as a nested 1D channel.



Figure 4-1 Topographic data coverage

## 4.2.2 Roughness

The Manning’s n roughness coefficients adopted for the baseline are consistent with modelling at other Hunter Water works sites. Some of the Manning’s n values adopted in the baseline event are lower than those used in the NCC Dark Creek model, which was done to ensure that changes in roughness were associated with the works were appropriately captured in the hydraulic modelling roughness parameters. Adopted roughness parameters have been agreed with Council during earlier correspondence.

The adopted Manning’s coefficients are shown in Table 4-2 and the layout of these categories is shown in Figure 4-2.

Table 4-2 Roughness values

Material	Manning’s n	
	NCC Model	HW Model Base Model Setup
Concrete channel	0.025	0.018
Roads	0.02	0.02
Riprap and pocket planting	-	0.04
Medium dense veg overbank		
Spaced trees		
Moderate vegetated banks	-	0.045
Thick vegetation	0.055	0.06
Fence / Fenced lot	-	0.1
Default floodplain	0.04 (grassed surfaces)	0.03
New concrete (shared path)	-	0.015

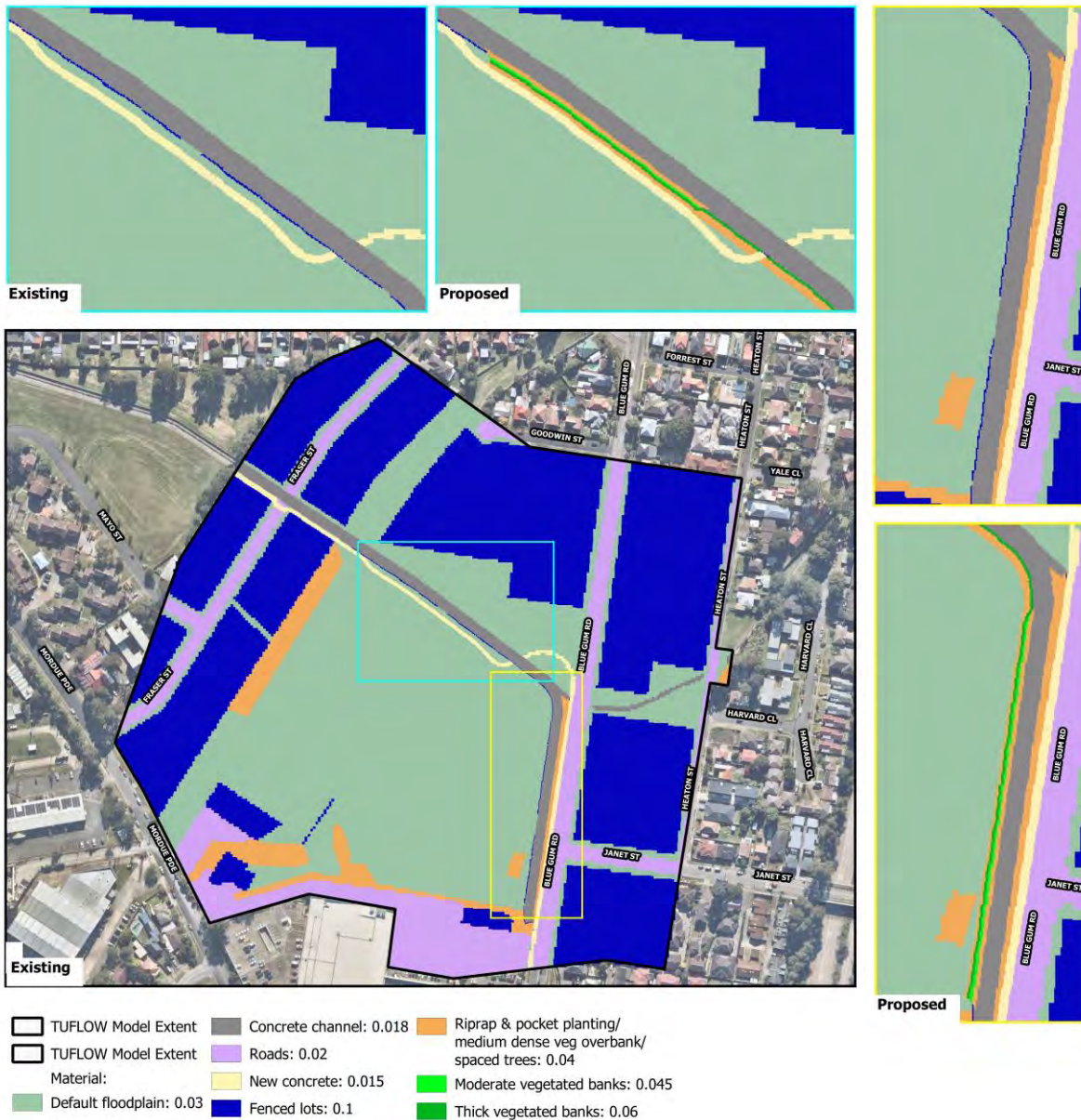


Figure 4-2 Manning's n coefficients for existing and proposed scenarios

### 4.2.3 Structures

There are several structures in the NCC Dark Creek MIKE model including the culverts under Blue Gum Road and under Heaton Street, the pedestrian bridge in Heaton Park, and the pedestrian bridge at Fraser Street. The details behind how these structures were modelled were kept consistent where possible but were updated in some cases as noted in Table 4-3.

It should be noted that all structures in the MIKE Flood model are 1D, whereas bridge structures are modelled as 2D flow constrictions in TUFLOW. Where these bridges were modelled in TUFLOW, a form loss coefficient of 0 was applied beneath the deck and 1.56 for the deck in line with the other Hunter Water works site models.

Table 4-3 1D and 2D structures in NCC and HW Dark Creek models

Structure	NCC Dark Creek MIKE Flood	HW Dark Creek TUFLOW
Heaton Road culvert (tributary)	1D 0.6m x 1.39m x 22m box culvert US/DS inverts: 4.2/4.1m AHD	1D 0.6m x 1.39m x 22m box culvert US/DS inverts: 4.6/4.5m AHD <b>Note:</b> inverts updated to better match LiDAR
Blue Gum Road culvert (tributary)	1D 1.2m x 2.7m x 22m box culvert US/DS inverts: 4.2/4.1m AHD	1D 1.2m x 2.7m x 22m box culvert US/DS inverts: 4.2/4.1m AHD
Blue Gum Road culvert (main channel)	1D Bridge soffit: 6.27 m AHD Bridge deck: 6.67 m AHD	1D 5.3m x 1.35m x 39m box culvert US/DS inverts: 4.45/4.35m AHD <b>Note:</b> modelled as culvert to maintain the structure as a 1D element for the purpose of applying the 1D model inflow at this upstream boundary. Inverts set based on LiDAR and survey, dimensions set based on survey of the channel cross section.
Heaton Park pedestrian bridge	1D Bridge soffit: 5.72 m AHD Bridge deck: 6.02 m AHD	2D Bridge soffit: 5.72 m AHD Bridge deck: 6.02 m AHD
Fraser Street pedestrian bridge	1D Bridge soffit: 4.38 m AHD Bridge deck: 4.68 m AHD	2D Bridge soffit: 4.38 m AHD Bridge deck: 4.68 m AHD

#### 4.2.4 Initial water level

The terrain elevation over the HW Dark Creek model extent is above 2.7 m AHD, which is higher than the 2 m AHD 'high tailwater' sensitivity case modelled in the NCC Dark Creek Flood Study. This indicates that there is no tailwater influence within the model extent and as such, a static initial water level was not applied to the model domain.

#### 4.2.5 Boundary conditions

The TUFLOW inflow and outflow boundaries are shown in Figure 4-3.

As previously discussed, the inflow hydrographs were extracted from NCC Dark Creek model results at the same locations as the HW Dark Creek model inflow boundaries.

As previously discussed, it has been assumed that there is no tailwater level influence at this elevation in the Dark Creek catchment. As such, the model outflows have been modelled using conveyance boundaries. Flow through conveyance boundaries is dependent on a pre-defined height-discharge

relationship generated in TUFLOW. The downstream slope at these boundaries is labelled in m/m on Figure 4-3.



Figure 4-3 TUFLOW Model Setup

## 5 Hydraulic Model Results

A comparison between flood conditions was undertaken for the site with and without the proposed stormwater amenity works.

Flow velocities and bed-shear-stresses were determined along the proposed works area to inform the design of stabilisation works.

The 1% AEP model performance was also compared to the existing mapping provided by NCC and is provided below in Section 6.

## 5.1 Hydraulic impacts

A flood impact assessment has been undertaken to determine the potential impact of the proposed creek naturalisation works on flood behaviour. The flood impact maps for the bank-full flow, 10% AEP, 1% AEP and PMF flow events are presented in Appendix A Figures A1 to A4.

These impacts represent the extent of structural works shown in Figure 2-3 and Figure 2-4, and the planting extent shown in Figure 4-2. However, it is noted that the extent of the final works is subject to final costing, construction budgets or constraints found on site which may reduce the final extent of planting, channel and rock works.

Flood level impacts maps of the modelled works show that during the bank-full flow estimation there is potential for some localised changes in flood levels along the extent of structural works, but for larger events these impacts are relatively localised and minor in extent.

In the 10% AEP the impacts around the works transitions result in an increase < 60 mm in peak flood levels in the undeveloped lot on the north side of the channel over an extent of 126m<sup>2</sup>, and 11m<sup>2</sup> that is newly inundated. This impact is at the end of the works where the channel profile changes from the design profile back to the existing concrete walls. Within this same lot on the north side of the channel there is also large extent (approximately 2088m<sup>2</sup>) of reduced flood levels (an average of 11mm reduction), and a total of 44m<sup>2</sup> that is no longer inundated.

The peak flood level impacts maps show that for the 1% AEP and greater, flood impacts are limited to the extent of bank works or are located directly around the works transitions. Extending the proposed works will not impact on private property or roads and therefore the modelling demonstrates that the works will not have a negative impact on flooding on the community or the feasibility of establishing development on adjacent land above the current flood planning level.

### 5.1.1 Hydraulic Impacts if Extent of Construction Works and New Planting Zones Are Altered

If the extent of the proposed channel works are reduced or extended, it is unlikely that there would be a different impact to flood levels than that already shown in the modelling undertaken.

If structural works are extended, it is unlikely that private property or Blue Gum Road would be impacted further in a 1% AEP event. Modelling of the proposed works shows that flood afflux is only likely to occur within the playing fields.

Similarly, if the extent of works is reduced, there would similarly be less impacts that shown.

The model has assumed a conservative width of planting between the two structural sections, and if this is reduced it will likely only result in locally reduced flood levels where floodplain roughness is reduced.

## 5.2 Design velocity

Flood velocity has also been reviewed for the proposed design case to ensure the rock sizes will not be subject to scour or uplift. The proposed case peak velocity maps are presented in Appendix A Figures A5 to A8.

These maps show that velocities over the rock riprap may exceed 2 m/s in the 10% AEP event and 2.5 m/s in the 1% AEP event. These higher velocities are typically at the transitions between the existing channel profile and the stormwater amenity works. The rock riprap and transition structures will be sized to accommodate these velocities.

Velocity sensitivity testing was also undertaken to determine the absolute range of velocities that may be experienced within the works area.



### 5.3 Sensitivity Testing of Roughness

A sensitivity test of Manning's *n* coefficients was undertaken to determine the sensitivity of hydraulic A sensitivity test of Manning's *n* coefficients was undertaken to determine the sensitivity of hydraulic behaviour to material roughness.

Manning's coefficients listed in Table 4-2 above were halved to reflect possible worst-case conditions, resulting in a significantly lower surface roughness.

The effect of reduced manning's roughness on 1% AEP velocities is shown in Figure 5-1 and Figure 5-2. It can be seen in the proposed scenario that velocities may exceed 2.5 m/s over the new 1V:2H banks.

The sensitivity test shows that the maximum velocities that could be expected would reach 4 m/s in some localised areas. The expected velocity over the proposed 1V:2H banks is an important consideration in the sizing of the rock riprap.

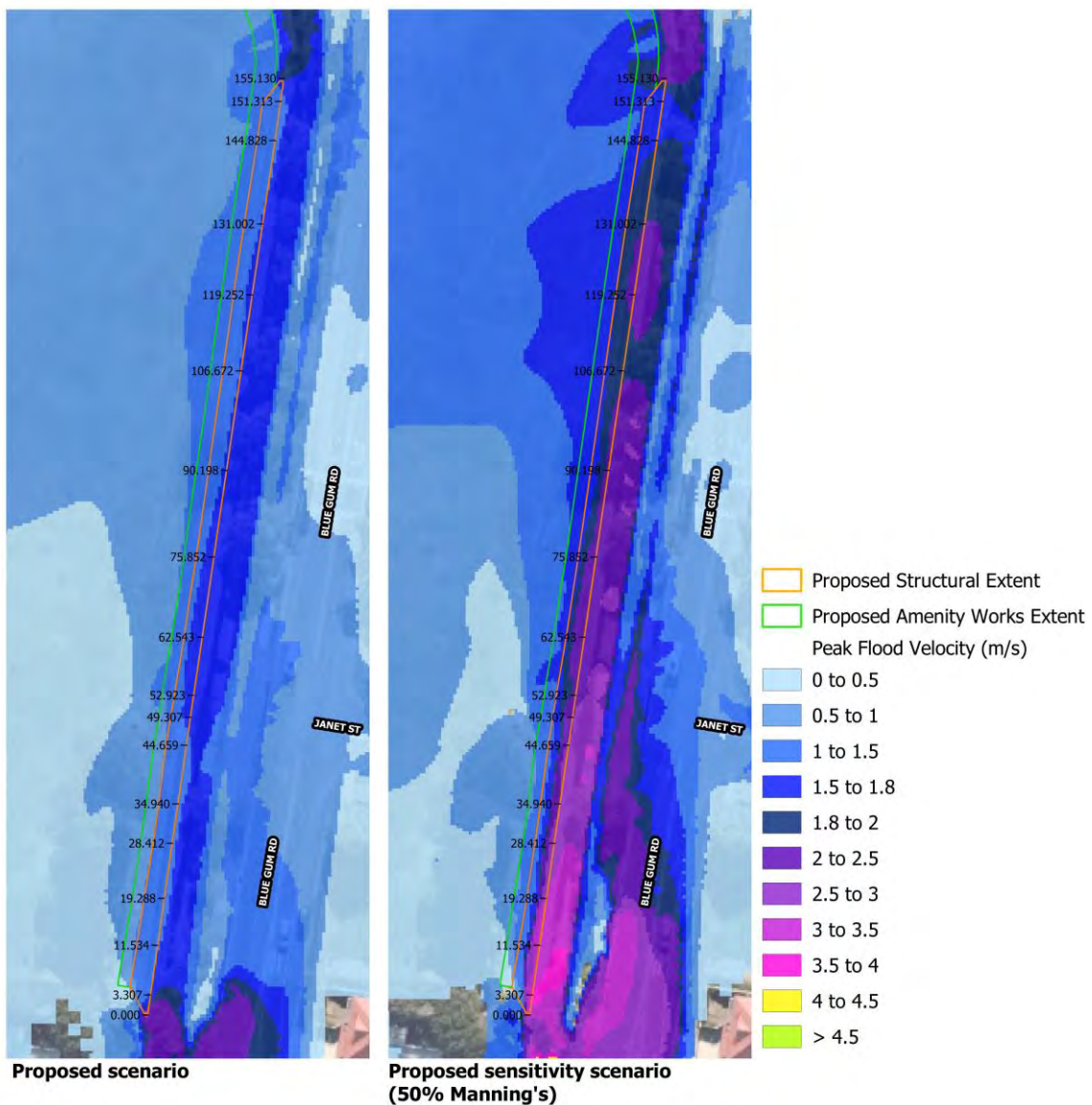
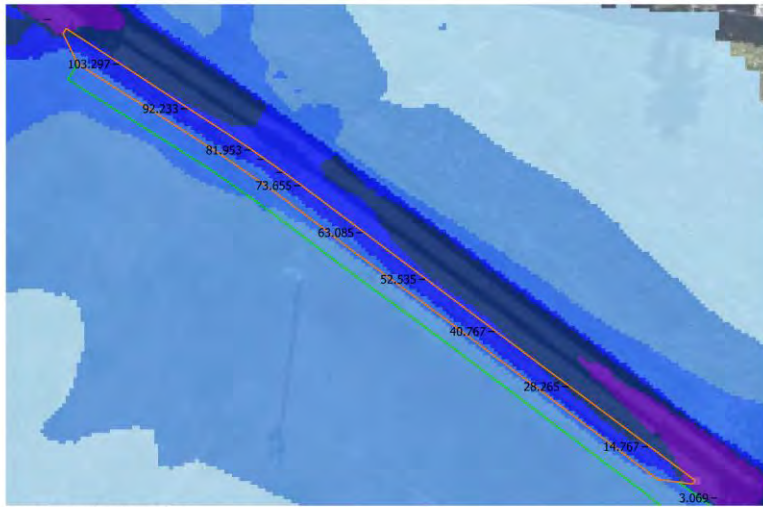
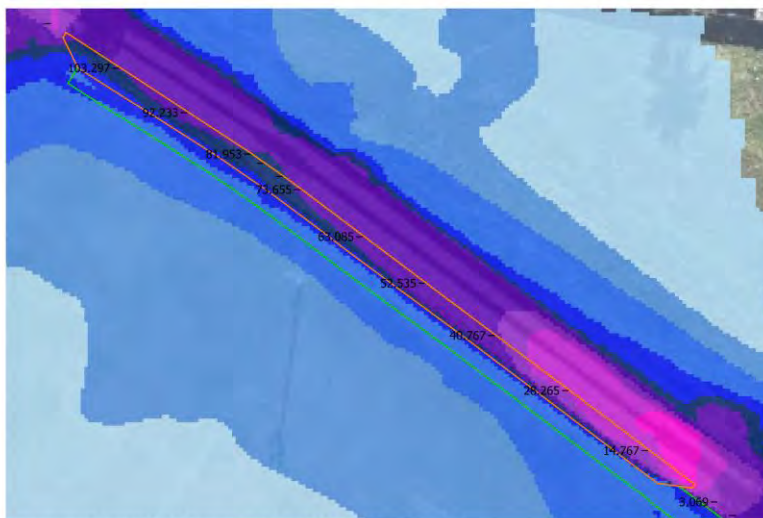


Figure 5-1 Design 1% AEP velocity and worst case velocity comparison at upstream works section



**Proposed scenario**



**Proposed sensitivity scenario (50% Manning's)**

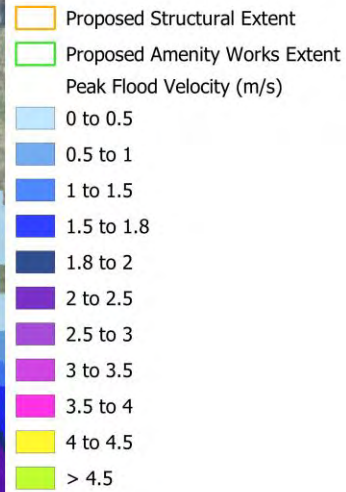


Figure 5-2 Design 1% AEP velocity and worst case velocity comparison at downstream works section

## 6 Model checks

Several model checks have been undertaken to review the model health and hydraulic behaviour of the model results. These model checks are discussed in the following sections.

### 6.1 Model health

The cumulative mass error output is a good indicator for model health, where a healthy model is considered to have a cumulative mass error of +/-1%.

Table 6-1 shows the CME outputs for each of the simulations.

Table 6-1 HW Dark Creek TUFLOW model health

Simulation	Final Cumulative Mass Error (CME) %
Bank full Existing	0.01
10% AEP 360min Existing	0.01
1% AEP 360min Existing	0.00
PMF 360min Existing	-0.00
Bank full Proposed	0.01
10% AEP 360min Proposed	0.01
1% AEP 360min Proposed	0.00
PMF 360min Proposed	-0.00

## 6.2 Hydrograph checks

A check of the flow hydrographs upstream and downstream of the project works for both existing case and proposed design scenario runs were compared to determine whether the design altered the flow regime. Combined flow plot output from the tributary and main channel immediately upstream of the works was summed and compared to the flow downstream of the works. These plot comparisons for the 10% AEP event and 1% AEP event are shown in Figure 6-1 and Figure 6-2 respectively.

These comparisons show that the flow behaviour between existing and proposed scenarios are effectively the same, and this behaviour remains similar both upstream and downstream of the proposed works. This indicates that while there does appear to be local flood impacts (in both an increase and decrease in levels) over the site works, the flow behaviour and floodplain storage remains effectively unchanged.

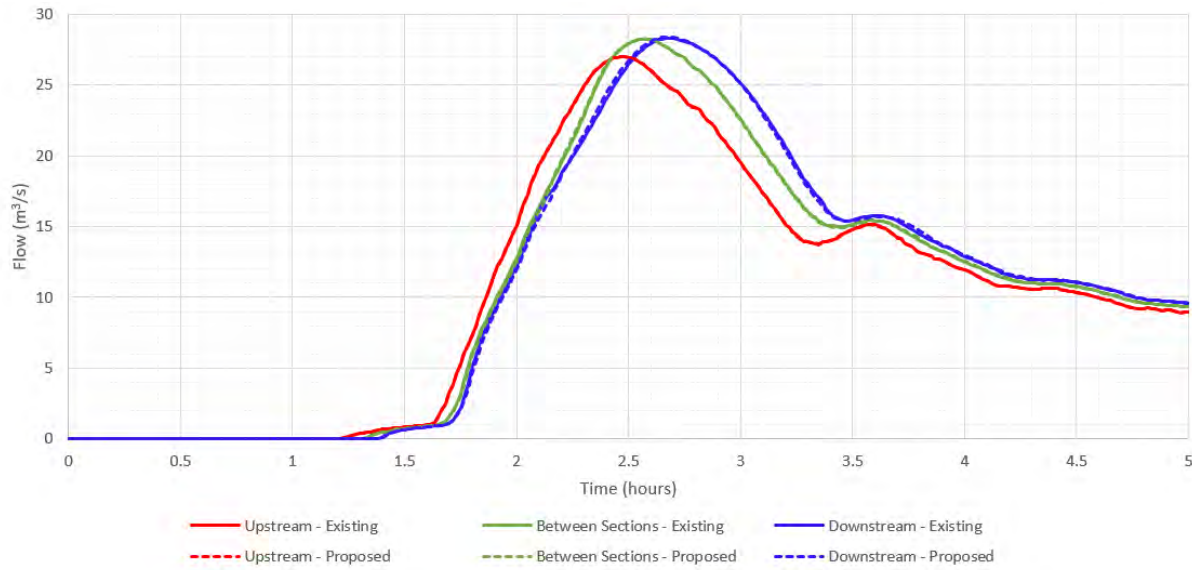


Figure 6-1 10% AEP flow plot comparisons upstream and downstream of the proposed works

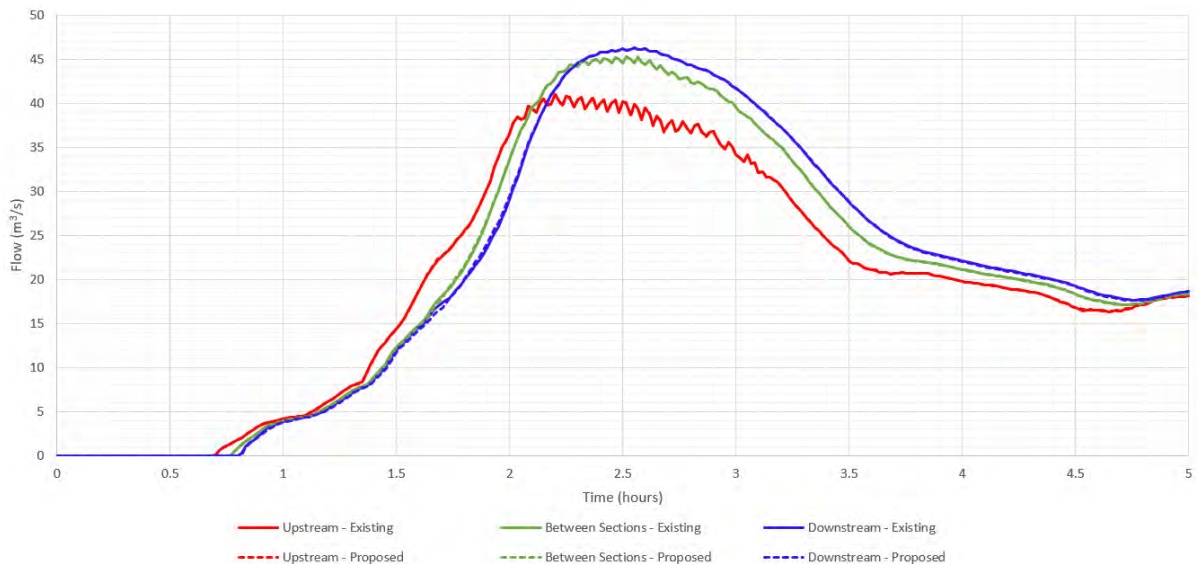


Figure 6-2 1% AEP flow plot comparisons upstream and downstream of the proposed works

Note: The 1% AEP hydrograph extracted from the 1D bridge in the MIKE Flood model showed instabilities at the peak flow. It is expected that the fluctuations apparent in Figure 6 2 above are a direct result of the hydrograph input.

### 6.3 Comparison to Council Flood Mapping

A comparison of the model peak flood extents between the NCC and HW Dark Creek model for 1% AEP and PMF events (critical durations) is compared below in Figure 6-3 and Figure 6-4 respectively.

These figures show that the HW Dark Creek model produces a reasonably well-matched flood extent to the NCC Dark Creek model for these events. Comparison of the 1% AEP event levels show that the HW Dark Creek model produces slightly lower levels than the NCC Dark Creek model but is typically within 100mm for the same 1% AEP flow and similar Manning's n values.

## 6.4 Validation of Flood Model

Base case model results of the existing floodplain were compared with the 1% AEP NCC model results. Flood levels compare reasonably well for the 1% AEP event results; with the HW 1% AEP flood levels within 100mm of the NCC model results. Further checks on the model performance show no mass errors or loss of mass across the model domain. Hydrograph boundaries at the downstream model show conservation of mass and no loss of floodplain storage.

The new HW TUFLOW model is considered to be an appropriate design tool for testing the incremental impacts of works in the floodplain.

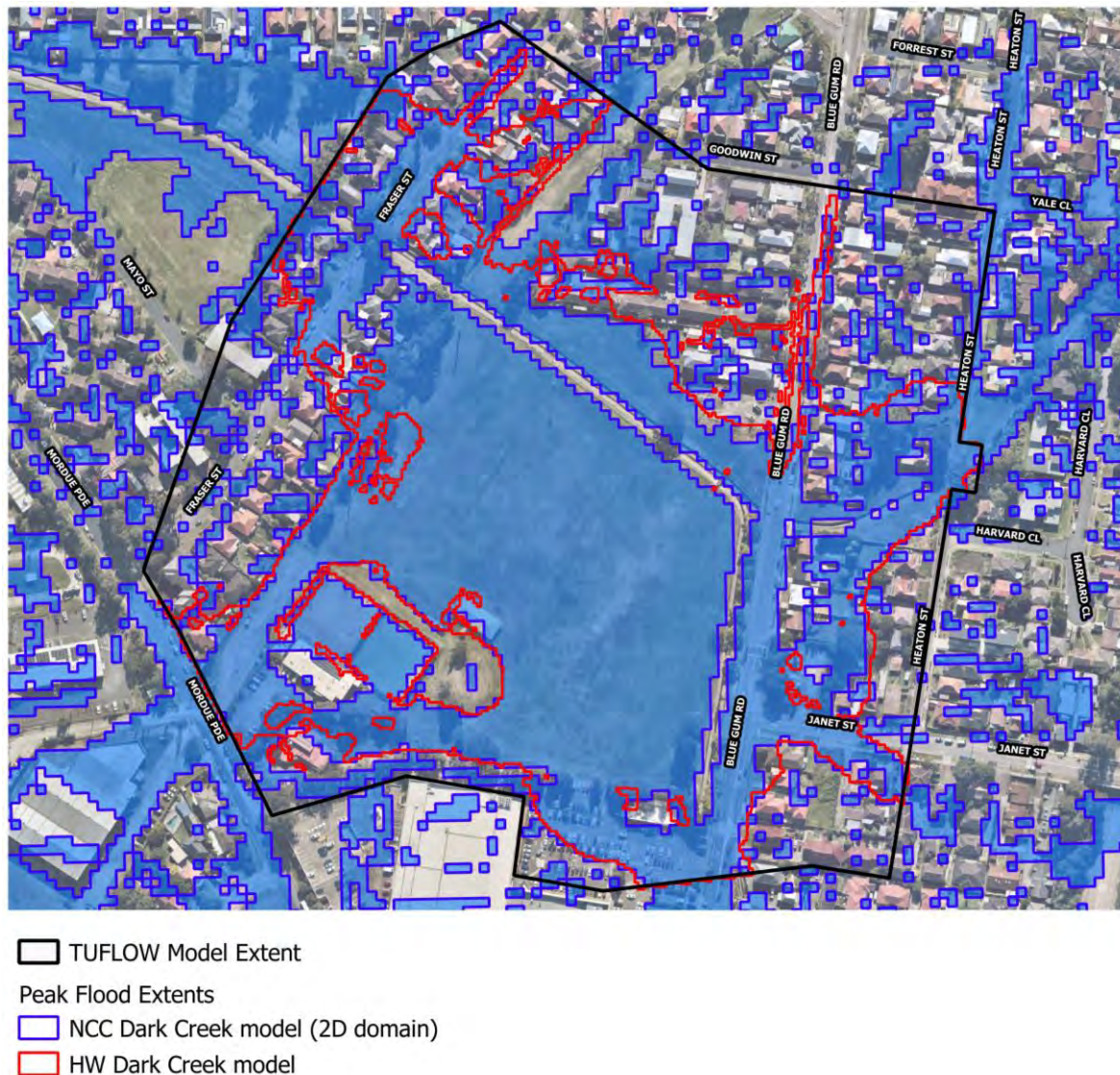
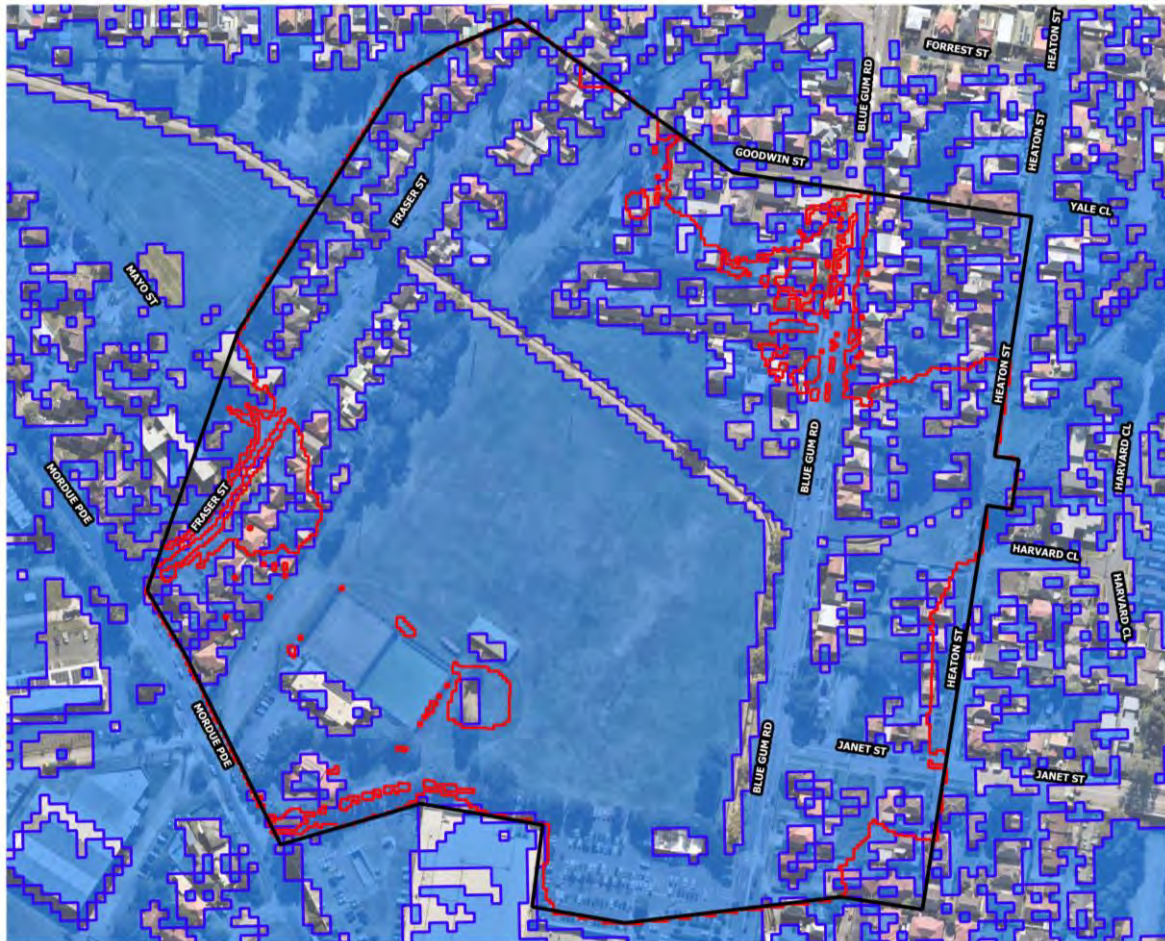


Figure 6-3 Comparison of model peak flood level extents for the 1% AEP extents



- TUFLOW Model Extent
- Peak Flood Extents
- NCC Dark Creek model (2D domain)
- HW Dark Creek model

Figure 6-4 Comparison of model peak flood level extents for PMF extents

## 7 Conclusions

The proposed works are located within flood prone land in the Dark Creek floodplain.

A flood impact assessment was undertaken where the bank-full flow, 10% Annual Exceedance Probability (AEP), 1% AEP and probable maximum flood (PMF) events were modelled using a new two-dimensional hydraulic model (TUFLOW).

### Model Development

The model uses a range of specific detailed site survey and locally specific Manning's values. Bridge data and a range of design flows were extracted from NCC Dark Creek model. Flows were extracted using WaterRide at the same locations as the HW Dark Creek model inflow boundaries.

The model uses a 2D grid to represent the channel.

### Model Validation

Base case model results of the existing floodplain were compared with the 1% AEP NCC model results. Flood levels compare reasonably well for the 1% AEP event results; with the HW 1% AEP flood levels within 100mm of the NCC model results. Further checks on the model performance show no mass errors or loss of mass across the model domain. Hydrograph boundaries at the downstream model show conservation of mass and no loss of floodplain storage.

Small differences between the NCC and HW models was not considered to require further validation of the HW Dark Creek TUFLOW modelling.

The HW model results match the flood conditions predicted by the NCC model and Manning's calculations.

The new HW TUFLOW model is an appropriate design tool for testing the incremental impacts of works in the floodplain.

### Flood Level Impacts

A comparison between flood conditions was undertaken for the site with and without the proposed stormwater amenity works.

The flood impact assessment indicates there is potential for localised increases in flood levels within the park for the immediate extent of the stormwater amenity works and locally around the transitions for a range of flow events.

Modelling shows that no increase in 1% AEP flooding will affect existing buildings, infrastructure, roads or private property.

Extensions or reductions in the extent/length of channel works extent are also unlikely to result in flood impacts to existing buildings, infrastructure, roads or private property.

### Velocity and Scour Protection

Flow velocities and bed-shear-stresses were determined along the proposed works area to inform the design of stabilisation works. The stormwater amenity improvement works will experience flooding and associated scour forces in a range of flows. Sensitivity testing of Manning's values provides the possible range of velocities that would be experienced by works area.

Model results demonstrate the expected scour velocities can be managed through a combination of placed rock and erosion control matting, such that no damage is likely to occur to works during flood events once all works are complete and stabilisation planting has been established.

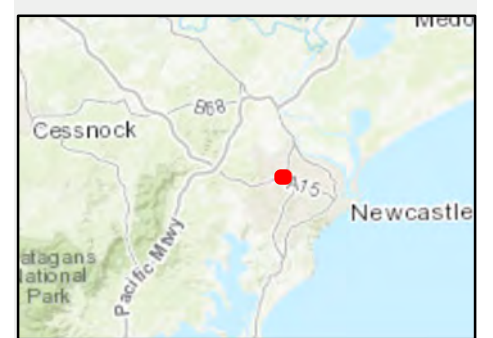
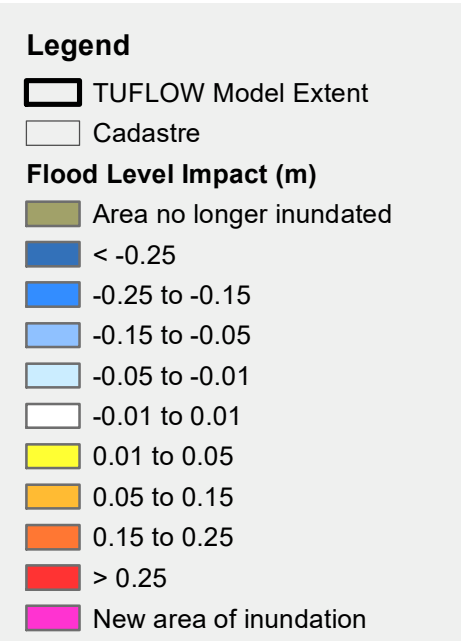


**Flood mapping**

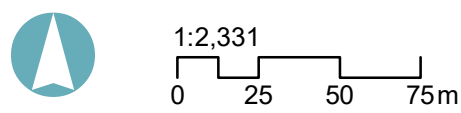




SWA\_N14\_BF\_Design\_planning-Ex\_quadtree\_2m\_002\_h\_Max  
SWA\_N14\_BF\_Design\_planning-Ex\_quadtree\_2m\_002\_h\_Max\_wd  
C:\Users\Shae.Jelly\Aurecon Group\512448 - HW DESP - SR00039 - Stormwater Amen - 5 Deliver Design\504 GIS\Mapping\_DDI\HW-DESP-SR00039\_Stormwater Amenity\_A3L\_Impacts\_N14.mxd\JOB No.130-06-22\Shae.Jelly\Rev 0



Source: Aurecon, Hunter H2O, Hunter Water, DPIE, Nearam, ESRI



Projection: GDA 1994 MGA Zone 56

FIGURE A1: Change in Peak Flood Level (Proposed vs. Existing) - Bank-full Flow



SWA\_N14\_10yr\_360min\_Design\_planting-Ex\_quadtree\_2m\_002\_h\_Max  
SWA\_N14\_10yr\_360min\_Design\_planting-Ex\_quadtree\_2m\_002\_h\_Max\_wd  
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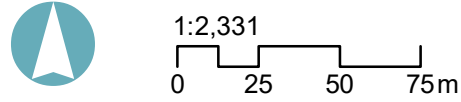


**Legend**

- TUFLOW Model Extent
- Cadastre
- Flood Level Impact (m)**
- Area no longer inundated
- < -0.25
- 0.25 to -0.15
- 0.15 to -0.05
- 0.05 to -0.01
- 0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- > 0.25
- New area of inundation



Source: Aurecon, Hunter H2O, Hunter Water, DPIE, Nearam, ESRI

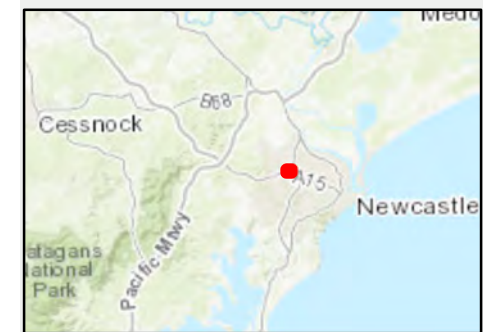
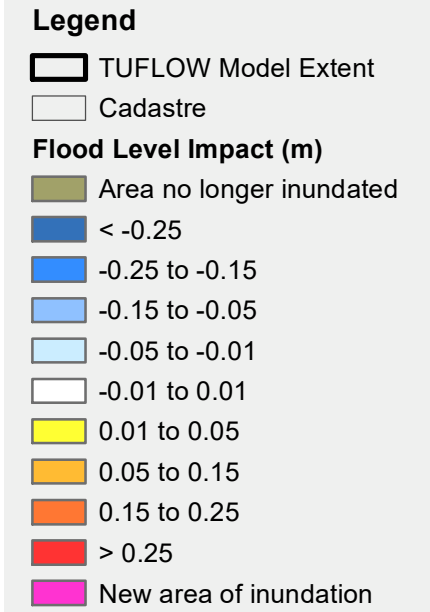


Projection: GDA 1994 MGA Zone 56

FIGURE A2: Change in Peak Flood Level (Proposed vs. Existing) - 10% AEP



SWA\_N14\_100yr\_360min\_Design\_planting-Ex\_quadtree\_2m\_002\_h\_Max  
SWA\_N14\_100yr\_360min\_Design\_planting-Ex\_quadtree\_2m\_002\_h\_Max\_wd  
C:\Users\Shae.Jelly\Aurecon Group\512448 - HW DESP - SR00039 - Stormwater Amen - 5 Deliver Design\504 GIS\Mapping\_DDI\HW-DESP-SR00039\_Stormwater Amenity\_A3L\_Impacts\_N14.mxd\JOB No.130-06-22\Shae.Jelly\Rev



Source: Aurecon, Hunter H2O, Hunter Water, DPIE, Nearnap, ESRI

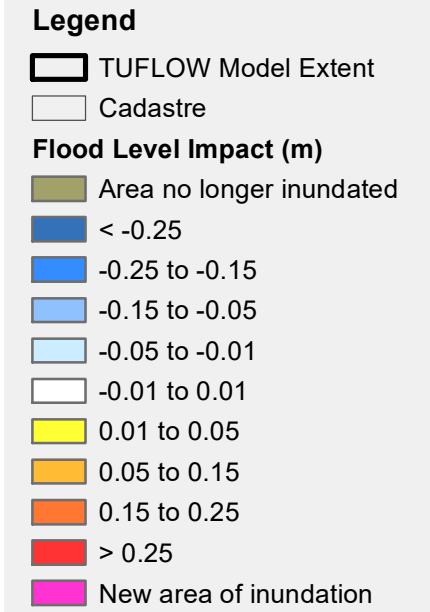


Projection: GDA 1994 MGA Zone 56

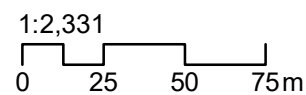
FIGURE A3: Change in Peak Flood Level (Proposed vs. Existing) - 1% AEP



SWA\_N14\_PMF\_360min\_Design\_planting-Ex\_quadtree\_2m\_002\_h\_Max  
SWA\_N14\_PMF\_360min\_Design\_planting-Ex\_quadtree\_2m\_002\_h\_Max\_wd  
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Source: Aurecon, Hunter H2O, Hunter Water, DPIE, Nearnap, ESRI

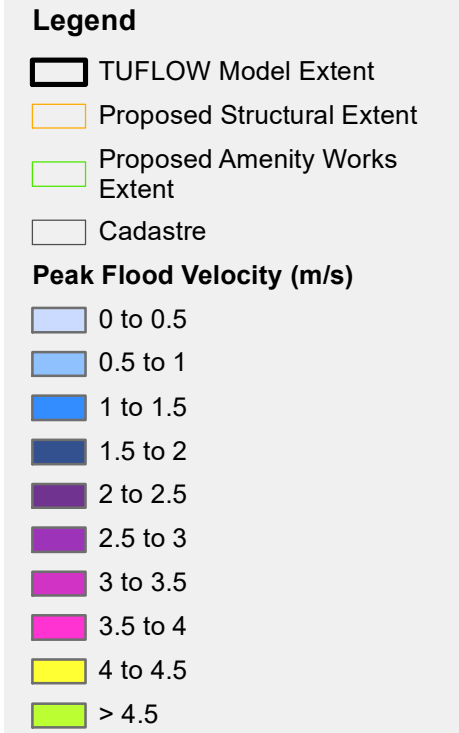


Projection: GDA 1994 MGA Zone 56

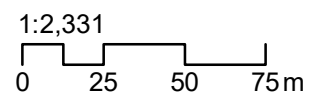
FIGURE A4: Change in Peak Flood Level (Proposed vs. Existing) - PMF



SWA\_N14\_BF\_Design\_planting\_quadtree\_2m\_002\_V\_Max  
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Source: Aurecon, Hunter H2O, Hunter Water, DPIE, Nearam, ESRI



Projection: GDA 1994 MGA Zone 56

Stormwater Amenity

FIGURE A5: Proposed Peak Flood Velocity - Bank-full Flow



SWA\_N14\_10yr\_360min\_Design\_planting\_quadtree\_2m\_002\_V\_Max  
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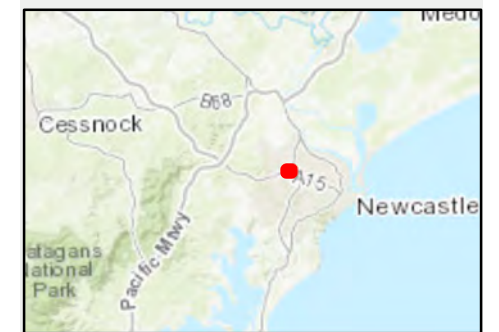


**Legend**

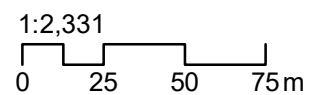
- TUFLOW Model Extent
- Proposed Structural Extent
- Proposed Amenity Works Extent
- Cadastre

**Peak Flood Velocity (m/s)**

- 0 to 0.5
- 0.5 to 1
- 1 to 1.5
- 1.5 to 2
- 2 to 2.5
- 2.5 to 3
- 3 to 3.5
- 3.5 to 4
- 4 to 4.5
- > 4.5



Source: Aurecon, Hunter H2O, Hunter Water, DPIE, Neamap, ESRI



Projection: GDA 1994 MGA Zone 56

Stormwater Amenity

FIGURE A6: Proposed Peak Flood Velocity - 10% AEP



SWA\_N14\_100yr\_360min\_Design\_planting\_quadtree\_2m\_002\_V\_Max  
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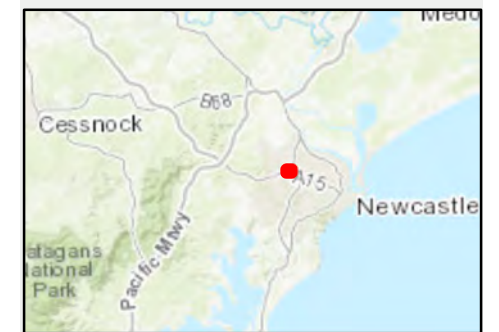


**Legend**

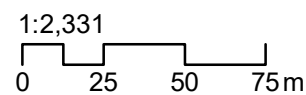
- TUFLOW Model Extent
- Proposed Structural Extent
- Proposed Amenity Works Extent
- Cadastre

**Peak Flood Velocity (m/s)**

- 0 to 0.5
- 0.5 to 1
- 1 to 1.5
- 1.5 to 2
- 2 to 2.5
- 2.5 to 3
- 3 to 3.5
- 3.5 to 4
- 4 to 4.5
- > 4.5



Source: Aurecon, Hunter H2O, Hunter Water, DPIE, Neamap, ESRI



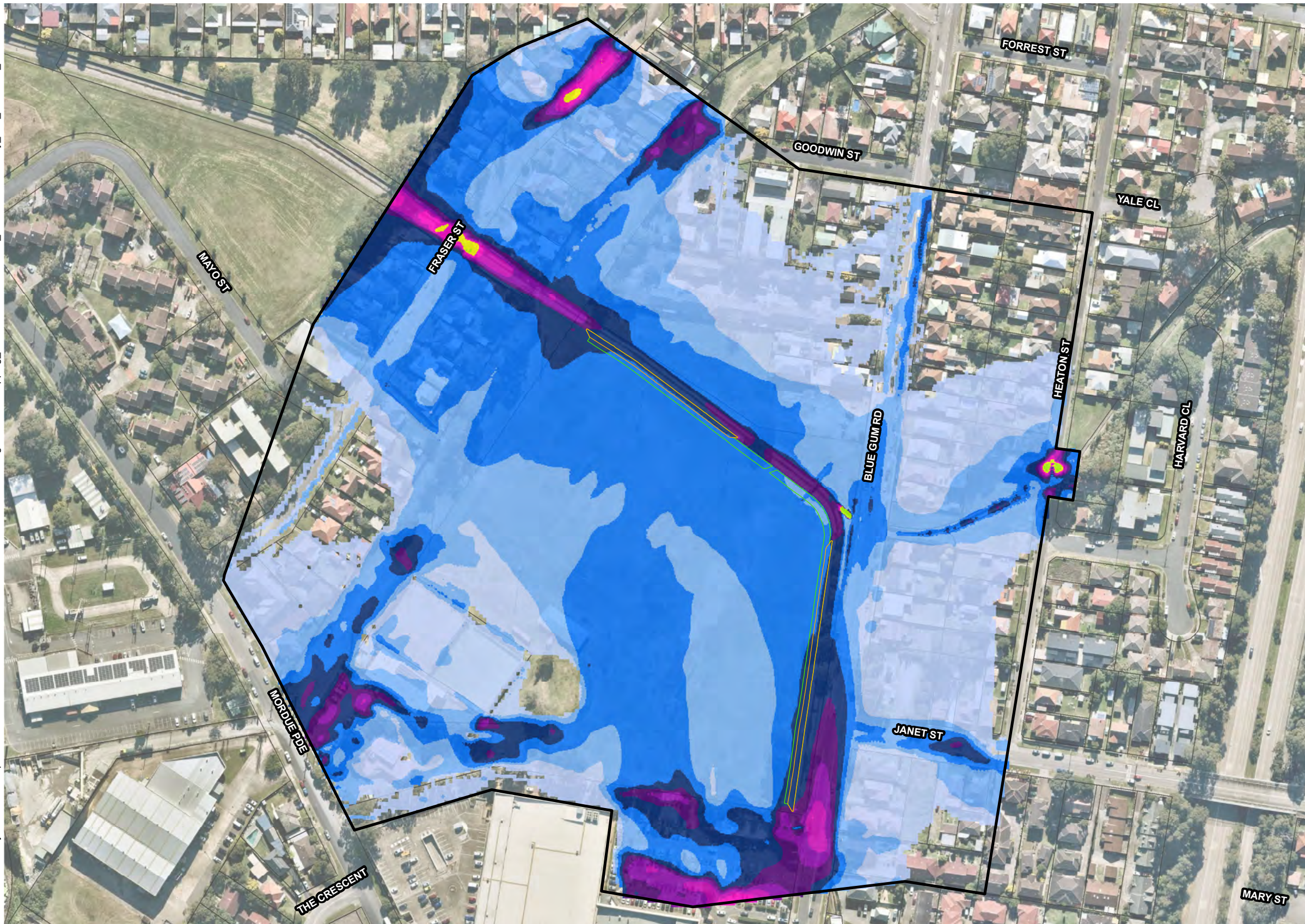
Projection: GDA 1994 MGA Zone 56

**Stormwater Amenity**

**FIGURE A7: Proposed Peak Flood Velocity - 1% AEP**



SWA\_N14\_PMF\_360min\_Design\_planting\_quadtree\_2m\_002\_V\_Max  
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**Legend**

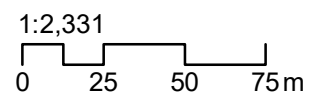
- TUFLOW Model Extent
- Proposed Structural Extent
- Proposed Amenity Works Extent
- Cadastre

**Peak Flood Velocity (m/s)**

- 0 to 0.5
- 0.5 to 1
- 1 to 1.5
- 1.5 to 2
- 2 to 2.5
- 2.5 to 3
- 3 to 3.5
- 3.5 to 4
- 4 to 4.5
- > 4.5



Source: Aurecon, Hunter H2O, Hunter Water, DPIE, Neamap, ESRI



Projection: GDA 1994 MGA Zone 56

**Stormwater Amenity**

**FIGURE A8: Proposed Peak Flood Velocity - PMF**



## APPENDIX F

### Groundwater Dewatering Memorandum



Stormwater Amenity Improvement –  
Dark Creek Heaton Park, Jesmond  
Groundwater Dewatering Memorandum

JULY 2022

ABN 16 602 201 552

Together...



hunterh<sub>2</sub>O

• aurecon



## Report Details

**Report Title** Stormwater Amenity Improvement –Dark Creek Heaton Park, Jesmond:  
Groundwater Dewatering Memorandum

**Project No.** 512448

**Status** Final

**File Location** [https://aurecongroup.sharepoint.com/sites/512448/5 Deliver Design/501 Engineering/Reports/Groundwater/Jesmond/512448 Jesmond\\_Stormwater Amen\\_Dewatering Memo\\_RevB.docx](https://aurecongroup.sharepoint.com/sites/512448/5%20Deliver%20Design/501%20Engineering/Reports/Groundwater/Jesmond/512448%20Jesmond_Stormwater%20Amen_Dewatering%20Memo_RevB.docx)

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## Appendices

Appendix A

Appendix B

# 1 Introduction

Hunter Water intends to construct 1,000 m of channel naturalisation works to improve the amenity of concrete lined waterways in response to various stakeholder preferences for naturalisation of Hunter Water's concrete stormwater open channels.

The majority of the naturalisation works involves removal of the concrete channel walls, battering the sides of the channel back to a 1V:2H slope, installation of rock revetment (rip-rap) on the channel sides, and planting of native species within and along the top of the rock revetment. Detailed designs have been prepared for these works at **Dark Creek Heaton Park, Jesmond (the site)**.

Based on the findings of previous geotechnical investigations at the site, carried out during concept design, it is anticipated that groundwater may be intercepted, therefore, temporary dewatering may be required during construction. Any dewatering requires a Water Supply Works (WSW) approval, (unless incidental, e.g. used for dust suppression, erosion mitigation risks). If more than 3 ML/year of groundwater is anticipated to be extracted, a Water Access License, under the *Water Management Act 2000*, must be sought through the Natural Resource Access Regulator (NRAR). To avoid potential program/timing impacts, if a Water Access License is required the application should start early in the project lifecycle, before construction commences.

This memorandum provides a dewatering assessment in relation to **Dark Creek Heaton Park, Jesmond (the site)**.

## 1.1 Objectives and Scope of Works

The objective of this memorandum is to assess groundwater conditions and provide advice in relation to expected dewatering volumes during construction to inform construction method, dewatering management requirements and details required for approvals with regulatory authorities (e.g. NRAR).

To meet the objective above, the following scope of works was carried out:

- Desktop review of geotechnical bore and test pit data and existing groundwater data in the project area.
- Calculation of the range of dewatering rates and estimation of total dewatering volumes.
- Comparison of dewatering volumes to legislative requirements to provide recommendations regarding the need for licencing and approvals.
- Provide recommendations regarding the need for further assessment (if required).

## 2 Overview of Design and Construction Activities

For the site, design details and expected hydrogeological properties were collated to form the basis of the analytical calculations.

Design details relevant to the dewatering calculations for the site are illustrated in **Figure 2-1**, **Figure 2-2**, **Figure 2-3** and **Figure 2-4** and are summarised in **Table 2-1** below. An overview of the site is presented in **Figure 3-1**.

*Table 2-1 Concept design details summary*

Site Location	Total excavation length (m)	Maximum excavation depth (mBGL*)
Dark Creek, Jesmond Upstream	157 (Western bank)	1.5
Dark Creek, Jesmond Downstream	108 (Southern bank)	1.5

\*mBGL = metres below ground level.

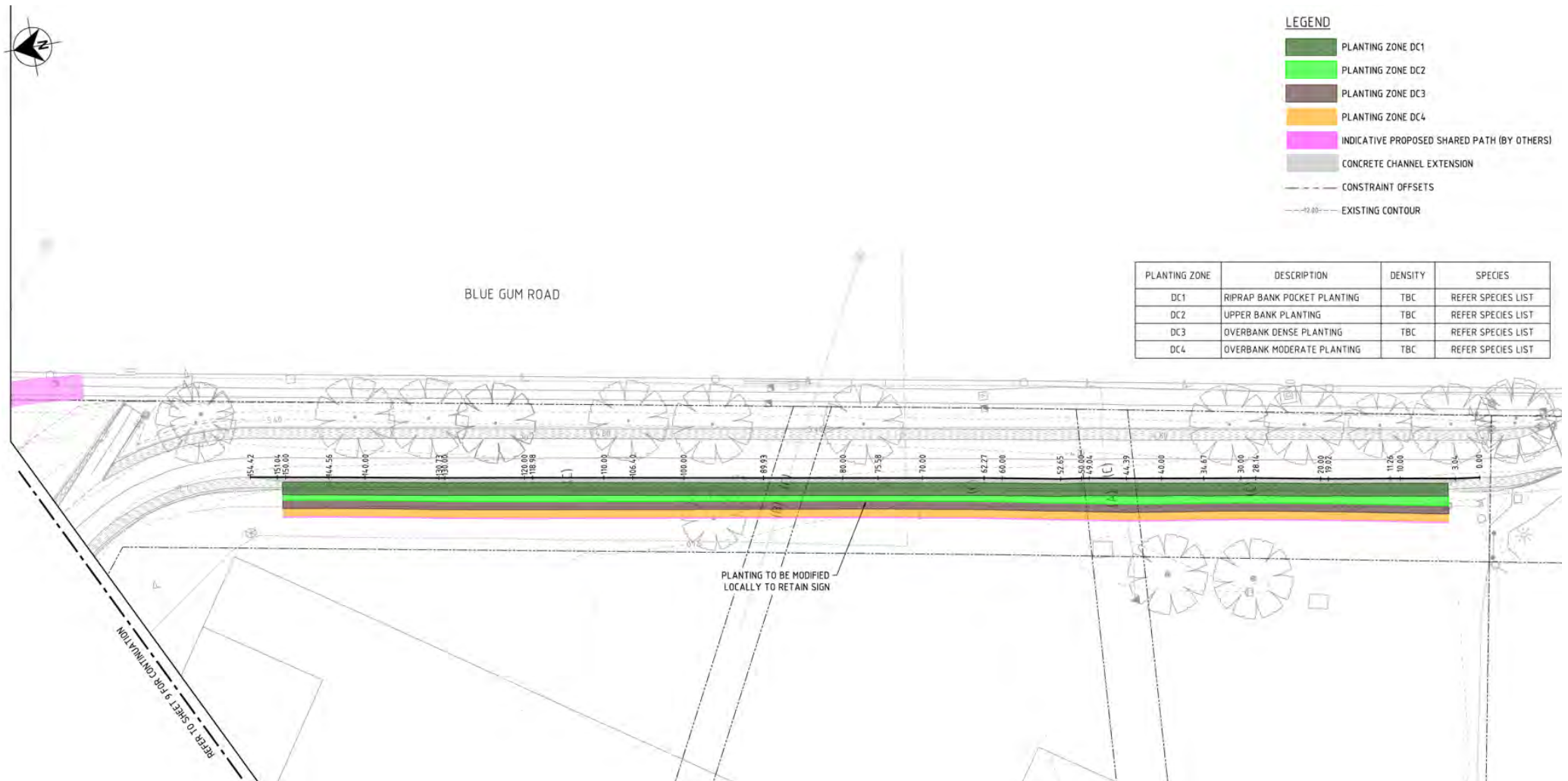


Figure 2-1 Dark Creek Heaton Park, Jesmond (Upstream) – Plan Overview



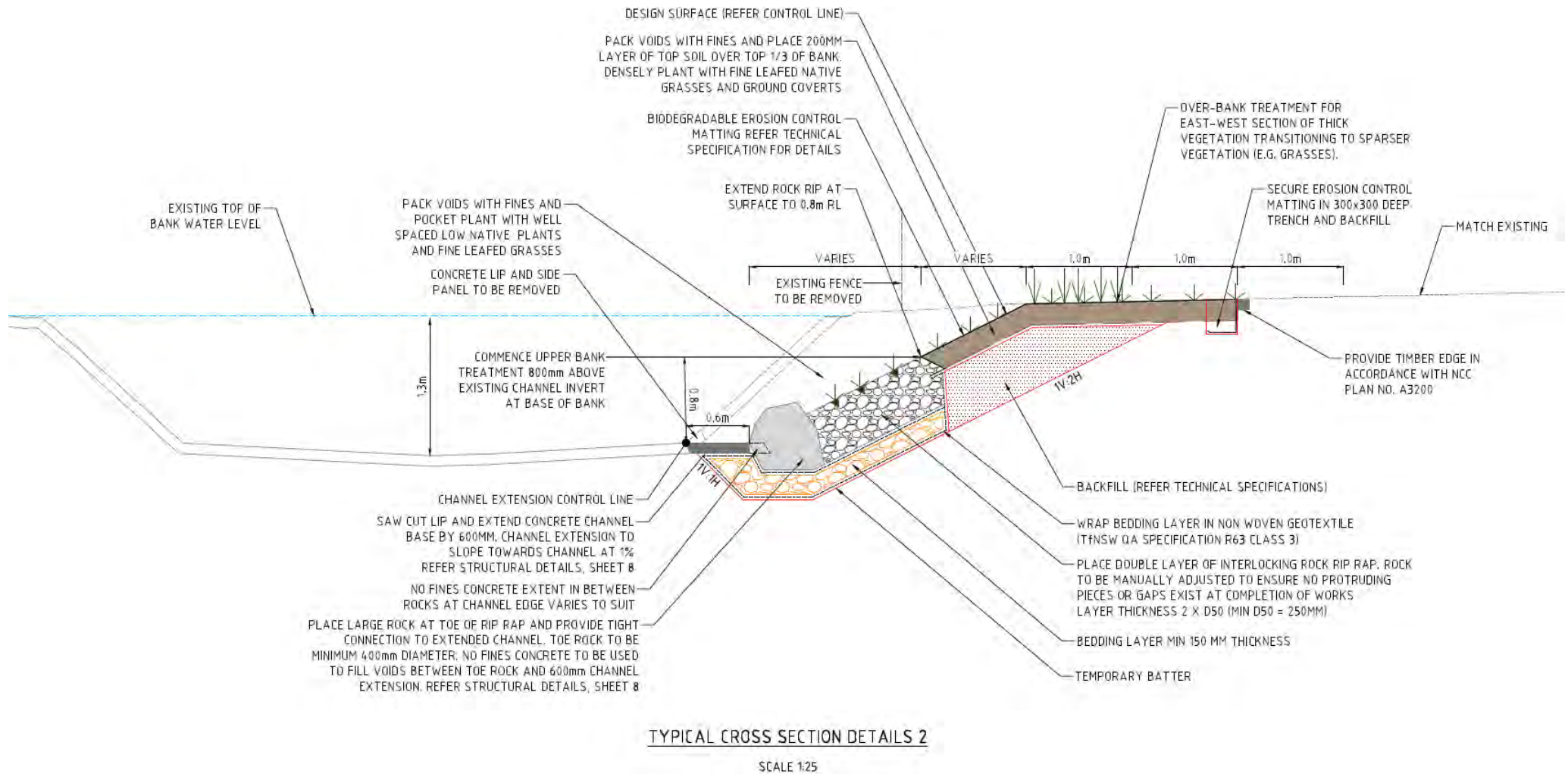


Figure 2-2 Dark Creek Heaton Park, Jesmond (Upstream) – Typical Cross-Section



Figure 2-3 Dark Creek Heaton Park, Jesmond (Downstream) – Plan Overview

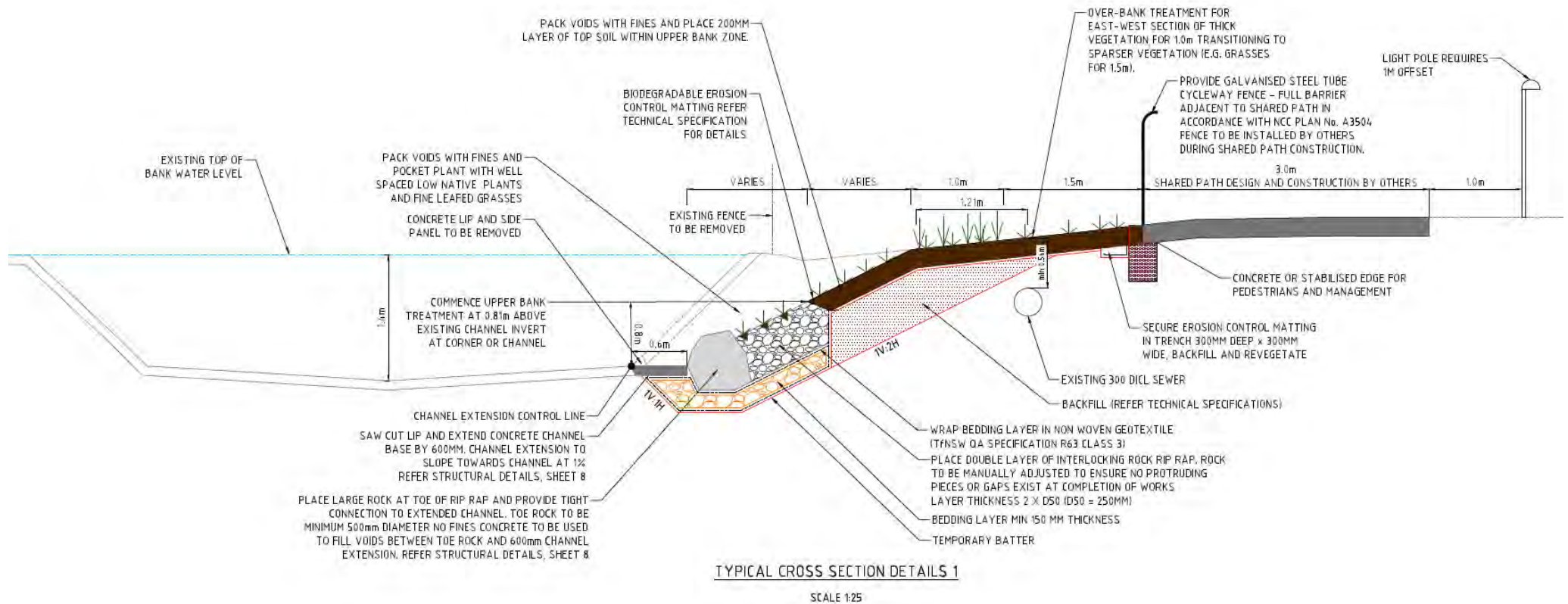


Figure 2-4 Dark Creek Heaton Park, Jesmond (Downstream) – Typical Cross-Section

## 2.1 Excavation and Dewatering Methodologies

Once the existing channel wall is removed and the excavations intersect the groundwater table, temporary dewatering is expected to be required. Temporary dewatering will provide a dry trench and allow for the placement of geofabric and bedding layer to be completed.

The adopted shoring system of the excavations will have significant impacts on the amount of groundwater inflows experienced. Adopting watertight trench support systems (e.g. sheet piling) would significantly reduce the amount of groundwater inflows experienced however are unlikely to be feasible at this site and for a project of this scale.

Temporary structures (e.g. sandbags or sandstone blocks) are likely to be positioned on the creek side of excavations to reduce inflows from Dark Creek into the excavation however some groundwater is likely to inflow into the excavations. Placement of fill materials would likely be undertaken within a wet environment in the lower portions of the excavations.

To provide a preliminary understanding of the dewatering rates and volumes, a conservative approach has been adopted in assuming that the adopted trench support system is unable to reduce groundwater inflows to the excavation. Therefore, dewatering would be required throughout the full duration of construction of a given trench length.

An open sump pumping technique (i.e. collector drains and a sump pump) is expected to be the most suitable dewatering method for this site. This is a cost-effective approach and suitable in stable ground conditions (i.e. relatively low permeability soils, small required drawdowns, and no immediately adjacent source of recharge) after excavation. Collector drains can be used to direct inflowing groundwater to the lowest point within the excavation, where a sump pump can be operated continuously or intermittently as required in the adopted construction schedule. If required, several sumps can be placed along the open trench to improve the drainage.

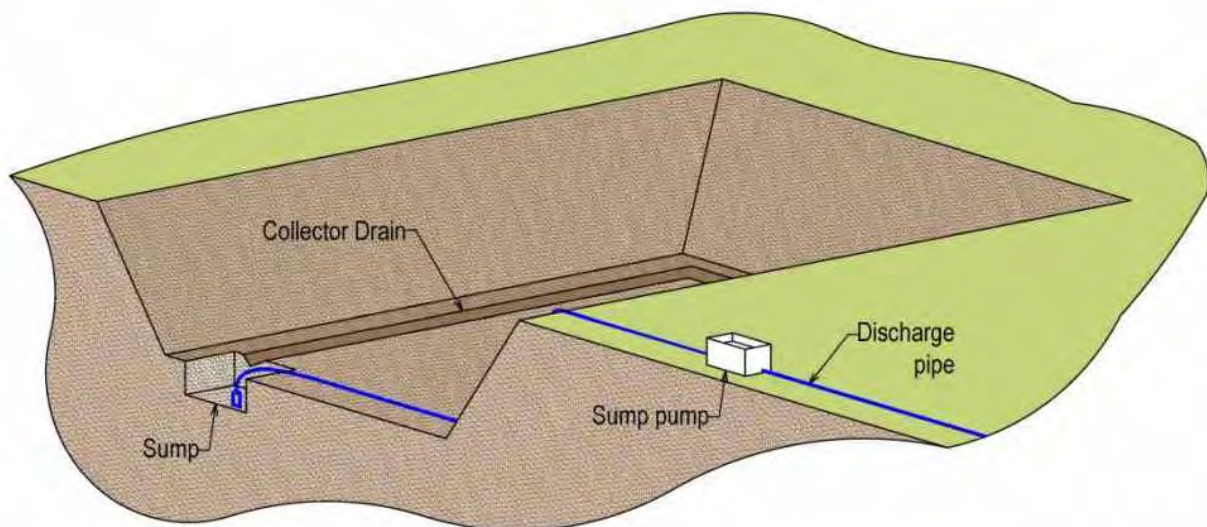


Figure 2-5 Conceptual diagram – Sump pump dewatering methodology (Image source: Gharpedia, 2022)

### 3 Assessment Methodology

To establish the existing baseline physical and environmental conditions pertinent to groundwater and estimate dewatering rates/volumes, the methodology outlined below was applied.

#### 3.1 Desktop Assessment

To develop an understanding of groundwater conditions at the site, the following documents were reviewed:

- SR00039 – Stormwater Amenity: Geotechnical Report – Rev 1 (Aurecon, 2022)
- SR00039 - Stormwater Amenity Dark Creek – Jesmond: Preliminary Waste Classification Assessment (Aurecon, 2022a)

In addition, publicly available information was reviewed from the following data sources:

- Surface Geology: Department of Regional NSW, 2018, NSW Seamless Geology
- Climate: Bureau of Meteorology (BoM), 2022a, Climate Data Online
- Registered groundwater bores: Bureau of Meteorology (BoM), 2022b, National Groundwater Information System (registered bores).

#### 3.2 Geotechnical Investigations

The geotechnical scope comprised drilling of four to a maximum depth of 5.45 m below ground level (mBGL). The boreholes were advanced using a DT1200 drilling rig using solid flight augers. The boreholes were backfilled upon completion.

A summary of the borehole information is presented in **Table 3-1**. The approximate locations of the boreholes are shown on **Figure 3-1** and the borehole logs and explanatory notes are included in **Appendix B**.

*Table 3-1 Summary of the borehole locations.*

Borehole ID/ Test Pit ID	Easting (mE)	Northing (mN)	Top RL (mAHD)	Drilled Depth / Excavated Depth (mBGL)	Depth of Encountered Groundwater (mBGL)	Piezometer Installed
N14-BH01	377473	6359128	5.21	5.45	1.30	-
N14-BH02	377594	6359015	5.29	2.45	1.30	-
N14-BH03	377587	6358970	5.36	5.45	1.60	Yes
N14-BH04	377579	6358918	5.66	2.45	1.30	-

Notes:

- The approximate ground surface levels are estimated using the surveyed data.
- Easting and Northing relate to the Map Grid of Australia (MGA) coordinate system.
- mBGL = metres below ground level

Upon completion of drilling, one standpipe piezometers were installed in N14-BH03. The screened zone was installed within the bottom 3 m of the borehole as detailed in **Table 3-2** below.

*Table 3-2 Standpipe piezometer details.*

Monitoring Well ID	Total Hole Depth (m)	Backfill Levels (from Depth mbgl to Depth mbgl)	Bentonite Levels (from Depth mbgl to Depth mbgl)	Screened Section (from Depth mbgl to Depth mbgl)	Sand Levels (from Depth mbgl to Depth mbgl)
N14-BH03	5.45	0.0 – 1.3	1.3 – 1.8	2.0 – 5.0	1.8 – 5.45

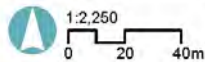


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- Study area
- Cadastre
- ◆ Borehole
- ◆ Borehole with piezometer installed



Source: Aurecon, Hunter Water, Hunter H2O, DPIE, Nearmap, ESRI



Projection: GDA 1994 MGA Zone 58

P512448 Stormwater Amenity

FIGURE : Environmental Investigation Locations - N14

Figure 3-1 Dark Creek Heaton Park, Jesmond: Geotechnical Investigation Locations

### 3.3 Analytical modelling methodology

Dewatering rate/volume calculations were carried out for the site. Design details and expected hydrogeological properties were collated to form the basis of the analytical calculations.

For the purposes of dewatering calculations, it is assumed that the duration of earthworks for the entire project will be 3 months. It is also assumed that each feature will be constructed using a staged approach in discrete 30 m sections.

To introduce a level of conservatism, and account for the potential variability in groundwater level at the site (due to climatic conditions etc.), 0.5 m has been added to the groundwater elevations (presented in **Section 4.3**) when deriving required drawdown values.

#### 3.3.1 Radius of Influence

The radius of influence (i.e. extent of induced groundwater drawdowns) was calculated using Sichardt's formula (Sichardt, 1930) for unconfined aquifers:

$$R_o = C \times s \sqrt{K}$$

Where:

$R_o$  = Radius of influence (m)

$C$  = Radial/linear flow conversion factor = 2000 for linear flow into trenches (dimensionless)

$s$  = Maximum drawdown (m)

$K$  = Hydraulic conductivity (m/d)

#### 3.3.2 Groundwater Recharge

In addition to the dewatering rates outlined below, any groundwater recharge that occurs within the radius of influence during dewatering, will contribute to the overall dewatering rates/volumes. The main groundwater recharge mechanism in an unconfined aquifer is expected to be direct infiltration via rainfall. To account for this, the groundwater recharge volume via rainfall was estimated and added to the overall dewatering rates.

Groundwater recharge volume via rainfall was calculated via the following formula:

$$G_R = r_h \times R$$

Where:

$G_R$  = Average annual groundwater recharge volume (m<sup>3</sup>)

$r_h$  = Average annual rainfall amount (m)

$R$  = Groundwater recharge rate (%)

This provides an estimation of the volume of uniformly distributed groundwater recharge that can be expected to contribute to dewatering volumes during a year where average rainfall conditions occur.

Groundwater recharge volumes have been estimated based on average annual rainfall amounts between 1862 to 2022 (Newcastle University, No. 61390 (BoM, 2022)) and typical groundwater recharge rates for unconfined coast alluvium aquifers in NSW (CSIRO, 2010).

#### 3.3.3 Dewatering Rates

Dewatering rates were calculated in accordance with an analytical scenario applicable to groundwater inflow into a linear trench. The adopted equation calculates the total discharge from a single row of partially penetrating well points in an unconfined aquifer midway between two equidistant and parallel line sources (Mansur & Kaufman, 1962).



$$Q = \left[ \left( 0.73 + 0.27 \frac{(H - h_w)}{H} \right) \frac{Kx}{R_o} (H^2 - h_w^2) \right]$$

Where:

Q = Total discharge from the well points (m<sup>3</sup>/d)

H = Height of the water table at the radius of influence (m)

h<sub>w</sub> = Height of the water table at well point (m)

K = Hydraulic conductivity (m/d)

x = Length of trench (m)

R<sub>o</sub> = Radius of influence = calculated from Sichardt's formula above (m)

The assumptions have been applied in these formulas include necessary simplifications of the existing groundwater conditions and dewatering methodology. Understanding these assumptions, which are provided in **Appendix A**, is important in interpreting the results.

Worthy of note is the assumption that the analytical model is run assuming the dewatering is in equilibrium / steady state. This assumes that pumping has continued for a period where the zone of influence has intercepted sufficient recharge to equal the amount being pumped.

The progressive excavation will introduce non-steady state or transient conditions where the pumped water will be released mainly from storage. The storage capacity or specific yield of the aquifer has not been considered in the adopted analytical model. In general, for the same drawdown, low storage capacity aquifers such as fractured rocks produce less amount of water from storage with rapid propagation of drawdown compared to high storage capacity aquifers such as alluvial aquifers. Therefore, the results may underestimate the expected volume of water to be pumped.

## 4 Groundwater Conditions

This section provides a summary of groundwater conditions pertinent to the dewatering calculations.

### 4.1 Surface Geology

The Seamless NSW state surface geology GIS dataset shows the site being overlain by Alluvial valley deposits (Q\_av) comprising silt, clay, (fluvially deposited) lithic to quartz-lithic sand, gravel. The approximate site location is also identified in relation to the Seamless NSW state geology in **Figure 4-1** below.



Figure 4-1 Surface geology mapping at the site (Department of Regional NSW, 2018)

### 4.2 Lithology

A summary of the lithology observations recorded during geotechnical investigations at the site are summarised in **Table 4-1** below.

Table 4-1 Lithological observations - Summary

Parameter / Lithological Description	Bore/Test Pit ID			
	N14-BH01	N14-BH02	N14-BH03	N14-BH04
Fill	0.00 – 1.30	0.00 – 1.00	0.00 – 1.00	0.00 – 1.70
Alluvium	1.30 – 5.45	1.00 – 2.45	1.00 – 5.45	1.20 – 2.45

The fill material was typically logged as sandy clay. The material was characterised as low plasticity with medium grained sand with coarse gravels. The colour of this material was dark grey or dark brown and had a moisture condition of less than the plastic limit or greater than the plastic limit.

The water bearing alluvium material was generally logged as the following:

- **Clayey Sand** – Characterised as very loose with fine to medium grained sand with fine to medium grained gravel. The colour of this material was grey and had a moisture condition of wet.
- **Silty Sand** – Characterised as loose with fine to medium grained sand with traces of fine to medium subangular gravel. The colour of this material was grey and had a moisture condition of moist.

These lithological observations are generally consistent with the material descriptions outlined in the surface geological mapping discussed in **Section 4.1**.

### 4.3 Groundwater Levels

The water levels were recorded within the standpipe piezometers using a dipping metre on 22 September 2021 as indicated in **Table 4-2**. It is noted that no rainfall was recorded on the measurement date or in the days preceding it.

*Table 4-2 Groundwater level measurement at the site*

Standpipe ID	Measurement Date	Groundwater level (mBGL)	Groundwater elevation (mAHD)
L03-BH01	22/09/2021	1.60	3.76

### 4.4 Hydraulic Conductivity

No site-specific measurements for hydraulic conductivity are available at the sites. In the absence of site-specific measurements, literature-based values for hydraulic conductivity have been adopted, matching the lithological observations and geological material descriptions as far as practicable. The adopted soil texture class, based on the United States Department of Agriculture (USDA) soil taxonomy system and the associated hydraulic conductivity estimates are outlined in **Table 4-3** below.

*Table 4-3 Adopted hydraulic conductivity values*

Lithological Description	Material Description	Adopted USDA soil texture class	Assumed hydraulic conductivity values (Saxton and Rawls, 2006)		
			Minimum (m/s)	Geometric mean (m/s)	Maximum (m/s)
Alluvium	Clayey sand / silty sand	Sandy loam	$2.82 \times 10^{-6}$	$7.33 \times 10^{-6}$	$1.91 \times 10^{-5}$

## 5 Results

Assumptions, input values and results of the analytical modelling are presented in **Appendix A** and summarised below.

Based on the maximum depth of excavation (1.5 mBGL) and the measured groundwater level (1.6 mBGL), the required drawdown is 0 m. However, to introduce a level of conservatism, and account for the potential variability in groundwater level at the site (due to climatic conditions etc.), 0.5 m has been added to the groundwater level value and 0.4 m has been adopted as the required drawdown value.

The full range of hydraulic conductivity values recorded at the site (presented in **Section 4.4**) were adopted in the calculations to provide a range of possible dewatering estimates. Minimum and maximum discharge rates were calculated using the minimum and maximum hydraulic conductivity values respectively. The “expected” discharge rates were calculated using the geometric mean hydraulic conductivity value.

Total dewatering volumes are dependent upon the estimated dewatering rates and the duration. Total length of the excavations is approximately 265 m. Based on an estimated 3-month (92 days) construction window, approximate dewatering durations were derived for each ~30 m section as follows:

- Total length = 265 m, section length = 30 m (6%), construction duration of each section = ~10.4 days.

Based on these durations, total dewatering volumes were calculated, and results are summarised in **Table 5-1** below.

*Table 5-1 Dark Creek Heaton Park, Jesmond – Dewatering Estimates*

Parameter	Values		
	Minimum	Expected	Maximum
Required drawdown (m)	0.4	0.4	0.4
Applied hydraulic conductivity (m/s)	2.82 x 10 <sup>-6</sup>	7.33 x 10 <sup>-6</sup>	1.91 x 10 <sup>-5</sup>
Radius of Influence (m)	1.34	2.17	3.50
Total length of trench (m)	507	507	507
Length of open section	30.00	30.00	30.00
Discharge rate per section (m <sup>3</sup> /day)	0.33	1.40	5.90
Dewatering duration per section (days)	10.42	10.42	10.42
Discharge per section (m <sup>3</sup> )	3.48	14.62	61.41
Total discharge (m <sup>3</sup> )	30.77	129.12	542.45

Groundwater recharge via rainfall that may occur during dewatering activities was also estimated in accordance with the methodology outlined in **Section 3.3.2**, as this will contribute to the overall dewatering volume. Calculated groundwater recharge rate is outlined in **Table 5-2** below.

*Table 5-2 Groundwater recharge rates*

Parameter	Value	Comment
Area of influence (m <sup>2</sup> )	629.7	Max radius of influence buffer around total length of excavations.
Average annual rainfall (m/year)	1.131	Annual average rainfall between 1999 to 2022 (Newcastle University, Station No. 61390 (BoM, 2022))
Average annual rainfall volume (m <sup>3</sup> )	712.2	Calculated based on above values

Parameter	Value	Comment
Groundwater recharge rate (%)	18%	Adopted as typical value based on recharge studies from unconfined coastal alluvium aquifers in NSW (CSIRO, 2010)
Groundwater recharge rate (m <sup>3</sup> /day)	0.4	Calculated based on above values
Total groundwater recharge volume (m <sup>3</sup> )	32.3	Calculated based on above values and assumed total duration

The estimated groundwater recharge volume can then be added to the overall dewatering volumes, which yields the results outlined in **Table 5-3** below.

*Table 5-3 Total dewatering volumes*

Site / Parameter	Total Dewatering Volumes (m <sup>3</sup> )		
	Minimum	Expected	Maximum
<b>Total including estimated groundwater recharge</b>	63.1	161.4	574.8

Therefore, the estimated total volume of dewatering, including groundwater recharge during dewatering, is expected to be 161.4 m<sup>3</sup>, or 0.16 ML.

There is a large difference between the estimated minimum and maximum dewatering rates/volume estimates. The results from the analytical calculations are sensitive to the adopted hydraulic conductivity, for which no site-specific measurements have been conducted. Therefore, hydrogeological conditions are unknown along the alignment(s) and there is a high degree of uncertainty associated with these estimates which should be considered in interpreting the modelling results.

## 6 Conclusions and Recommendations

Based on the analysis presented in this memorandum, the estimated total volume of dewatering for the project is expected to be approximately 0.16 ML.

Any dewatering requires a Water Supply Works (WSW) approval, (unless incidental, e.g. used for dust suppression, erosion control). If more than 3 ML/year of groundwater is anticipated to be extracted, a Water Access License, under the *Water Management Act 2000*, must be sought through the Natural Resource Access Regulator (NRAR). The estimated total volume of dewatering is below 3 ML/year; therefore, a Water Access License is not expected to be required.

There is a large difference between the estimated minimum and maximum dewatering rates/volume estimates. The results from the analytical calculations are highly sensitive to the adopted hydraulic conductivity, which has not been measured at the sites and literature values have been adopted. The results are also influenced by the depth of required drawdown, however, are less sensitive to these values in comparison to hydraulic conductivity. Therefore, hydrogeological conditions are unknown along the alignment and there is a high degree of uncertainty associated with these estimates.

It is possible that during excavation works, unexpected hydrogeological conditions may be encountered due to previously unknown heterogeneities in the subsurface or changes in the proposal scope/design that affect the underlying assumptions used in this groundwater dewatering assessment. In this instance, the contractor should revisit the evaluation and groundwater management process and decide if additional data, or an approval is required. The development of a change management strategy may be required depending on the quantity and quality of the encountered groundwater.

Further approval may be required to discharge extracted groundwater to a receiving water body, stormwater collection system or sewer. The primary discharge options for extracted groundwater, to be determined by the contractor, would be managed in accordance with the *Water Management Act 2000* and the *Protection of the Environment Operations Act 1997*. The primary discharge options include:

- **Discharge to a receiving surface water body (i.e. Dark Creek).** A discharge assessment would be required to demonstrate that the groundwater quality is suitable, and that discharge will not have significant deleterious impacts to the receiving water body. Otherwise, treatment may be required prior to discharge, or a different disposal method applied.
- **Discharge to stormwater collection system.** This would require a similar level of assessment to discharging to receiving surface water body as described above.
- **Discharge to sewer via a Trade Waste Agreement (TWA)** with the wastewater system operator. Discharge to sewer is to be conducted in accordance with the TWA, which may require treatment of the water prior to discharge.
- **Land based application or reinjection / irrigation.** Feasibility of this option is dependent upon soil properties (infiltration rates, salinity etc.) at the reinjection / irrigation area. This option is generally precluded as a discharge option in areas with low permeability soils and salinity issues. However, for incidental or small volumes of extracted groundwater, this option could be considered provided the groundwater quality is suitable and other approval mechanisms are in place. Stability of nearby trenches / excavations and surrounding underground structures must be considered.
- **Offsite disposal.** Extracted groundwater could be trucked offsite and treated and/or disposed of at a licensed wastewater treatment plant or waste facility.

## 7 References

- Aurecon, 2022, SR00039 – Stormwater Amenity: Geotechnical Report – Rev 1
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- Saxton K. E., and Rawls W.J., 2006, *Soil Water Characteristics Estimates by Texture and Organic Matter for Hydrologic Solutions*, Soil Science Society of America, Volume 70: 1569–1578.
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- CSIRO, 2010, *Review of Australian Groundwater Recharge Studies*, Water for a Healthy Country National Research Flagship, 81pp.
- Department of Regional NSW, 2018, *NSW Seamless Geology*
- Gharpedia, 2022, *Dewatering Methods During Excavation in Waterlogged Area*, [ONLINE], Available at: <<https://gharpedia.com/blog/dewatering-methods-for-waterlogged-area/>>, Accessed 7<sup>th</sup> June 2022.
- Mansur, C.I., and R.I. Kaufman, 1962: *Dewatering, Chapter 3 in Foundation Engineering*, G.A. Leonards (ed.), McGraw-Hill Book Company, New York, New York, pp. 241-350.
- Sichert, W., Kyrieleis, W., 1930: *Grundwasserabsenkung bei Fundierungsarbeiten (Translation = Lowering of groundwater during foundation work)*, Springer, Berlin.

## 8 Assumptions and Limitations

Where hydrogeologic information and design details were not available, the following assumptions have been made:

- Based on the maximum depth of excavation (1.5 mBGL) and the measured groundwater level (1.6 mBGL), the required drawdown is 0 m. However, to introduce a level of conservatism, and account for the potential variability in groundwater level at the site (due to climatic conditions, possible tidal influence etc), 0.5 m has been added to the groundwater level value and 0.4 m has been adopted as the required drawdown value.
- No site-specific measurements for hydraulic conductivity are available at the sites. In the absence of site-specific measurements, literature-based values for hydraulic conductivity have been adopted, matching the lithological observations and geological material descriptions as far as practicable. The adopted soil texture class, based on the United States Department of Agriculture (USDA) soil taxonomy system and the associated hydraulic conductivity (presented in **Section 4.4** (Saxton and Rawls, 2006).
- For the purposes of dewatering calculations, it is assumed that the duration of earthworks for the project will be 3 months. It is also assumed that each feature will be constructed using a staged approach in discrete 30 m sections.
- Groundwater recharge volumes have been estimated based on average annual rainfall amounts between 1862 to 2022 (Newcastle University, No. 61390 (BoM, 2022) and typical groundwater recharge rates for unconfined coast alluvium aquifers in NSW (CSIRO, 2010).

In preparing the report, Aurecon has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). The report also relies on publicly available data and the level of characterisation is dependent upon the reliability of this data and how often the various databases are updated.

Except as otherwise stated in the report, Aurecon has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Aurecon will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Aurecon.

In accordance with the scope of services, Aurecon has relied upon the data and has not conducted any environmental field monitoring or testing in the preparation of this report. The conclusions are based upon the data sources included in this report and are therefore merely indicative of the environmental condition of the site at the time of preparing the report.

Within the limitations imposed by the scope of services, the assessment of the site and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.



Appendix A

# Analytical Calculations

21) Radius of influence (Sichardt)

$$R_0 = C \sqrt{K}$$

Empirical equation based on drawdown and permeability

Essential input
Optional input
Calculated

		expected	min	max
Drawdown in well	s	0.4 m	0.4	0.4 m
Hydraulic conductivity	K	7.33E-06 m/s	2.82E-06	1.91E-05 m/s
		0.6333 m/d	0.24365	1.65024 m/d
Factor	C	2000	3000 for radial flow 1500-2000 for line flow to trenches or wellpoints	
Radius of influence	R <sub>0</sub>	2.17 m	1.34	3.50 m

The following assumptions apply to this equation

- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, isotropic and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer
- the flow to the well is in a steady state

Data sources (to complete an audit trail)

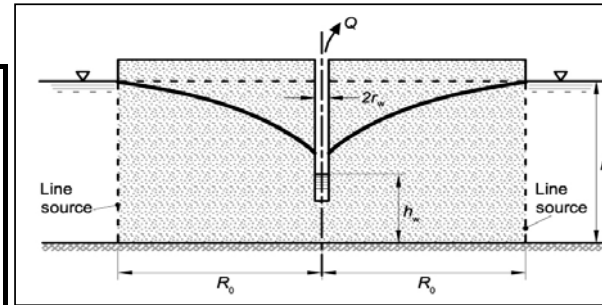
Drawdown in well	s	Depth of excavation (1.5m) - groundwater depth (1.6 m) + 0.5 m
Hydraulic conductivity	K	Assumed hydraulic conductivity range (Saxton and Rawls, 2000)
Factor	C	Linear trench

**10) Partial penetration by a single row of wellpoints of an unconfined aquifer midway between two equidistant and parallel line sources**

$$Q = \left[ \left( 0.73 + 0.27 \frac{(H - h_w)}{H} \right) \frac{Kx}{R_0} (H^2 - h_w^2) \right]$$

Essential input
Optional input
Calculated

<b>Head</b>		expected	min	max
Height of water table at radius of influence	H	0.4 m	0.4	0.4 m
Height of water table at well	$h_w$	0 m	0	0 m
<b>Conductivity</b>				
Hydraulic conductivity of aquifer	K	0.633 m/d	0.244	1.650 m/d
<b>Radius</b>				
Length of trench	x	30 m	30	30 m
Distance to line source, equal to radius of influence	$R_0$	2.17 m	1.34	3.50 m
Is $R_0/H$ greater than or equal to 3 ?		Yes	Yes	Yes
<b>Total discharge from wellpoints</b>	<b>Q</b>	1.40 m <sup>3</sup> /d	0.33	5.90 m <sup>3</sup> /d



(Figure adapted from Mansur & Kaufman, 1962)

The following assumptions apply to this equation

- the slot is infinite in length
- $R_0/H$  greater than or equal to 3
- the aquifer is unconfined
- the aquifer is homogeneous, isotropic and of uniform thickness
- the Dupuit Forcheimer assumption is valid
- the aquifer has reached steady state conditions
- the initial water table is horizontal

(Mansur & Kaufman, 1962)

<b>Data sources (to complete an audit trail)</b>	
Height of water table at radius of influence	H Depth of excavation (1.5m) - groundwater depth (1.6 m) + 0.5
Height of water table at well	$h_w$ Water level relative to level at radius of influence
Hydraulic conductivity of aquifer	K Assumed hydraulic conductivity range (Saxton and Rawls, 20
Length of trench	x Proposed length of open section (constructed in 30m sections
Radius of influence	$R_0$ Calculated from Sichardt method

Appendix B

# Borehole Logs

Engineering Log - Borehole

Client		Hunter Water		Project No.		512448					
Project		Stormwater Amenity		Logged By		MC					
Location		Jesmond		Checked By		NS					
Started Drilling		22.9.21		Northing		6359128.00					
Completed Drilling		22.9.21		Easting		377473.00					
Slope		90°		Equipment		DT1200					
Bearing		---		Ground Level		5.209 AHD					
DRILLING		MATERIAL DESCRIPTION				TESTING, SAMPLING & OTHER INFORMATION					
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
		5			CL	FILL: Sandy CLAY: low plasticity, dark grey, medium grained sand, with coarse, subangular gravel	<PL				FILL
		4			CI	Silty CLAY: medium plasticity, dark grey, trace coarse, subangular gravel			SPT 2, 2, 1 N=3		SPT Recovery: 0.45 m
		3				3.00m: becomes grey mottled orange brown	>PL		SPT 0, 0, 0 N=0		ALLUVIUM 1.3m - seepage observed
		2									SPT Recovery: 0.45 m
		1				4.20m: with coarse, subangular gravels			SPT 0, 0, 0 N=0		SPT Recovery: 0.45 m
		0			SM	Silty SAND: fine to medium grained, grey, trace fine to medium, subangular gravel	M	L	SPT 2, 2, 4 N=6		SPT Recovery: 0.45 m
						Borehole N14-BH01 Terminated at 5.45 m					Borehole terminated at target depth
Remarks:											

AURECON SYD LIB 05.GLB Log CW NON-CORED BOREHOLE LOG - STORMWATER AMENITY.GPJ <-DrawingFile>> 03/11/2021 15:08 10.00.01.07 Developed by Daigal

# Engineering Log - Borehole

Client		Hunter Water		Project No.		512448					
Project		Stormwater Amenity		Logged By		MC					
Location		Jesmond		Checked By		NS					
Started Drilling		22.9.21		Northing		6359015.00					
Completed Drilling		22.9.21		Easting		377594.00					
Slope		90°		Equipment		DT1200					
Bearing		---		Ground Level		5.288 AHD					
DRILLING		MATERIAL DESCRIPTION				TESTING, SAMPLING & OTHER INFORMATION					
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
AD/T			5		CI-CH	FILL: Sandy CLAY: medium to high plasticity, dark brown, fine grained sand					FILL
			1		CI-CH	Sandy CLAY: medium to high plasticity, grey mottled orange brown, fine grained sand, trace black, coarse gravel	>PL		SPT 0, 0, 0 N=0		ALLUVIUM SPT Recovery: 0.45 m 1.3m - seepage observed
			2					VS			
			3				2.00m: becomes grey mottled orange brown with traces of black coarse gravels	S to F		SPT 3, 2, 3 N=5	
			3			Borehole N14-BH02 Terminated at 2.45 m					Borehole terminated at target depth
Remarks:											

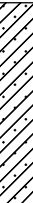
AURECON SYD LIB 05.GLB Log CW NON-CORED BOREHOLE LOG STORMWATER AMENITY.GPJ <-DrawingFile>> 08/11/2021 12:25 10:00:01.07 Developed by Dalgal

# Engineering Log - Borehole

Client		Hunter Water		Project No.		512448					
Project		Stormwater Amenity		Logged By		MC					
Location		Jesmond		Checked By		NS					
Started Drilling		22.9.21		Northing		6358970.00					
Completed Drilling		22.9.21		Easting		377587.00					
Slope		90°		Equipment		DT1200					
Bearing		---		Ground Level		5.362 AHD					
DRILLING		MATERIAL DESCRIPTION				TESTING, SAMPLING & OTHER INFORMATION					
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
			5		CL	FILL: Sandy CLAY: low plasticity, dark grey, medium grained sand, with coarse, brown, subangular gravel	<PL				FILL
			1		CL	Sandy CLAY: low plasticity, grey mottled orange brown, fine grained sand			SPT 0, 0, 0 N=0		ALLUVIUM SPT Recovery: 0.45 m
			4			2.00m: traces of coarse gravels which are approximately 40mm in size and black in colour	>PL	VS to S	SPT 3, 3, 3 N=6		1.6m - seepage observed SPT Recovery: 0.45 m
			2			3.00m: sand becomes medium grained			SPT 2, 2, 2 N=4		SPT Recovery: 0.45 m
			3		SC	Clayey SAND: fine to medium grained, grey					
			2			4.00m: trace fine to medium, red, black and brown coarse gravels approximately 10 mm in size	W	VL	SPT 2, 2, 3 N=5		SPT Recovery: 0.45 m
			4								
			1						SPT 3, 2, 1 N=3		SPT Recovery: 0.45 m
			5								
			0			Borehole N14-BH03 Terminated at 5.45 m					Borehole terminated at target depth
			6								
			-1								
			7								
			-2								
			8								
Remarks:											

AURECON SYD LIB 05.GLB Log CW NON-CORED BOREHOLE LOG - STORMWATER AMENITY.GPJ <-DrawingFile>> 03/11/2021 15:08 10:00.01.07 Developed by Daigal

# Engineering Log - Borehole

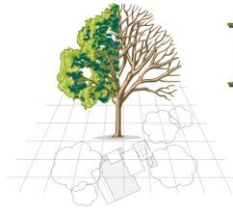
Client	Hunter Water	Project No.	512448								
Project	Stormwater Amenity	Logged By	MC								
Location	Jesmond	Checked By	NS								
Started Drilling	22.9.21	Northing	6358918.00	Slope	90°	Equipment	DT1200				
Completed Drilling	22.9.21	Easting	377579.00	Bearing	---	Ground Level	5.664 AHD				
DRILLING		MATERIAL DESCRIPTION				TESTING, SAMPLING & OTHER INFORMATION					
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity/grainsize, colour and other components)	Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
AD/T	▲	5	1		CL	FILL: Sandy CLAY: low plasticity, dark grey, medium grained sand, with black, brown, coarse and subangular gravel	>PL	VS	SPT 2, 0, 0 N=0		FILL
					CL	Silty CLAY: medium plasticity, grey mottled orange brown, no gravels present 1.20m: As above, becomes grey slightly mottled orange brown. No gravels present					ALLUVIUM 1.3m - seepage observed
						2.30m: As above, with coarse black and brown gravels					SPT Recovery: 0.45 m
						Borehole N14-BH04 Terminated at 2.45 m					Borehole terminated at target depth
		4	2								
		3	3								
		2	4								
		1	5								
		0	6								
		-1	7								
		-2	8								
Remarks:											

AURECON SYD LIB 05.GLB Log CW NON-CORED BOREHOLE LOG - STORMWATER AMENITY.GPJ <-DrawingFile>> 03/11/2021 15:08 10.00.01.07 Developed by Daigel



## APPENDIX G

### Arboricultural Impact Assessment



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ABN: 58 359 914 843

## Arboricultural Impact Appraisal and Method Statement

48 Mordue Parade  
Jesmond, NSW

Prepared for  
Hunter Water

---

4 July 2022

by Andrew Scales

Dip. Horticulture / Dip. Arboriculture AQF5

PO Box 5085, Elanora Heights NSW 2101

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## Summary

The proposed works include improvements to the existing stormwater amenity that are to be undertaken along the existing concrete-lined stormwater channel. I have inspected all the trees that could be affected and list their details in Appendix 2. Based on this information, I provided guidance to project architect on the constraints these trees impose on the use of the site.

Two low category trees will require removal because of this proposal. However, they are relatively small, or in poor condition, and the retention of all the significant boundary tree cover will ensure there is little impact on the wider setting. The proposed changes may adversely affect a further three high category trees if appropriate protective measures are not taken. However, if adequate precautions to protect the retained trees are specified and implemented through the arboricultural method statement included in this report, the development proposal will have no adverse impact on the contribution of trees to local amenity or character.



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## 1. INTRODUCTION

- 1.1 **Instruction:** I am instructed by Aurecon Group to inspect the tree population at 48 Mordue Parade, Jesmond and to provide an arboricultural report to accompany a development application. This report investigates the impact of the proposed development on trees and provides the following guidelines for appropriate tree management and protective measures:
- a schedule of the relevant trees to include basic data and a condition assessment;
  - an appraisal of the impact of the proposal on trees and any resulting impact that has on local character and amenity;
  - a preliminary arboricultural method statement setting out appropriate protective measures and management for trees to be retained
- 1.2 **Purpose of this report:** This report provides an analysis of the impact of the development proposal on trees with additional guidance on appropriate management and protective measures. Its primary purpose is for Hunter Water to review the tree information as part of the planning phase and use as the basis for tree management. Within this planning phase, it will be available for inspection by people other than tree experts, so the information is presented to be helpful to those without a detailed knowledge of the subject.
- 1.3 **Qualifications and experience:** I have based this report on my site observations and the provided information, and I have come to conclusions in the light of my experience. I have experience and qualifications in arboriculture and include a summary in Appendix 1.
- 1.4 **Documents and information provided:** Aurecon Group provided me with copies of the following documents:
- Stormwater Amenity Plans, Dwg No. 85222-16266-001 to 85222-16266-010 (Revision 01), by Hunter Water dated 25 May 2022.
- 1.5 **Scope of this report:** This report is only concerned with four individual trees, plus a stand of similar trees, within the site precinct. It takes no account of other trees, shrubs or groundcovers within the site unless stated otherwise. It includes a preliminary assessment based on the site visit and the documents provided, listed in 1.4 above.



## 2. THE LAYOUT DESIGN

- 2.1 **Tree AZ method of tree assessment:** The TreeAZ assessment method determines the worthiness of trees in the planning process. TreeAZ is based on a systematic method of assessing whether individual trees are important and how much weight they should be given in management considerations. Simplistically, trees assessed as potentially important are categorised as 'A' and those assessed as less important are categorised as 'Z'. Further explanation of TreeAZ can be found in Appendix 3.

In the context of new development, all the Z trees are discounted as a material constraint in layout design. All the A trees are potentially important and they dictate the design constraints. This relatively simple constraints information is suitable for use by the architect to optimise the retention of the best trees in the context of other material considerations.

### 2.2 Site visit and collection of data

- 2.2.1 **Site visit:** I carried out an unaccompanied site visit on 27 June 2022. All my observations were from ground level and I estimated all dimensions unless otherwise indicated. Aerial inspections, root or soil analysis, exploratory root trenching and internal diagnostic testing was not undertaken as part of this assessment. The weather at the time of inspection was clear and dry with good visibility.
- 2.2.2 **Brief site description:** 48 Mordue Parade is located in the residential suburb of Jesmond (refer figure 1). The site is on the southern side of the road and surrounded by residential and commercial development. The site consists of Heaton Park which has a variety of indigenous trees scattered around the site boundaries.

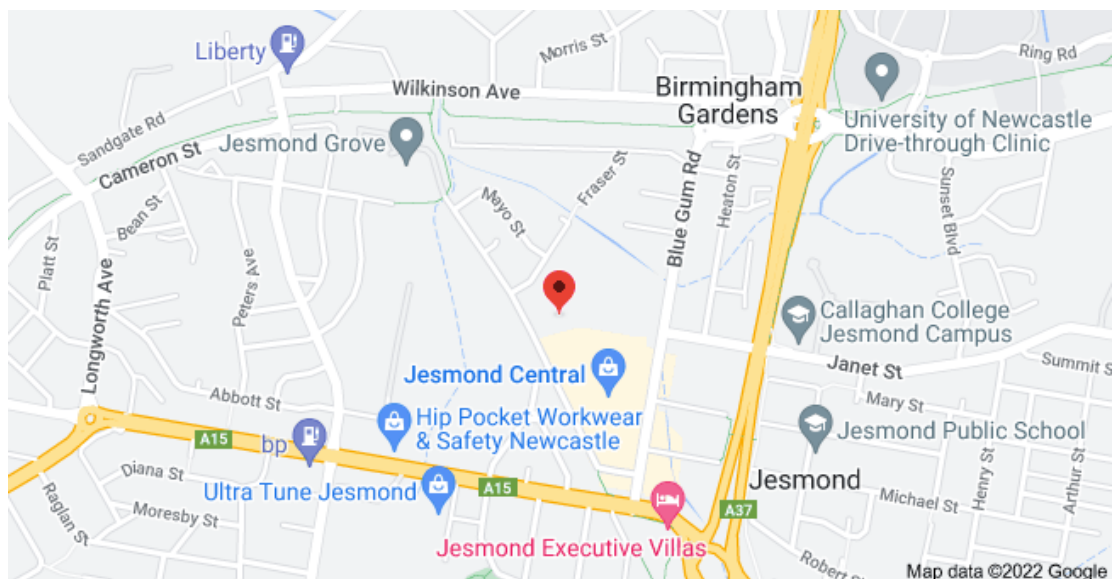


Figure 1: The location of the subject site (www.googlemaps.com).



- 2.2.3 **Collection of basic data:** I inspected each tree and have collected information on species, height, diameter, maturity and potential for contribution to amenity in a development context. I have recorded this information in the tree schedule included, with explanatory notes, in Appendix 2. Each tree was then allocated to one of four categories (**AA**, **A**, **Z** or **ZZ**), which reflected its suitability as a material constraint on development.
- 2.2.4 **Identification and location of the trees:** I have illustrated the locations of the significant trees on the Tree Management Plan (Plan TMP01) included as Appendix 8. This plan is for illustrative purposes only and it should not be used for directly scaling measurements.
- 2.2.5 **Advanced interpretation of data:** Australian Standard *Protection of trees on development sites* (AS4970-2009), recommends that the trunk diameter measurement for each tree is used to calculate the tree protection zone (TPZ), which can then be interpreted to identify the design constraints and, once a layout has been consented, the exclusion zone is to be protected by barriers.
- 2.3 **The use of the tree information in layout design:** Following my inspection of the trees, the information listed in Appendix 2 was used to provide constraints guidance based on the locations of all the A trees. All the Z trees were discounted because they were not considered worthy of being a material constraint. This guidance identified two zones of constraint based on the following considerations:
- **The tree protection zone (TPZ)** is an area where ground disturbance must be carefully controlled. The TPZ was established according to the recommendations set out in AS4970-2009 and is the radial offset distance of twelve (x12) times the trunk diameter. In principle, a maximum encroachment of 10% is acceptable within the TPZ and a high level of care is needed during any activities that are authorised within it if important trees are to be successfully retained.
  - **The structural root zone (SRZ)** is a radial distance from the centre of a tree's trunk, where it is likely that structural, woody roots would be encountered. The distance is calculated on trunk flare diameter at ground level. The SRZ may also be influenced by natural or built structures, such as rocks and footings. The SRZ only needs to be calculated when major encroachment (>10%) into a TPZ is proposed.



### 3. ARBORICULTURAL IMPACT APPRAISAL

3.1 **Summary of the impact on trees:** I have assessed the impact of the proposal on trees by the extent of disturbance in TPZs and the encroachment of structures into the SRZ (as set out briefly in 2.3 above and more extensively in Appendix 2). All the trees that may be affected by the development proposal are listed in Table 1

**Table 1: Summary of existing trees and trees that may be affected by development**

Impact	Reason	Important trees		Unimportant trees	
		AA	A	Z	ZZ
Retained trees that may be affected through disturbance to TPZs	Removal of existing surfacing/structures/landscaping and/or installation of new surfacing/structures/landscaping	3	4, B		
Trees to be removed	Civil and construction and/or level variations within TPZ			2	5

### 3.2 Detailed impact appraisal

3.2.1 **Category AA and A trees that could potentially be adversely affected through TPZ disturbance:** Three category A and AA trees (Trees 3, 4 and B) could potentially be adversely affected through disturbance to their TPZs as follows:

- Trees 3 and 4: These are important trees with a high potential to contribute to amenity so any adverse impacts on them should be minimised. The proposed upgrades will impede with 14% and 5% respectively. AS4970-2009 identifies encroachments of greater than 10% of a TPZ are major encroachment. However, to assist in identifying the extent of impacts to the trees I use the following guideline:

0% of root zone impacted – no impact of significance  
 0 to 10% of TPZ impacted – low level of impact  
**10 to 15% of TPZ impacted – low to moderate level of impact**  
 15 to 20% of TPZ impacted – moderate level of impact  
 20 to 25% of TPZ impacted – moderate to high level of impact  
 25 to 35% of TPZ impacted – high level of impact  
 >35% of TPZ impacted – significant level of impact

Although these changes may cause harm if not carried out with care, I have reviewed the situation carefully and my experience is that these trees could





be successfully retained without any adverse effects if appropriate protective measures are properly specified and controlled through a detailed arboricultural method statement.

- **Tree B:** This is an important stand of trees on the western boundary with existing HV powerlines near them. The proposed works remain largely outside their TPZ and is not expected to have any direct impacts. It should be noted that these trees have been pruned regularly for powerline clearance and their canopies do not exceed beyond the powerlines. Maintaining a 5.4m radius around these trees will ensure they are protected and remain free from construction impacts. I have reviewed the situation carefully and my experience is that this tree could be successfully retained without any adverse effects if appropriate protective measures are properly specified and controlled through a detailed arboricultural method statement.

**3.2.2 Low category trees to be removed:** The proposed development will necessitate the removal of two trees of low and very low retention value. These include Trees 2 and 5. None of these trees are considered significant or worthy of special measures to ensure their preservation. It should be noted that Tree 5 is in very poor condition and exhibits decaying trunk and upper branches. This tree should be considered for removal irrespective of the proposed works.

### **3.3 Proposals to mitigate any impact**

**3.3.1 Protection of retained trees:** The successful retention of trees within the site will depend on the quality of the protection and the administrative procedures to ensure protective measures remain in place throughout the development. An effective way of doing this is through an arboricultural method statement that can be specifically referred to in the planning condition. An arboricultural method statement for this site is set out in detail in Section 4.

**3.3.2 Summary of the impact on local amenity:** Two low category trees will require removal because of this proposal. However, they are relatively small, or in poor condition, and the retention of all the significant boundary tree cover will ensure there is little impact on the wider setting. The proposed changes may adversely affect a further three high category trees if appropriate protective measures are not taken. However, if adequate precautions to protect the retained trees are specified and implemented through the arboricultural method statement included in this report, the development proposal will have no adverse impact on the contribution of trees to local amenity or character.



## 4. ARBORICULTURAL METHOD STATEMENT

### 4.1 Introduction

4.1.1 **Terms of reference:** The impact appraisal in Section 3 identified the potential impacts on trees caused by proposed development. Section 4 is an arboricultural method statement setting out management and protection details that must be implemented to secure successful tree retention. It has evolved from Australian Standard AS4970-2009 *Protection of trees on development sites*.

4.1.2 **Plan TMP01:** Plan TMP01 in Appendix 8 is illustrative and based entirely on provided information. This plan should only be used for dealing with the tree issues and all scaled measurements must be checked against the original submission documents. The precise location of all protective measures must be confirmed at the pre-commencement meeting before any demolition or construction activity starts. Its base is the existing land survey, which has the proposed layout superimposed so the two can be easily compared. It shows the existing trees numbered, with high categories (A) highlighted in green triangles and low categories (Z) highlighted in blue rectangles. It also shows the locations of the proposed protective measures.

### 4.2 Tree protection with fencing and ground protection

4.2.1 **Protection fencing:** Tree protection fencing must comply with AS4970 (section 4.3) recommendations. An illustrative guide is included as Appendix 4. The approximate location of the barriers and the TPZs is illustrated on plan TMP01. The precise location of the fencing must be agreed with the project Arborist before any development activity starts.

4.2.2 **Ground protection:** Any TPZs outside the protective fencing must be covered in ground protection based on AS4970 recommendations until there is no risk of damage from the demolition and construction activity. An illustrative specification for this ground protection is included as Appendix 5. On this site, it must be installed near Trees 3 and 4 as illustrated on plan TMP01 before any demolition and construction starts.

4.3 **Precautions when working in TPZs:** Any work in TPZs must be done with care as set out in Appendix 6. On this site, special precautions must be taken near Trees 3, 4 and B as illustrated on plan TMP01 and summarised below:

- **Removal of existing surfacing/structures and replacement with new surfacing/structures:** Trees 3, 4 and B may be adversely affected by the demolition and construction works. Any adverse impact must be minimised by following the guidance set out in Appendix 6.
- **Installation of new soft landscaping:** All landscaping activity within TPZs has the potential to cause severe damage and any adverse impact



must be minimised by following the guidance set out in Section 7 of Appendix 6.

- **Installation of new services or upgrading of existing services:** It is often difficult to clearly establish the detail of services until the construction is in progress. Where possible, it is proposed to use the existing services into the site and keep all new services outside TPZs. However, where existing services within TPZs require upgrading or new services have to be installed in TPZs, great care must be taken to minimise any disturbance. Trenchless installation should be the preferred option but if that is not feasible, any excavation must be carried out by hand according to the guidelines set out in Section 6 of Appendix 6. If services do need to be installed within TPZs, consultation must be obtained from the project Arborist and/or council before any works are carried out.

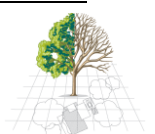
#### 4.4 Other tree related works

4.4.1 **Site storage, cement mixing and washing points:** All site storage areas, cement mixing and washing points for equipment and vehicles must be outside TPZs unless otherwise agreed with the project Arborist and/or council. Where there is a risk of polluted water run off into TPZs, heavy-duty plastic sheeting and sandbags must be used to contain spillages and prevent contamination.

4.4.2 **Pruning:** Any pruning that is required to accommodate hoardings, scaffolding or to accommodate the unloading/loading of vehicles and has been approved by Council shall be carried out by a qualified Arborist (AQF3) and must be in accordance with AS4373 Australian Standards 'Pruning of Amenity Trees'.

#### 4.5 Programme of tree protection and supervision

4.5.1 **Site management:** It is the developer's responsibility to ensure that the details of this arboricultural method statement and any agreed amendments are known and understood by all site personnel. Copies of the agreed documents must be kept on site at all times and the site manager must brief all personnel who could have an impact on trees on the specific tree protection requirements. This must be a part of the site induction procedures and written into appropriate site management documents.



## 5. HOW TO USE THIS REPORT

5.1 **Limitations:** It is common that the detail of logistical issues such as site storage and the build programme are not finalised until after consent is issued. As this report has been prepared in advance of consent, some of its content may need to be updated as more detailed information becomes available once the post-consent project management starts. Although this document will remain the primary reference in the event of any disputes, some of its content may be superseded by authorised post-consent amendments.

5.2 **Suggestions for the effective use of this report:** Section 4 of this report, including the relevant appendices, is designed as an enforcement reference. It is constructed so the council can directly reference the detail in a planning condition. Referencing the report by name and relating conditions to specific subsections is an effective means of reducing confusion and facilitating enforcement in the event of problems during implementation. More specifically, the following issues should be directly referenced in the conditions for this site:

1. Pre-commencement meeting	4.5
2. Protection fence	4.2.1 and Appendix 4
3. Ground protection	4.2.2 and Appendix 5
4. Removal of surfacing/structures	4.3 and Appendix 6 (Section 4)
5. Installation of surfacing/structures	4.3 and Appendices 6 (Section 5)
6. Services	4.3 and Appendix 6 (Section 6)
7. Landscaping	4.3 and Appendix 6 (Section 7)
8. Programming of tree protection	4.5 and Appendix 7

Each of the above matters shall be certified by the project arborist, where applicable. The last column of the table in Appendix 7 is to be used so that the various supervision issues can be recorded as they are confirmed by supervision letters. It is intended to act as a summary quick reference to help keep track of the progress of the supervision.



## 6. OTHER CONSIDERATIONS

- 6.1 **Trees subject to statutory controls:** The subject trees are legally protected under Newcastle City Council's Tree Preservation Order, it will be necessary to consult the council before any pruning or removal works other than certain exemptions can be carried out. The works specified above are necessary for reasonable management and should be acceptable to the council.

## 7. BIBLIOGRAPHY

### 7.1 List of references:

Australian Standard AS4373-2007 *Pruning of Amenity Trees*.  
Standards Australia.

Australian Standard AS4970-2009 *Protection of trees on development sites*.  
Standards Australia.

Barrell, J (2009) Draft for Practical Tree AZ version 9.02 A+NZ  
Barrel Tree Consultancy, Bridge House, Ringwood BH24 1EX

Brooker, M. Kleinig, D (1999) Field guide to eucalypts – South eastern Aust.  
Blooming Books, Hawthorn Vic.

Matheny, N.P. & Clark, J.R. (1998) Trees & Development: A Technical Guide to Preservation of Trees During Land Development  
International Society of Arboriculture, Savoy, Illinois.

Mattheck, Dr. Claus R., Breloer, Helge (1995) The Body Language of Trees - A Handbook for Failure Analysis;  
The Stationery Office, London. England.

Robinson, L (1994) Field Guide to the Native Plants of Sydney  
Kangaroo Press, Kenthurst NSW



## 8. DISCLAIMER

### 8.1 Limitations on use of this report:

*This report is to be utilized in its entirety only. Any written or verbal submission, report or presentation that includes statements taken from the findings, discussions, conclusions or recommendations made in this report, may only be used where the whole of the original report (or a copy) is referenced in, and directly attached to that submission, report or presentation.*

#### ASSUMPTIONS

*Care has been taken to obtain all information from reliable sources. All data has been verified insofar as possible: however, Naturally Trees can neither guarantee nor be responsible for the accuracy of information provided by others.*

*Unless stated otherwise:*

- Information contained in this report covers only those trees that were examined and reflects the condition of those trees at time of inspection: and*
- The inspection was limited to visual examination of the subject trees without dissection, excavation, probing or coring. There is no warranty or guarantee, expressed or implied, that problems or deficiencies of the subject trees may not arise in the future.*

Yours sincerely



Andrew Scales  
Dip. Horticulture  
Dip. Arboriculture AQF5



## APPENDIX 1

### Brief qualifications and experience of Andrew Scales

#### 1. Qualifications:

Associate Diploma Horticulture	Northern Sydney Institute of TAFE	1998
Certificate in Tree Surgery	Northern Sydney Institute of TAFE	1998
Diploma of Horticulture (Arboriculture)	Northern Sydney Institute of TAFE	2006
Diploma of Arboriculture AQF5	Northern Sydney Institute of TAFE	2019

- 2. Practical experience:** Being involved in the arboricultural/horticultural industry for in excess of 20 years, I have developed skills and expertise recognized in the industry. Involvement in the construction industry and tertiary studies has provided me with a good knowledge of tree requirements within construction sites.

As director of Naturally Trees, in this year alone I have undertaken hundreds of arboricultural consultancy projects and have been engaged by a range of clients to undertake tree assessments. I have gained a wide range of practical tree knowledge through tree removal and pruning works.

#### 3. Continuing professional development:

Visual Tree Assessment (Prof. Dr. Claus Mattheck)	Northern Sydney Institute of TAFE	2001
Wood Decay in Trees (F.W.M.R.Schwarze)	Northern Sydney Institute of TAFE	2004
Visual Tree Assessment (Prof. Dr. Claus Mattheck)	Carlton Hotel, Parramatta NSW	2004
Tree A-Z / Report Writing (Jeremy Barrell)	Northern Sydney Institute of TAFE	2006
Up by Roots – Healthy Soils and Trees in the Built Environment (James Urban)	The Sebel Parramatta NSW	2008
Tree Injection for Insect Control (Statement of Attainment)	Northern Sydney Institute of TAFE	2008
Quantified Tree Risk Assessment (QTRA) Registered Licensee #1655	South Western Sydney Institute TAFE	2011
Practitioners Guide to Visual Tree Assessment	South Western Sydney Institute TAFE	2011
Quantified Tree Risk Assessment (QTRA) Registered Licensee #1655	Richmond College NSW TAFE	2014
VALID Approach to Likelihood of Failure (David Evans)	Centennial Park NSW	2017



## APPENDIX 2 Tree schedule

NOTE: Colour annotation is AA & A trees with green background; Z & ZZ trees with blue background; trees to be removed in red text.

No.	Genus species	Height	Spread	DBH	TPZ	Foliage %	Age class	Defects   Comment	Location	Services	Significance	Tree AZ
2	<i>Jacaranda mimosifolia</i>	8	8	300	3.6	80%	M	Lopped near powerlines, Epicormic shoots	Grass	LV wires	M	Z9
3	<i>Eucalyptus saligna</i>	28	24	1000	12.0	80%	M	Nil	Grass	Nil	H	AA1
4	<i>Eucalyptus saligna</i>	24	16	700	8.4	70%	M	Cavities throughout trunk, Potential habitat	Grass	Nil	H	A2
5	<i>Salix weeping willow</i>	9	9	500	6.0	60%	O	Cavity, Branch failures, Decayed trunk	Grass	Nil	M	ZZ5
B	Stand of mixed <i>Eucalyptus robusta</i> and <i>Eucalyptus saligna</i>	14	9	450	5.4	80%	M	Stand of mixed tree species	Grass	Nil	H	A1





## Explanatory Notes

- **Measurements/estimates:** All dimensions are estimates unless otherwise indicated. Measurements taken with a tape or clinometer are indicated with a '\*'. Less reliable estimated dimensions are indicated with a '?'.
- **Species:** The species identification is based on visual observations and the botanical name. In some instances, it may be difficult to quickly and accurately identify a particular tree without further detailed investigations. Where there is some doubt of the precise species of tree, it is indicated with a '?' after the name in order to avoid delay in the production of the report. The botanical name is followed by the abbreviation sp if only the genus is known. The species listed for groups and hedges represent the main component and there may be other minor species not listed.
- **Tree number:** relates to the reference number used on site diagram/report.
- **Height:** Height is estimated to the nearest metre.
- **Spread:** The average crown spread is visually estimated to the nearest metre from the outermost tips of the live lateral branches.
- **DBH:** These figures relate to 1.4m above ground level and are recorded in millimetres. If appropriate, diameter is measured with a diameter tape. 'M' indicates trees or shrubs with multiple stems.
- **Foliage Cover:** Percent of estimated live foliage cover for particular species range.
- **Age class:**

Y	Young = recently planted
S	Semi-mature (<20% of life expectancy)
M	Mature (20-80% of life expectancy)
O	Over-mature (>80% of life expectancy)
- **TPZ:** The Tree Protection Zone (TPZ) is the radial offset distance of twelve times the trunk diameter in meters.
- **Tree AZ:** See reference for Tree AZ categories in Appendix 3.
- **Significance:** A tree's significance/value in the landscape takes into account its prominence from a wide range of perspectives. This includes, but is not limited to neighbour hood perspective, local perspective and site perspective. The significance of the subject trees has been categorized into three groups, such as: High, Moderate or Low significance.



## APPENDIX 3

### TreeAZ Categories (Version 10.04-ANZ)

#### Z **Category Z: Unimportant trees not worthy of being a material constraint**

**Local policy exemptions:** Trees that are unsuitable for legal protection for local policy reasons including size, proximity and species

<b>Z1</b>	Young or insignificant small trees, i.e. below the local size threshold for legal protection, etc
<b>Z2</b>	Too close to a building, i.e. exempt from legal protection because of proximity, etc
<b>Z3</b>	Species that cannot be protected for other reasons, i.e. scheduled noxious weeds, out of character in a setting of acknowledged importance, etc

**High risk of death or failure:** Trees that are likely to be removed within 10 years because of acute health issues or severe structural failure

<b>Z4</b>	Dead, dying, diseased or declining
<b>Z5</b>	Severe damage and/or structural defects where a high risk of failure cannot be satisfactorily reduced by reasonable remedial care, i.e. cavities, decay, included bark, wounds, excessive imbalance, overgrown and vulnerable to adverse weather conditions, etc
<b>Z6</b>	Instability, i.e. poor anchorage, increased exposure, etc

**Excessive nuisance:** Trees that are likely to be removed within 10 years because of unacceptable impact on people

<b>Z7</b>	Excessive, severe and intolerable inconvenience to the extent that a locally recognised court or tribunal would be likely to authorise removal, i.e. dominance, debris, interference, etc
<b>Z8</b>	Excessive, severe and intolerable damage to property to the extent that a locally recognised court or tribunal would be likely to authorise removal, i.e. severe structural damage to surfacing and buildings, etc

**Good management:** Trees that are likely to be removed within 10 years through responsible management of the tree population

<b>Z9</b>	Severe damage and/or structural defects where a high risk of failure can be temporarily reduced by reasonable remedial care, i.e. cavities, decay, included bark, wounds, excessive imbalance, vulnerable to adverse weather conditions, etc
<b>Z10</b>	Poor condition or location with a low potential for recovery or improvement, i.e. dominated by adjacent trees or buildings, poor architectural framework, etc
<b>Z11</b>	Removal would benefit better adjacent trees, i.e. relieve physical interference, suppression, etc
<b>Z12</b>	Unacceptably expensive to retain, i.e. severe defects requiring excessive levels of maintenance, etc

**NOTE:** Z trees with a high risk of death/failure (Z4, Z5 & Z6) or causing severe inconvenience (Z7 & Z8) at the time of assessment and need an urgent risk assessment can be designated as ZZ. ZZ trees are likely to be unsuitable for retention and at the bottom of the categorisation hierarchy. In contrast, although Z trees are not worthy of influencing new designs, urgent removal is not essential and they could be retained in the short term, if appropriate.

#### A **Category A: Important trees suitable for retention for more than 10 years and worthy of being a material constraint**

<b>A1</b>	No significant defects and could be retained with minimal remedial care
<b>A2</b>	Minor defects that could be addressed by remedial care and/or work to adjacent trees
<b>A3</b>	Special significance for historical, cultural, commemorative or rarity reasons that would warrant extraordinary efforts to retain for more than 10 years
<b>A4</b>	Trees that may be worthy of legal protection for ecological reasons (Advisory requiring specialist assessment)

**NOTE:** Category A1 trees that are already large and exceptional, or have the potential to become so with minimal maintenance, can be designated as AA at the discretion of the assessor. Although all A and AA trees are sufficiently important to be material constraints, AA trees are at the top of the categorisation hierarchy and should be given the most weight in any selection process.

TreeAZ is designed by Barrell Tree Consultancy ([www.treeaz.com/tree\\_az/](http://www.treeaz.com/tree_az/))



## APPENDIX 4

### Tree protection fencing and signs - Illustrative specification

**Protective fencing:** Protective 1.8m high fencing should be installed at the location illustrated on the Tree Management Plan before any site works start. All uprights should be fixed in position for the duration of the development activity. The fixings must be able to withstand the pressures of everyday site work.

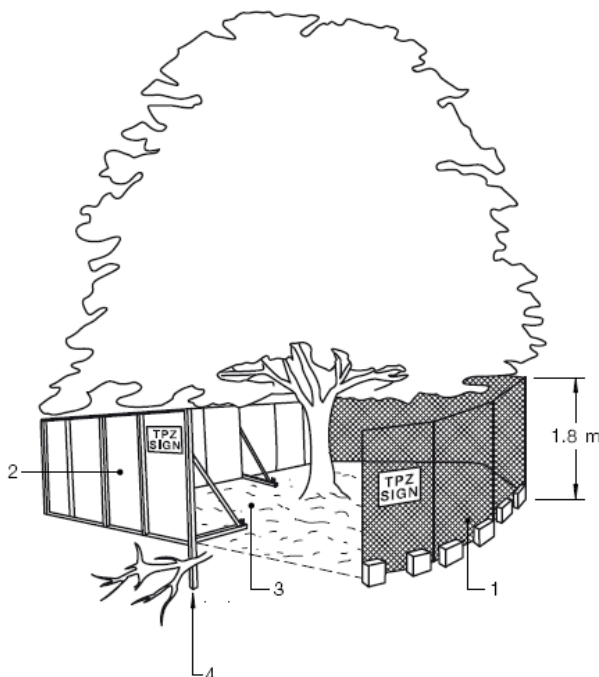
Inside the protective fencing, the following rules must be strictly observed:

- No vehicular access without adequate ground protection
- No storage of excavated debris, building materials or fuels
- No excessive cultivation for landscape planting
- No fires
- No mixing of cement
- No service installation or excavation

Once erected, protective fencing must not be removed or altered without consulting first with the project Arborist.

Shade cloth or similar should be attached to reduce the transport of dust, other particulate matter and liquids into the protected area and signage must be attached to outside of fencing.

**Signage:** All signs are to provide clear and readily accessible information to indicate that a TPZ has been established. Signage identifying the TPZ must be attached to outside of fencing and be visible from within the development site.



Signage example:



#### Legend

1. Chain wire mesh panels with shade cloth (if required) attached, held in place with concrete feet.
2. Alternative plywood or wooden paling fence panels. This fencing material also prevents building materials or soil entering the TPZ.
3. Mulch installation across surface of TPZ (at the discretion of the project arborist). No excavation, construction activity, grade changes, surface treatment or storage of materials of any kind is permitted within the TPZ.
4. Bracing is permissible within the TPZ. Installation of supports should avoid damaging roots.

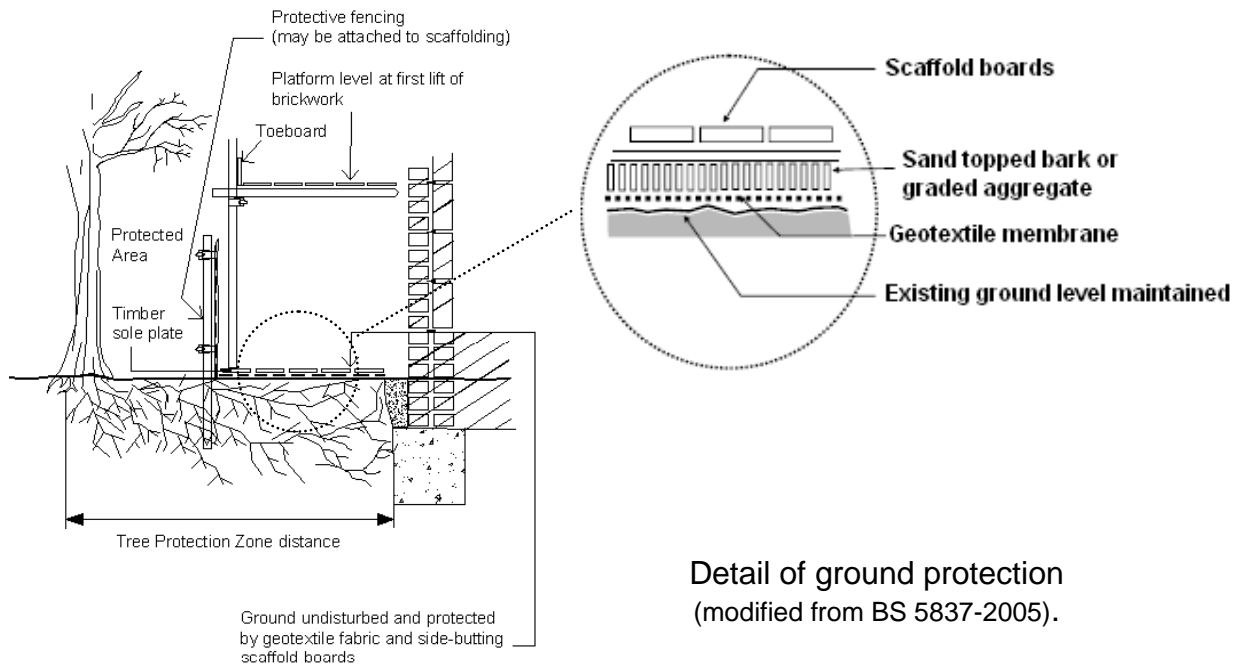
(Naturally Trees- reproduced under copyright Licence number 1009-c095)



## APPENDIX 5

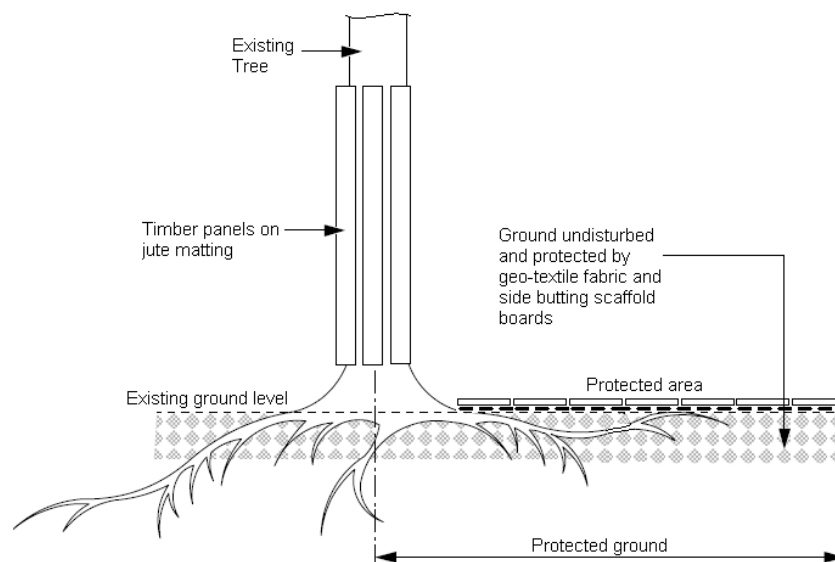
### Root zone and trunk protection - Illustrative specification

**Root zone protection:** Where necessary, access through the TPZ can be achieved by laying aggregate and timber boards (or similar) over the root zone to protect roots. The ground beneath the boarding should be left undisturbed and should be protected with a porous geo-textile fabric covered with sand or mulch.



Detail of ground protection  
(modified from BS 5837-2005).

**Trunk protection:** Where fencing cannot be installed, the vertical trunk of exposed trees shall be protected by the placement of 3.6m lengths of 50 x 100mm hardwood timbers, spaced vertically, at 150mm centres and secured by 2mm wire at 300mm wide spacing over suitable protective padding material e.g. Jute Matting. The trunk protection shall be maintained intact until the completion of all work on site.



Detail of trunk protection.



## APPENDIX 6

### General guidance for working in TPZ

#### 1 PURPOSE OF THIS GUIDANCE

This guidance sets out the general principles that must be followed when working within a TPZ. Where more detail is required, it will be supplemented by illustrative specifications in other appendices in this document (refer Appendix 4 and 5).

This guidance is based on the Australian Standards (2009) AS4970: *Protection of Trees on Construction Sites*.

Once the site works start, this guidance is specifically for the site personnel to help them understand what has been agreed and explain what is required to fully meet their obligations to protect trees. All personnel working in TPZs must be properly briefed about their responsibilities towards important trees based on this guidance.

This guidance should always be read in conjunction with the Tree Management Plan (TMP01) illustrating the areas where specific precautions are necessary. Each area where precautions are required is explained on the plan as identified on the legend. All protective measures should be installed according to the prevailing site conditions and agreed as satisfactory by the Project Arborist before any demolition or construction work starts.

#### 2 TREE PROTECTION

##### 2.1 Tree Protection Zone (TPZ)

The TPZ is a radial setback, extending outwards from the centre of the trunk, where disturbance must be minimised if important trees are to be successfully retained. The TPZ area is illustrated on the Tree Management Plan (TMP01) accompanying this guidance.

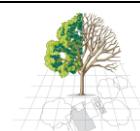
- The TPZ is a radial setback extending outwards from the centre of the trunk equal to the DBH x 12.
- This area shall be protected by tree protective fencing (refer Appendix 4).
- Any part of the TPZ outside of the tree protective fencing area must be isolated from the work operations by protective barriers and/or root zone protection for the duration of the work (refer Appendix 5).
- The Project Arborist shall approve the extent of the TPZ prior to commencement of works.
- The TPZ shall be mulched to a depth of 90mm with approved organic mulch e.g. leaf and wood chip where possible.
- Supplementary watering shall be provided in dry periods to reduce water or construction stress, particularly to those trees which may incur minor root disturbance.

The following activities shall be excluded within the TPZ:

- Excavation, compaction or disturbance of the existing soil.
- The movement or storage of materials, waste or fill.
- Soil level changes
- Disposal/runoff of waste materials and chemicals including paint, solvents, cement slurry, fuel, oil and other toxic liquids
- Movement or storage of plant, machinery, equipment or vehicles.
- Any activity likely to damage the trunk, crown or root system.

##### 2.2 Arboricultural supervision

Any work within TPZs requires a high level of care. Qualified arboricultural supervision is essential to minimise the risk of misunderstanding and misinterpretation. Site personnel must be properly briefed before any work starts. Ongoing work must be inspected regularly and, on completion, the work must be signed off by the Project Arborist to confirm compliance by the contractor.



### **2.3 Tree protection fencing, root zone and trunk protection**

Prior to site establishment, tree protection fencing and root zone and trunk protection shall be installed to establish the TPZ for trees to be retained in accordance with site conditions. These protective barriers shall be maintained entire for the duration of the construction program (refer Appendix 4 and 5).

Tree protection fencing and trunk and root zone protection shall be removed following completion of construction. The mulch layer in the TPZ shall be retained and replenished where required to maintain a 75mm thickness

### **2.4 Pruning**

All pruning work required (including root pruning) should be in accordance with Australian Standard No 4373-1996 - Pruning of Amenity Trees.

### **2.5 Tree Damage**

In the event of damage to a tree or the TPZ, the Project Arborist shall be engaged to inspect and provide advice on remedial action. This should be implemented as soon as practicable and certified by the Project Arborist.

### **2.6 Post construction maintenance**

In the event of any tree deteriorating in health after the construction period, the Project Arborist shall be engaged to provide advice on any remedial action. Remedial action shall be implemented as soon as practicable and certified by the Project Arborist.

## **3 EXCAVATION AND FILL IN TPZ**

### **3.1 Excavation within TPZ**

If excavation within the TPZ is required the following shall be applied to preserve tree root systems:

- Excavation within TPZ must be carried out under the instruction and supervision of the Project Arborist.
- A root mapping exercise is to be undertaken and certified by the Project Arborist. Root mapping shall be undertaken by either ground penetrating radar, air spade, water laser or by hand excavation using hand tools, taking care not to damage the bark and wood of any roots.
- The purpose of the root mapping shall be to locate woody structural roots greater than 40mm in diameter. Where possible, flexible clumps of smaller roots, including fibrous roots, should be retained if they can be displaced temporarily or permanently beyond the excavation without damage.
- If digging by hand, a fork shall be used to loosen the soil and help locate any substantial roots.
- Once roots have been located, the trowel shall be used to clear the soil away from them without damaging the bark.
- Exposed roots to be removed shall be cut cleanly with a sharp saw or secateurs.
- Roots temporarily exposed shall be protected from direct sunlight, drying out and extremes of temperature by appropriate covering.

### **3.2 Fill within TPZ**

Placement of fill material within the Tree Protection Zone of trees to be retained should be avoided where possible. However, where fill cannot be avoided:

- All fill material to be placed within the TPZ should be approved by Project Arborist and consist of a course, gap-graded material to provide aeration and percolation to the root zone. Materials containing a high percentage of 'fines' is unacceptable for this purpose.
- The fill material should be consolidated with a non-vibrating roller to minimise compaction of the underlying soil.
- No fill material should be placed in direct contact with the trunk.



## 4 DEMOLITION OF SURFACING/STRUCTURES IN TPZ

### 4.1 Definitions of surfacing and structures

For the purposes of this guidance, the following broad definitions apply:

- **Surfacing:** Any hard surfacing used as a vehicular road, parking or pedestrian path including tarmac, solid stone, crushed stone, compacted aggregate, concrete and timber decking.
- **Structures:** Any man-made structure above or below ground including service pipes, walls, gate piers, buildings and foundations. Typically, this would include drainage structures, services, car-ports, bin stores and concrete slabs that support buildings.

### 4.2 Demolition and access

Roots frequently grow adjacent to and beneath existing surfacing/structures so great care is needed during access and demolition. Damage can occur through physical disturbance of roots and/or the compaction of soil around them from the weight of machinery or repeated pedestrian passage. This is not generally a problem whilst surfacing/structures are in place because they spread the load on the soil beneath and further protective measures are not normally necessary. However, once they are removed and the soil below is newly exposed, damage to roots becomes an issue and the following guidance must be implemented:

- No vehicular or repeated pedestrian access into TPZ permitted unless on existing hard surfacing or root zone protection.
- Regular vehicular and pedestrian access routes must be protected from compaction with temporary root zone protection as set out in Appendix 5.
- Where a TPZ is exposed by the work, it must be protected as set out in AS4970 until there is no risk of damage from the development activity.

### 4.3 Removal of surfacing/structures

Removing existing surfacing/structures is a high-risk activity for any adjacent roots and the following guidance must be observed:

- Appropriate tools for manually removing debris may include a pneumatic breaker, crow bar, sledgehammer, pick, mattock, shovel, spade, trowel, fork and wheelbarrow.
- Machines with a long reach may be used if they can work from outside the TPZ or from protected areas within the TPZ.
- Debris to be removed from the TPZ manually must be moved across existing hard surfacing or temporary root zone protection in a way that prevents compaction of soil. Alternatively, it can be lifted out by machines provided this does not disturb the TPZ.
- Great care must be taken throughout these operations not to damage roots.

## 5 INSTALLATION OF SURFACING/STRUCTURES IN TPZ

**5.1 Basic principles:** New surfacing/structures in a TPZ are potentially damaging to trees because they may disturb the soil and disrupt the existing exchange of water and gases in and out of it. Adverse impact on trees can be reduced by minimising the extent of these changes within the TPZ.

- **Surfacing:** Suitable surfacing should be relatively permeable to allow water and gas movement, load spreading to avoid localised compaction and require little or no excavation to limit direct damage. The actual specification of the surfacing is an engineering issue that needs to be considered in the context of the bearing capacity of the soil, the intended loading and the frequency of loading. The detail of product and specification are beyond the scope of this guidance and must be provided separately by the appropriate specialist.
- **Structures:** Where possible structures are to be constructed above ground level on piled supports and redirecting water to where it is needed. The detailed design and specification of such structures is an engineering issue that should be informed and guided by the Project Arborist. Conventional strip foundations in the TPZ for any significant structure may cause excessive root loss and are unlikely to be acceptable. However, disturbance can be significantly reduced by supporting the above ground part of the structures on small diameter piles/piers or



cast floor slabs set above ground level. The design should be sufficiently flexible to allow the piles to be moved if significant roots are encountered in the preferred locations.

## 5.2 Establishing the depth of roots

The precise location and depth of roots within the soil is unpredictable and will only be known when careful digging starts on site. Ideally, all new surfacing within a TPZ should be no-dig, i.e. requiring no excavation whatsoever, but this is rarely possible on undulating surfaces.

New surfacing normally requires an evenly graded sub-base layer, which can be made up to any high points with granular, permeable fills such as crushed stone or sharp sand. This sub-base must not be compacted as would happen in conventional surface installation. Some limited excavation is usually necessary to achieve this and need not be damaging to trees if carried out carefully and large roots are not cut.

Tree roots and grass roots rarely occupy the same soil volume at the top of the soil profile, so the removal of a turf layer up to 50mm is unlikely to be damaging to trees. It may be possible to dig to a greater depth depending on local conditions but this would need to be assessed by the Project Arborist.

## 6 SERVICES IN TPZ

For the purposes of this guidance, services are considered as structures. Excavation to upgrade existing services or to install new services within a TPZ may damage retained trees and should only be chosen as a last resort. In the event that excavation emerges as the preferred option, the decision should be reviewed by the Project Arborist before any work is carried out. If excavation is agreed, all digging should be done carefully and follow the guidance set out in 3.1 above.

## 7 SOFT LANDSCAPING IN TPZ

For the purposes of this guidance, soft landscaping includes the re-profiling of existing soil levels and covering the soil surface with new plants or an organic covering (mulch). It does not include the installation of solid structures or compacted surfacing.

Soft landscaping activity after construction can be extremely damaging to trees.

No significant excavation or cultivation shall occur within the TPZ (e.g. planting holes). Where new designs require levels to be increased to tie in with new structures or surrounding ground level, good quality and relatively permeable top soil should be used for the fill. It should be firmed into place but not over compacted in preparation for turfing or careful shrub planting.

All areas close to tree trunks should be kept at the original ground level and have a mulched finish rather than grass to reduce the risk of mowing damage.





## APPENDIX 7

### Schedule of works and responsibilities

Hold Point	Task	Responsibility	Certification	Timing of Inspection
1	Indicate clearly (with spray paint) trees approved for removal only	Principal Contractor	Project Arborist	Prior to demolition and site establishment
2	Establishment of tree protection fencing and additional root, trunk and/or branch protection	Principal Contractor	Project Arborist	Prior to demolition and site establishment
3	Supervise all excavations works proposed within the TPZ	Principal Contractor	Project Arborist	As required prior to the works proceeding adjacent to the tree
4	Inspection of trees by Project Arborist	Principal Contractor	Project Arborist	As required during construction period
5	Final inspection of trees by Project Arborist	Principal Contractor	Project Arborist	Completion of works












## APPENDIX 8

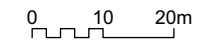
### Tree management plan

-refer attached Tree Management Plan, Dwg No. TMP01,  
by Naturally Trees dated 4 July 2022



LEGEND:

-  Category AA Trees worthy of being a constraint
-  Category A
-  Category Z Trees not worthy of being a constraint
-  Category ZZ
-  Existing layout
-  Proposed layout
-  Tree protection zone (TPZ) boundaries. No access permitted
-  Protective fencing and TPZ area within
-  TPZ where ground protection must be installed. Retain all existing levels.
- 01 Tree to be removed



ISSUE	DATE	REVISION
<small>NOTE DO NOT SCALE FROM DRAWING. USE FIGURED DIMENSIONS ONLY. CHECK ALL DIMENSIONS ON SITE BEFORE ANY MANUFACTURE OR CONSTRUCTION.</small>		

PROJECT  
**48 Mordue Parade, Jesmond NSW**

CLIENT  
**Hunter Water**

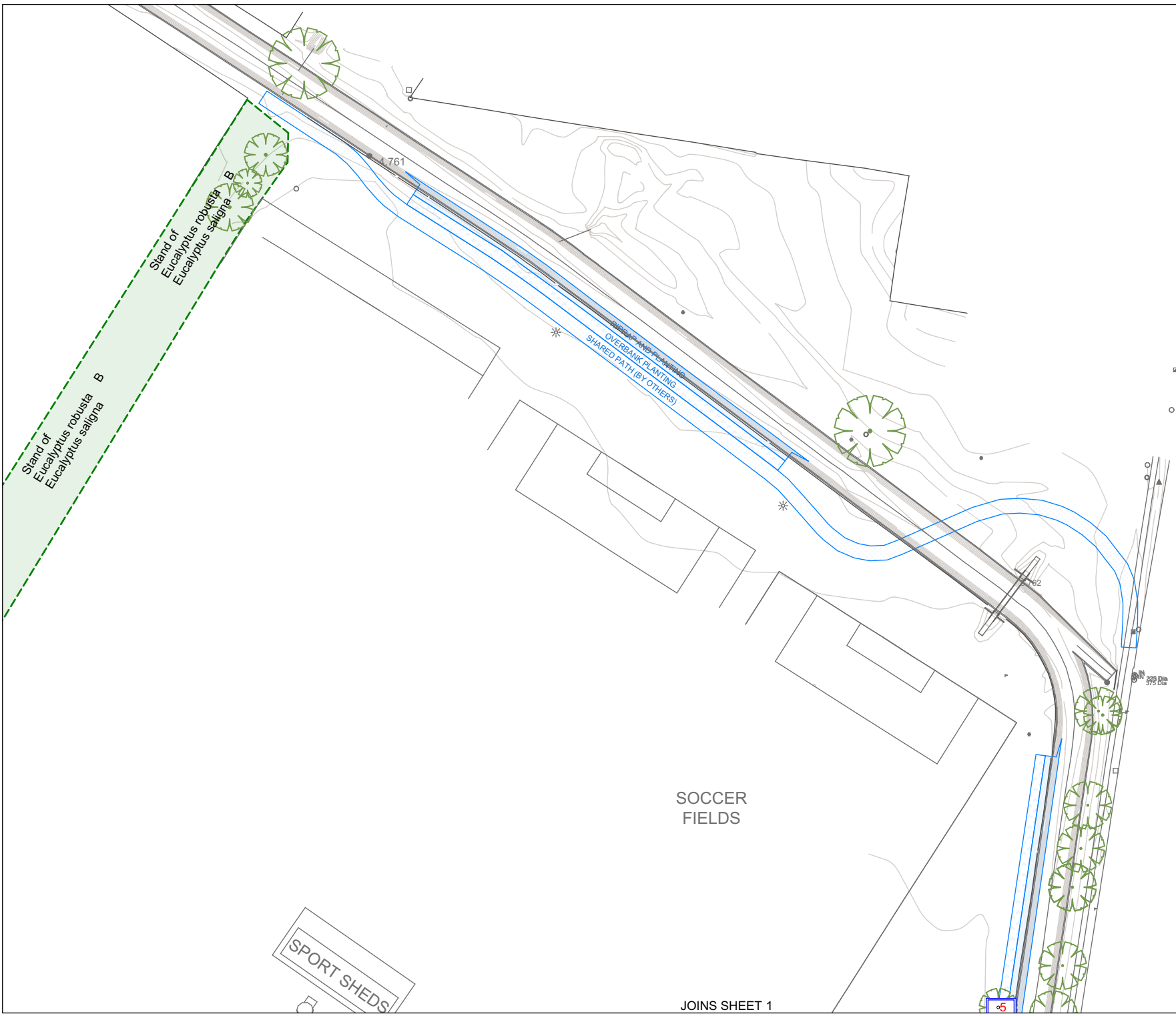
DRAWING  
**Tree Management Plan**













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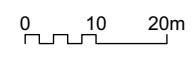
**Naturally Trees Arboricultural Consulting**  
 PO Box 5085 Elanora Heights NSW 2101 Australia  
 T: 0417 250 420 W: www.naturallytrees.com.au E: info@naturallytrees.com.au





LEGEND:

-  Category AA Trees worthy of being a constraint
-  Category A
-  Category Z Trees not worthy of being a constraint
-  Category ZZ
-  Existing layout
-  Proposed layout
-  Tree protection zone (TPZ) boundaries. No access permitted
-  Protective fencing and TPZ area within
-  TPZ where ground protection must be installed. Retain all existing levels.
-  Tree to be removed



ISSUE DATE REVISION  
**NOTE** DO NOT SCALE FROM DRAWING. USE FIGURED DIMENSIONS ONLY.  
 CHECK ALL DIMENSIONS ON SITE BEFORE ANY MANUFACTURE OR CONSTRUCTION

PROJECT  
**48 Mordue Parade, Jesmond NSW**

CLIENT  
**Hunter Water**

DRAWING  
**Tree Management Plan**



PROJECT # \_\_\_\_\_ DWG # \_\_\_\_\_ REV \_\_\_\_\_  
 DATE 04/07/2022  
 SCALE @ A1 **1:1000** **TMP01**  
 DRAWN AS Sheet 2 of 2

**Naturally Trees Arboricultural Consulting**  
 PO Box 5085 Elanora Heights NSW 2101 Australia  
 T: 0417 250 420 W: www.naturallytrees.com.au E: info@naturallytrees.com.au

SPORT SHEDS

## APPENDIX H

### Noise and Vibration Impact Assessment

# STORMWATER AMENITY IMPROVEMENT: JESMOND – DARK CREEK

## Construction Noise and Vibration Impact Assessment

29 July 2022

Aurecon

TM711-01F06 (r5) Jesmond REF Construction NVIA.docx

## Document details

Detail	Reference
Doc reference:	TM711-01F06 (r5) Jesmond REF Construction NVIA.docx
Prepared for:	Aurecon
Address:	Level 5, 116 Military Road, Neutral Bay, Sydney Australia 2089
Attention:	Katie Schultz

## Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Authorised
03.06.2022	Draft	0	1	R.Phillips	R.Phillips	A.Leslie
06.07.2022	Final	2-3	4	R.Phillips	R.Phillips	A.Leslie
29.07.2022	Final. Update figure	-	5	R.Phillips	R.Phillips	A.Leslie

### Important Disclaimer:

The work presented in this document was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for the particular requirements of our Client referred to above in the 'Document details' which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Renzo Tonin & Associates. The information herein should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

In preparing this report, we have relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, we have not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

We have derived data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination and re-evaluation of the data, findings, observations and conclusions expressed in this report.

We have prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

The information contained herein is for the purpose of acoustics only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of acoustics engineering including and not limited to structural integrity, fire rating, architectural buildability and fit-for-purpose, waterproofing and the like.

Supplementary professional advice should be sought in respect of these issues.

## Executive summary

Renzo Tonin & Associates has been engaged Aurecon to undertake a noise and vibration impact assessment as part of the Review of Environmental Factors (REF) for the Hunter Water Stormwater Amenity Improvement Project at Jesmond, Dark Creek. The Proposal would involve about 265m of amenity works (naturalisation of the creek) along two sections of the stormwater channel. The Jesmond Upstream works include a 157m section of structural works on the western Bank, and the Downstream works include a 108m section of structural works on the southern bank.

The assessment considers the following impacts on nearby sensitive receivers:

- Construction noise impacts from the works in accordance with the *Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2009).
- Construction vibration impacts from the works in accordance with *Assessing Vibration: A technical guideline* (Department of Environment and Conservation, 2009) for human disturbance and relevant standards for structural damage from vibration.

### Construction noise

The construction noise assessment found that nearby residential and other sensitive receivers that are located near works will be noise affected during the construction works.

During standard construction hours, the assessment found that receivers located near to the construction works areas are likely to be noise affected by the works. During most noise intensive activities, nearby residences are generally predicted to be more than 20 dB(A) above the NML, which is considered highly intrusive. These residences are located on Blue Gum Road to the north and east, and Fraser Street to the west.

Impacts would be greatest during periods where high noise plant and equipment, such as an excavator with hydraulic hammer, are being used. During this period, up to 11 residences on Blue Gum Road are predicted to be highly noise affected (ie. > 75 dB(A)). Where typical construction works are occurring without the use of high noise generating plant and equipment, receivers are not predicted be highly noise affected.

Mitigation measures have been provided to reduce and manage noise levels and are to be reviewed and adopted where feasible and reasonable during construction.

### Construction vibration

A review of potential construction vibration impact impacts to nearby receivers has been completed. Potential vibration impacts have been assessed against the relevant guidelines for structural damage from vibration and for human disturbance.



The identified minimum working distance for an excavator with excavator with hydraulic hammer attachment for both reinforced and unreinforced structures is five metres. The nearest residences dwellings to the proposal are approximately 25 metres to the north on Blue Gum Road. The KFC Jesmond is the nearest structure to the proposed works which is approximately 15 metres to the south. Based on this, there are no reinforced or unreinforced structures within the minimum working distance for cosmetic damage

No heritage structures have been identified near to the construction works.

All nearby receivers are predicted to comply with the relevant vibration criteria for human annoyance from vibration.

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# 1 Introduction

## 1.1 Proposal scope

Renzo Tonin & Associates has been engaged by Aurecon to undertake a noise and vibration impact assessment as part of the Review of Environmental Factors (REF) for the Hunter Water Stormwater Amenity Improvement Project at Jesmond, Dark Creek (the Proposal).

The Proposal would involve about 265 metres of amenity works (naturalisation of the creek) along two sections of the stormwater channel. The Jesmond Upstream works include a 157 metre section of structural works on the western Bank, and the Downstream works include a 108 metre section of structural works on the southern bank.

The naturalisation works involves removal of the existing concrete stormwater channel walls, battering the sides of the stormwater channel back to a 1V:2H slope, installation of rock revetment (rip-rap) on the western bank of the Upstream section and the southern bank of the Downstream section, planting of native species within the revetment and along the top of the bank, and widening of the concrete channel base by 600mm. Sandstone block transition walls will also be installed to transition between the concrete bank and the rip-rap bank.

## 1.2 Proposal construction activities

The construction activities and associated works of the Proposal are summarised in Table 1-1 below.

**Table 1-1: Construction activities and associated works**

Construction activity	Description
Site establishment	<ul style="list-style-type: none"> <li>placing temporary fencing and signage to designate site access and construction zones</li> <li>setting up security measures</li> <li>establishing ancillary facilities including site amenities and site sheds, laydown and stockpiling areas</li> </ul>
Environmental controls	<ul style="list-style-type: none"> <li>install temporary flow and tide diversion in channel base e.g. sandbags and/ or barriers</li> <li>install temporary erosion and sediment controls</li> <li>place spill kits</li> </ul>
Investigations	<ul style="list-style-type: none"> <li>pre-construction asset inspections.</li> </ul>
Materials delivery	<ul style="list-style-type: none"> <li>delivery of fill materials to laydown areas</li> </ul>
Structural works – Stage 1 (removing concrete channel)	<ul style="list-style-type: none"> <li>channel structural works would be completed in sections, starting at the downstream end. This phasing of structural works will ensure protection of the Proposal site during stormwater flow events in the channel</li> <li>excavator to remove turf and topsoil within Proposal site and move to stockpile</li> <li>following an arborist assessment, excavator to remove trees within works extent</li> <li>sawcut channel wall and undertake bank works within the Proposal site</li> <li>excavate to base of works and temporarily stockpile spoil for disposal</li> <li>batter slopes to be shaped at a 1V:2H to facilitate placement of fill and rock revetment (rip-rap)</li> <li>demolition of existing drainage outlet headwall</li> </ul>

Construction activity	Description
Dewatering	<ul style="list-style-type: none"> <li>dewatering using portable pumps as required and appropriate disposal</li> </ul>
Waste disposal	<ul style="list-style-type: none"> <li>disposal of construction waste including spoil to a licensed waste facility</li> </ul>
Structural works – Stage 2 (asset protection/restoration, transition wall works and channel base extension)	<ul style="list-style-type: none"> <li>constructing transition retaining walls (concrete) grouted to existing bank wall</li> <li>extend existing concrete base slab including tie-in to existing slab i.e. install starter bars using hammer or core drill</li> <li>removal of abandoned water main and concrete casing of water main to be retained</li> <li>overhead powerline stay pole to be relocated</li> </ul>
Structural works – Stage 3 (bank protection works)	<ul style="list-style-type: none"> <li>placing select fill and rock revetment (rip-rap)</li> <li>placing of planting material in planting areas</li> <li>placing erosion control matting and plant native plants</li> <li>remove ancillary facilities</li> <li>install permanent fence along East-west section</li> </ul>
Site restoration	<ul style="list-style-type: none"> <li>final landscaping/rehabilitation</li> <li>remove temporary environmental controls</li> <li>remove ancillary facilities such as construction fencing and signage, waste bins and waste materials</li> </ul>

Construction of the Proposal is scheduled to occur between November 2022 and be completed by June 2024.

Figure 1-1: Proposal site location



### 1.3 Report objectives

The noise and vibration impact assessment objectives are to:

- Identify existing noise conditions and relevant noise and vibration objectives
- Assess potential construction noise and vibration impacts
- Recommend feasible and reasonable mitigation and management measures to limit the noise and vibration impacts of the construction works.

### 1.4 Relevant policies and guidelines and assessment aspect

This assessment considers policies, guidelines and standards presented in Table 1-2.

**Table 1-2: Construction noise and vibration policies, guidelines and standards**

Guideline/policy document	Assessment aspect
<i>Interim Construction Noise Guideline</i> (Department of Environment and Climate Change, 2009)	Airborne noise and ground-borne noise impacts (including construction traffic within the construction support site boundary)
<i>Assessing Vibration: a technical guideline</i> (Department of Environment and Climate Change, 2006)	Vibration amenity
British Standard BS 7385: Part 2-1993 <i>Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration</i> (BSI, 1993)	Vibration impacts to structures impacts
German Standard DIN 4150-3 (2016) <i>Structural vibration – Effects of vibration on structures</i> (Deutsches Institut für Normung, 2016)	Vibration impacts to structures impacts
<i>NSW Road Noise Policy</i> (Department of Environment, Climate Change and Water, 2011)	Construction road traffic noise impacts (on public roads)
<i>Noise Policy for Industry</i> (Environment Protection Authority, 2017)	Establishing the existing noise environment

### 1.5 Acoustic concepts, terminology & quality

This report is technical in nature and uses acoustic terminology throughout. A summary and explanation of the common acoustic terms that has been used in this report is presented in Section A.1.

Some of the key acoustic concepts used in this report are outlined in Section A.2.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.



## 2 Existing noise environment

### 2.1 Noise and vibration-sensitive receivers

A desktop land use survey was carried out to identify the receiver types and uses of buildings around the Proposal that could potentially be impacted by noise or vibration from the Proposal. During construction planning, further review of potentially impacted noise-sensitive receivers should be undertaken to confirm that impacts are mitigated and managed appropriately.

The noise and vibration-sensitive receivers are generally separated into the following major categories, with further details of the breakdowns of categories and noise and vibration objectives presented in Section 3:

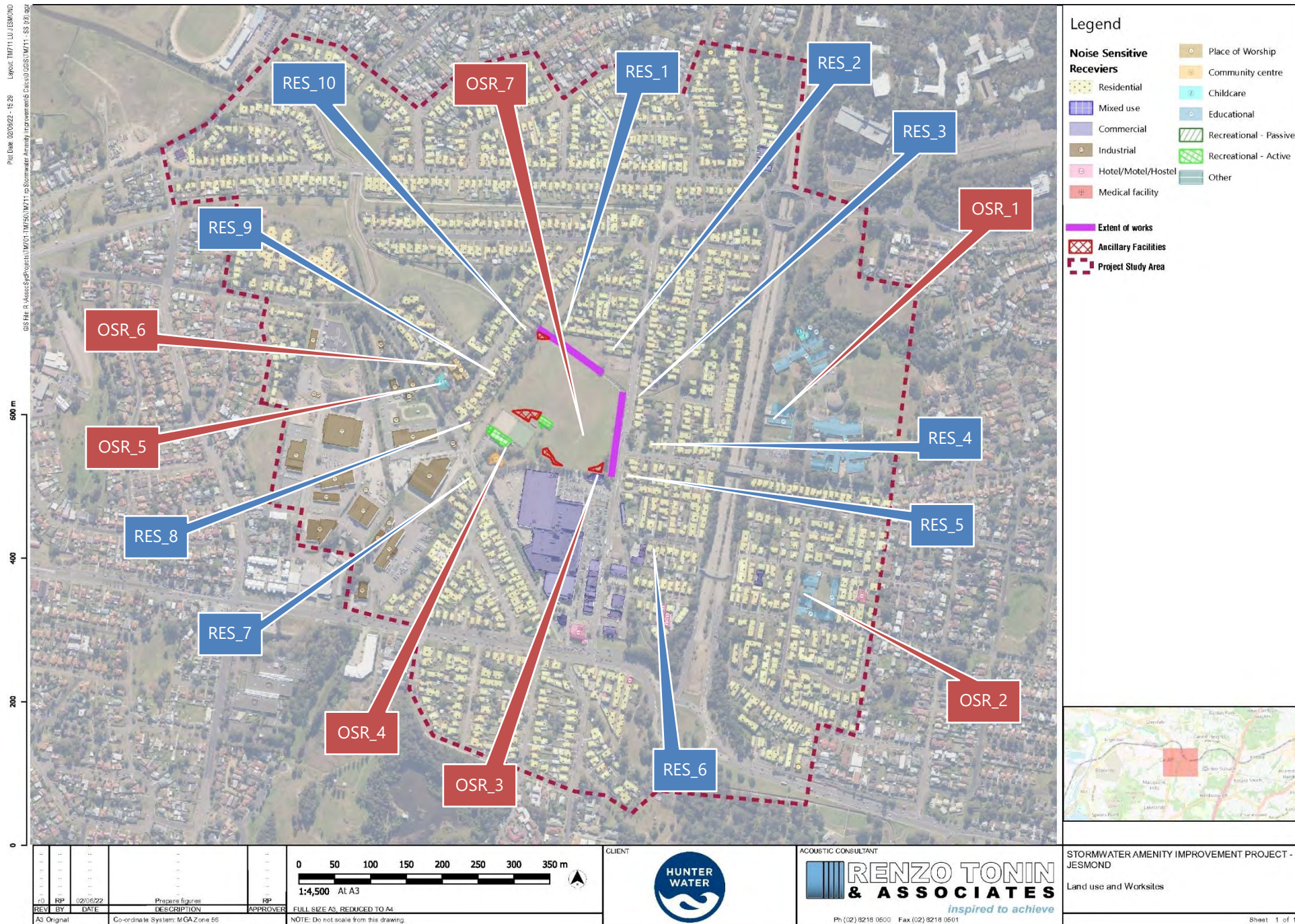
- Residential receivers (including mixed use buildings and aged care facilities) [RES]
- Other noise and vibration-sensitive receivers [OSR], including:
  - Classrooms at schools and other educational institutions
  - Hospital wards and operating theatres
  - Places of worship
  - Childcare centres
  - Active recreation areas (eg. sports fields/activities which generate their own noise and are generally less sensitive to external noise)
  - Passive recreation areas (eg. areas used for low intensity and low noise producing activities which have the potential to be impacted by external noise such as reading or meditation)
  - Community centres
  - Special noise and/or vibration-sensitive receivers (eg. laboratories, recording studios)
- Commercial premises (including offices and retail outlets) [OSR]
- Industrial premises [OSR].

All assessed noise and vibration-sensitive receiver types for the Proposal are shown in APPENDIX B. A number of the nearest representative noise sensitive receivers surrounding the Proposal have been identified for the purposes of reporting noise levels at nearby noise sensitive receivers. These selected receivers are detailed in Table 2-1 and identified in Figure 2-1 below.

**Table 2-1: Nearest and representative noise sensitive receivers**

Receiver ID	Receiver type	Description	Address/location	Approximate closest distance to the Proposal, (m)
RES_1	Residential	Residence	78 Blue Gum Road, Jesmond	25
RES_2	Residential	Residence	74 Blue Gum Road, Jesmond	45
RES_3	Residential	Residence	59 Blue Gum Road, Jesmond	30
RES_4	Residential	Residence	2 Janet Street, Jesmond	70
RES_5	Residential	Residence	43 Blue Gum Road, Jesmond	30
RES_6	Residential	Residence	65 William Street, Jesmond	160
RES_7	Residential	Residence	39 The Crescent, Wallsend	255
RES_8	Residential	Residence	50 Mordue Parade, Jesmond	250
RES_9	Residential	Residence	39 Fraser Street, Jesmond	135
RES_10	Residential	Residence	25 Fraser Street, Jesmond	60
OSR_1	Educational facility	Callaghan College Jesmond Campus	24 Janet Street, Jesmond	300
OSR_2	Educational facility	Jesmond Public School	16 Ralph Street, Jesmond	450
OSR_3	Commercial	KFC Jesmond	30 Blue Gum Road, Jesmond	10
OSR_4	Active recreation	Jesmond Bowlo	48 Mordue Parade, Jesmond	200
OSR_5	Child-care centre	Jesmond Early Education Centre	56 Mordue Parade, Jesmond	225
OSR_6	Place of Worship	Newcastle Intercessory Prayer Fellowship	36 Fraser Street, Jesmond	180
OSR_7	Active recreation	Heaton Park	44 Mordue Parade, Jesmond	50

Figure 2-1: Nearby sensitive receivers to proposal



Proj Date: 02/06/22 - 15:28  
 Layout: TM/7/1\_LU1\_JESMOND  
 GIS File: R:\Assets\GIS\Projects\TM/7/1-01/F06\TM/7/1-01\_S Stormwater\_Amenity\_Improvement\GIS\LU1\_JESMOND\_15\_28.apr

REV	BY	DATE	DESCRIPTION	APPROVER
A3	Original		Co-ordinate System: MGA Zone 56	

NOTE: Do not scale from this drawing.



## 2.2 Noise monitoring

Background noise varies over the course of any 24 hour period, typically from a minimum at 3:00 am in the morning, to a maximum during morning and afternoon traffic peak hours. Therefore, the *Noise Policy for Industry* (NPfl) (EPA, 2017), referenced by the ICNG for determining the Rating Background Level (RBL), requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The NPfl defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

## 2.3 Existing background noise levels

Long term unattended noise monitoring was conducted for a continuous period from 26 April to 6 May 2022, to measure ambient and background noise levels in the vicinity of residential receivers around the proposed works. Calibration of the noise monitors was conducted before and after the monitoring period, with no significant calibration drift observed. The unattended noise monitoring location [M1] and observed noise environment are summarised in Table 2-3.

The noise monitoring methodology is provided in APPENDIX C. A summary of the unattended noise monitoring results along with a graphical recorded output from the long-term noise monitoring are included in APPENDIX D. The graphs in APPENDIX D were analysed in accordance with the procedure outlined in the NPfl to determine an Assessment Background Level (ABL) for each day, evening and night period in each 24-hour period of noise monitoring. Based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with the NPfl.

**Table 2-2: Unattended noise monitoring location**

Noise logger #	Location	Observed noise environment
M1	27 Fraser St, Jesmond	<p>Ambient noise environment had contribution from noise natural environment (bird noise etc.) in addition to distant traffic noise.</p> <p>Noise from use of sports fields.</p> <p>Background noise levels had contribution from distant traffic noise from Main Road, Newcastle Road and other surrounding roads</p>

**Table 2-3: Measured existing ambient and background noise levels, dB(A)**

Noise logger #	Location	Rating background noise levels (RBL), L <sub>A90</sub>			Ambient noise levels, L <sub>Aeq</sub>		
		Day	Evening	Night	Day	Evening	Night
M1	27 Fraser St, Jesmond	37	39	34	54	52	47

## 3 Noise and vibration criteria

### 3.1 Construction noise criteria

#### 3.1.1 Noise metrics

For the assessment of construction noise, which is typically temporary in nature and highly variable, the EPA's Interim Construction Noise Guideline (ICNG) uses three noise metrics to determine the potential construction noise impact.

$L_{Aeq}$  - To protect against long-term repeated noise exposure, the indicator for assessing the cumulative noise exposure level over a specific time interval is the equivalent sound pressure level, denoted as  $L_{Aeq}$ . The  $L_{Aeq}$  indicator accounts for the total energy content from all sources of sound under consideration. The fact that the  $L_{Aeq}$  is a cumulative measure means that louder activities have greater influence of the  $L_{Aeq}$  level than do quieter ones, and activities that last longer in time have greater  $L_{Aeq}$  than do shorter ones. An increase in the number of events also increases the  $L_{Aeq}$ . Further, people react to the duration of noise events, judging longer events to be more annoying than shorter ones, assuming equal maximum noise levels.

$L_{Amax}$  - It is important to note that even though  $L_{Aeq}$  levels are numerically lower than maximum noise levels (denoted as  $L_{Amax}$ ), none of the noise is ignored, just as all the rain that falls in the rain gauge in one hour counts toward the total. In the case of noisy but short-lived maximum noise events, which can sometime result in immediate short-term awakening reaction, potential impact is assessed using the  $L_{Amax}$  indicator in which its emergence above the background noise environment is evaluated.

$L_{A90}$  - The  $L_{A90}$  is the level of noise that is present almost constantly, or for 90 percent of the time and is commonly referred to as the background noise. Typical examples of what types of noise may contribute to the background noise levels are continuously flowing traffic or air conditioner noise.

#### 3.1.2 Noise management levels (NMLs)

The *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) provides guidelines for assessing noise generated during the construction phase of developments. There are two methods described for the assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the scale of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG.

Table 3-1 reproduced from the ICNG, sets out the airborne noise management levels and how they are to be applied for residential receivers.

**Table 3-1: Noise management levels at residential receivers**

Time of day	Management level L <sub>Aeq</sub> (15 min) *	How to apply
<b>Recommended standard hours:</b> Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. <ul style="list-style-type: none"> <li>Where the predicted or measured L<sub>Aeq</sub> (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.</li> <li>The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.</li> </ul>
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. <ul style="list-style-type: none"> <li>Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:               <ol style="list-style-type: none"> <li>times identified by the community when they are less sensitive to noise (such as before/ after school for works near schools, or mid-morning or mid-afternoon for works near residences</li> <li>if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</li> </ol> </li> </ul>
<b>Outside recommended standard hours</b>	Noise affected RBL + 5dB	<ul style="list-style-type: none"> <li>A strong justification would typically be required for works outside the recommended standard hours.</li> <li>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</li> <li>Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community.</li> <li>For guidance on negotiating agreements see <i>ICNG</i> section 7.2.2.</li> </ul>

\* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 metre above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 3-2 sets out the ICNG noise management levels for other noise sensitive receiver locations.

Where premises are noise-sensitive and cannot be suitably classified by the categories in this table, it is recommended that the recommended 'maximum' internal noise levels presented in AS/NZS 2107:2016 are adopted.

**Table 3-2: Noise management levels at other noise sensitive land uses, dB(A)**

Land use	Time of day	Where objective applies	Management level L <sub>Aeq</sub> (15 min)
Childcare centre <sup>2</sup>	When in use	Outdoor noise level	50 <sup>2</sup>
Classrooms at schools and other educational institutions	When in use	Indoor noise level	45
		Outdoor noise level <sup>1</sup>	55
Hospital wards and operating theatres	When in use	Indoor noise level	45
		Outdoor noise level <sup>1</sup>	55

Land use	Time of day	Where objective applies	Management level $L_{Aeq}$ (15 min)
Places of worship	When in use	Indoor noise level	45
		Outdoor noise level <sup>1</sup>	55
Hotel/Motel/Hostel	When in use	Indoor noise level	40
		Outdoor noise level <sup>5</sup>	60
Community centres	When in use	Indoor noise level	40 <sup>6</sup>
		Outdoor noise level <sup>6</sup>	60 <sup>6</sup>
Active recreation areas <sup>4</sup>	When in use	Outdoor noise level	65
Passive recreation areas <sup>3</sup>	When in use	Outdoor noise level	60
Commercial premises	When in use	Outdoor noise level	70
Industrial premises	When in use	Outdoor noise level	75

- Notes:
1. Outdoor noise level based on internal noise level in ICNG and assumes 10 dB loss through an open window
  2. An external screening level of 50 dB(A) is adopted for assessing childcare centres, based upon the recommended noise levels in the Association of Australian Acoustical Consultants (AAAC) Guideline for Child Care Centre Acoustics Assessment (2013). This considers the centre has sleeping areas.
  3. Passive recreation - Areas used for low intensity and low noise producing activities which could be impacted by external noise such as reading or meditation
  4. Active recreation - Sports fields/activities which generate their own noise and are generally less sensitive to external noise
  5. Based upon AS2107 (Sleeping areas: Hotels near major roads), and 20 dB(A) outside to inside difference (closed windows)
  6. Community centres have been assessed to an external noise level of 60 dB(A). Depending on the intended use of the centre, the noise management level may vary.

### 3.1.3 Summary of construction noise management levels

Table 3-2 presents the construction noise management levels established for the nearest noise sensitive residential receivers based upon the noise monitoring outlined in Section 2.

**Table 3-3: Construction noise management levels at residential receivers, dB(A)**

Rating background level (RBL)	Noise management level $L_{Aeq}(15min)$
Day	Day (Standard) <sup>1</sup>
37	47

Notes:

1. Standard construction hours, as defined in Section 4.1.

Works outside standard construction hours are not proposed for the Proposal and have therefore not been addressed in this report. Should any works be proposed to be required outside of standard hours, they will require strong justification as per the ICNG. Where clear justification is provided, an assessment of potential impacts would be undertaken against suitable noise management levels considering the RBL values presented in Section 2.3 along with the feasible and reasonable mitigation and management measures.

## 3.2 Construction-related road traffic noise

When trucks and other vehicles are operating within the boundary of a construction site, road vehicle noise contributions are included in the overall predicted  $L_{Aeq}(15minute)$  construction site noise emissions. When construction-related traffic moves onto the public road network a different noise assessment



methodology is appropriate, as vehicle movements would be regarded as 'additional road traffic' rather than as part of the construction site.

Construction-related traffic operating on the public road network, especially heavy vehicle movements travelling on roads located immediately adjacent to construction sites are likely to be associated to the Proposal by the community. However, once the heavy vehicles move further from the Proposal site onto major sub-arterial or arterial roads, the noise may be perceived as being part of the general road traffic.

Noise from construction traffic on public roads is not assessed under the ICNG, although the guideline does reference the *Environmental Criteria for Road Traffic Noise* (EPA 1999), which has been superseded by the RNP. The RNP states that in assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments (in this case the construction area), any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'without construction' scenario.

Where the road traffic noise levels are predicted to increase by more than 2 dB as a result of construction traffic, consideration would be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2 dB, consideration should be given to the actual noise levels associated with construction traffic and whether these levels comply with the road traffic noise criteria in the RNP presented in Table 3-4.

**Table 3-4: Construction-related road traffic noise assessment criteria**

Road type	Day criteria (7am – 10pm)	Night criteria (10pm – 7am)
Freeway/ arterial/ sub-arterial roads	60 $L_{Aeq}$ 15 hour	55 $L_{Aeq}$ 9 hour
Local roads	55 $L_{Aeq}$ 1 hour	50 $L_{Aeq}$ 1 hour

### 3.3 Construction vibration criteria

Construction vibration is associated with three main types of impact:

- disturbance to building occupants
- potential damage to buildings
- potential damage to sensitive equipment in a building.

Generally, if disturbance to building occupants is controlled, there is limited potential for structural damage to the buildings.

Vibration amplitude may be measured as displacement, velocity, or acceleration.

- Displacement ( $x$ ) measurement is the distance or amplitude displaced from a resting position. The International System of Units (SI unit) for distance is the metre (m), although common industrial standards include mm.
- Velocity ( $v=\Delta x/\Delta t$ ) is the rate of change of displacement with respect to change in time. The SI unit for velocity is metres per second (m/s), although common industrial standards include mm/s. The Peak Particle Velocity (PPV) is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis (x, y, and z) then the resultant PPV is the vector sum (i.e. the square root of the summed squares of the maximum velocities) regardless of when in the time history those occur.
- Acceleration ( $a=\Delta v/\Delta t$ ) is the rate of change of velocity with respect to change in time. The SI unit for acceleration is metres per second squared ( $m/s^2$ ). Construction vibration goals are summarised below.

Construction vibration goals are summarised below.

### 3.3.1 Disturbance to buildings occupants

The acceptable vibration values to assess the potential for human annoyance from vibration are set out in the *Environmental Noise Management Assessing Vibration: A Technical Guideline (AVTG)* (DEC, 2006). To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The screening test is based on the continuous vibration velocity (i.e. vibration that continues uninterrupted for a defined period). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance.

The initial screening test values and VDV's recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in Table 3-5. The 'Low probability of adverse comment eVDV' represent the preferred and maximum value presented in the AVTG.

**Table 3-5: Vibration management levels for disturbance to building occupants**

Place and Time	Initial screening test Velocity, PEAK, mm/s (>8Hz)	Low probability of adverse comment eVDV $m/s^{1.75}$	Adverse comment possible eVDV $m/s^{1.75}$	Adverse comment probable eVDV $m/s^{1.75}$
Critical areas (day or night) <sup>1</sup>	0.28	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Residential buildings 16 hr day <sup>2</sup>	0.56	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night <sup>2</sup>	0.40	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Offices, schools, educational institutions and places of worship (day or night)	1.10	0.4 to 0.8	0.8 to 1.6	1.6 to 2.4
Workshops (day or night)	2.20	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above
2. Daytime is 7:00 am to 10:00 pm and night-time is 10:00 pm to 7:00 am

### 3.3.2 Damage to buildings or structures

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard *BS 7385 Part 2 – 1993 Evaluation and measurement for vibration in buildings* and German Standard *DIN 4150-3: 2016 Structural Vibration – Part 3: Effects of vibration on structures*. There is no Australian Standard for assessment of structural building damage caused by vibration energy.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however, the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

Within British Standard 7385 Part 1, different levels of structural damage are defined:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

The vibration limits in Table 1 of British Standard 7385 Part 2 are for the protection against cosmetic damage, however guidance on limits for minor and major damage is provided in Section 7.4.2 of the Standard:

#### *7.4.2 Guide values for transient vibration relating to cosmetic damage*

*Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*

*Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3, damage is defined as “any permanent consequence of an action that reduces the serviceability of a structure or one of its components” (p.4). The Standard also outlines:

*"For buildings as in lines 2 and 3 of Tables 1, 4 or B.1, the serviceability is considered to have been reduced if, for example*

- cracks form in plastered or rendered surfaces of walls;*
- existing cracks in a structure are enlarged;*
- partitions become detached from load-bearing walls or floor slabs.*

*These effects are deemed 'minor damage.' (DIN4150.3:2016, p.6)*

While the DIN Standard defines the above damage as 'minor', based on the definitions provided in BS7385, the DIN standard is considered to deal with cosmetic issues rather than major structural failures.

### **3.3.2.1 British Standard**

British Standard 7385: Part 2 '*Evaluation and measurement of vibration in buildings*', can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types.

BS 7385 sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

BS7385 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in BS7385 relate to transient vibrations which does not give rise to resonant responses in structures and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 3-6 may need to be reduced by up to 50%.

BS7385 goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 3-6 and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in BS7385 and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 3-6 should not be reduced for fatigue considerations. It is noteworthy that, extra to the guide values nominated in Table 3-6, the standard states that: *“Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.”*

**Table 3-6: BS 7385 structural damage criteria**

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50

Notes: Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

Notes:

1. Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.
2. PPV values increase between specified frequencies as detailed in BS7385-2
3. Values referred to are at the base of the building, as per Section 6.3 of BS7385-2

### 3.3.2.2 German Standard

German Standard DIN 4150 - Part 3 (2016) '*Vibration in buildings - Effects on Structures*' (DIN 4150-3:2016), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3:2016 presents the recommended maximum limits over a range of frequencies (Hz), measured at the foundations, in the plane of the uppermost floor of a building or structure or vertically on floor slabs. The vibration limits at the foundations increase as the frequency content of the vibration increases. The criteria are presented in Table 3-7.

**Table 3-7: DIN 4150-3:2016 structural damage criteria**

Group	Type of structure	Vibration velocity, mm/s				
		At foundation in all directions at frequency of			Plane of floor uppermost storey in horizontal direction	Floor slabs, vertical direction
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that because of their particular sensitivity to vibration, cannot be classified under Groups 1 and 2 and are of great intrinsic value (eg listed buildings)	3	3 to 8	8 to 10	8	20

### 3.3.3 Heritage structures and items

Heritage items are considered on a case by case basis, and care should be taken as these structures can be difficult to repair in the case of damage. It should be noted that British Standard BS 5228-2:2009 states that '*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*' (p.39) when compared to other structures.

As part of the identification of noise and vibration sensitive receivers discussed in Section 2.1, potentially impacted heritage receivers should be identified nearby to the construction works areas.

Where a structure is found to have defects, or is structurally unsound following an inspection, maximum vibration criteria are to be established for that specific structure for works to not further damage the structure. As stated previously, German Standard DIN 4150: Part 3 provides guidance for structures that are sensitive to vibration (eg. structurally unsound).

A conservative vibration damage screening level of 2.5 mm/s has been adopted as a screening level for heritage structures. This does not necessarily reflect that there would be a vibration impact on the structure if this level is exceeded, instead it is a suitable vibration level that is used as part of the construction vibration management process to trigger further investigation.

If a heritage building or structure is found to be structurally unsound (following inspection), the conservative cosmetic damage objective of 2.5 mm/s peak component particle velocity (from DIN 4150) would be considered, and appropriate protections put in place.

The general approach to manage potential vibration impacts on heritage items would be to:

1. Identify heritage items where the 2.5 mm/s peak component particle velocity objective may be exceeded during specific construction activities
2. Carry out a structural engineering report on identified heritage items, to confirm structural integrity of the building and confirm if item is 'structurally sound'
3. Adopt the appropriate screening level from BS7385 Part 2 if the item was confirmed as 'structurally sound', or
4. Adopt the more conservative cosmetic damage level of 2.5 mm/s (long-term impacts) or 3 mm/s (short term impacts, with additional consideration for frequency as outlined in DIN 4150-3: 2016) peak component particle velocity if the item was confirmed as 'structurally unsound'.

### 3.3.4 General vibration (building damage) screening criterion

In accordance with *BS 7385-2 and DIN 4150-3*, a conservative vibration damage screening level (peak component particle velocity) per receiver type is outlined below:

- reinforced or framed structures: 25.0 mm/s
- unreinforced or light framed structures: 7.5 mm/s
- heritage structures (structurally unsound): 2.5 mm/s.

Where the predicted and/or measured vibration is greater than shown above, a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure will be completed to determine the applicable vibration limit.

### 3.3.5 Damage to vibration sensitive equipment

Some high technology manufacturing facilities, hospitals and laboratories utilise equipment that is highly sensitive and susceptible to vibration, for example scanning electron microscopes and micro-electronic manufacturing facilities. In addition, buildings housing sensitive computer or telecommunications equipment may require assessment against stricter criteria than those nominated for building damage.

There is no explicit guidance on acceptable vibration levels for such equipment, so recommended vibration levels should be obtained from instrument manufacturers. In the absence of equipment specific data provided by manufacturers, there are generic vibration criteria that can be used to assess the impact of vibration generating activities on buildings housing vibration sensitive equipment. For example, the Vibration Criteria (VC) curves are often referred to as they are generic and apply to all tools/ equipment types within each category. The VC curves are defined over the frequency range 8 to 100 Hz.

Table 3-8 below summarises a range of suitable and conservatively stringent vibration limits that are applicable to buildings housing vibration sensitive equipment which may potentially be affected by construction vibration.

**Table 3-8: Acceptable vibration limits for vibration measured on building structure housing sensitive equipment**

Equipment Requirements	Vibration Limit <sup>1</sup> mm/s,		Description of Use <sup>3</sup>
	RMS <sup>4</sup>	Peak <sup>5</sup>	
Computer Areas <sup>2</sup>	0.7	1.0	Barely perceptible vibration. Adequate for computer equipment accommodation environments.
Medical <sup>2,3</sup>	0.1	0.14	Vibration not perceptible. Suitable in most instances for microscopes to 100X and for other equipment of low sensitivity.
VC-A <sup>3</sup>	0.05	0.07	Vibration not perceptible. Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc

Notes: 1. As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz. Vibration measured on the building structure near vibrating equipment or in areas containing sensitive equipment.  
 2. Based on AS 2834 Computer Accommodation  
 3. Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment  
 4. Root Mean Square value representing the average value of a signal  
 5. In the absence of Peak limits, RMS limits are converted to Peak by conservatively assuming the vibration signal is sinusoidal and random with a nominal crest factor of 1.414

### 3.3.6 Damage to buried services

Section 5.3 of DIN 4150-3: 2016 also sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework. These values, which apply at the wall of the pipe, are reproduced and presented in Table 3-9 below. For long-term vibration the guideline levels presented in Table 3-9 should be halved.

**Table 3-9: DIN 4150-3: 2016 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework**

Line	Pipe Material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Vitrified clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
3	Masonry, plastics	50

For continuous vibration the guideline levels presented in Table 3-9 should be halved.

Recommended vibration goals for electrical cables and telecommunication services such as fibre optic cables range from between 50 mm/s and 100 mm/s. It is noted however that although the cables may sustain these vibration levels, the services they are connected to, such as transformers and switch blocks, may not. It is recommended that should such equipment be encountered during the construction process an individual vibration assessment should be carried out. This may include a



specific vibration assessment addressing impact on the utility and consultation with the utility provider to confirm specific vibration requirements.

## 4 Construction noise and vibration assessment

### 4.1 Construction hours

#### 4.1.1 Standard construction hours

The recommended standard hours for construction are defined in the ICNG. Whilst the standard construction hours are not mandatory, limiting construction works to within standard construction hours as much as practicable assists in managing noise or vibration impact and provides a lengthy respite period whilst people are most likely to be relaxing or sleeping.

#### 4.1.2 Works outside standard construction hours

The ICNG identifies five categories of works that might be undertaken outside the recommended standard hours (OOH):

1. the **delivery of oversized plant or structures** that police or other authorities determine require special arrangements to transport along public roads
2. **emergency work** to avoid the loss of life or damage to property, or to prevent environmental harm
3. **maintenance and repair of public infrastructure** where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
4. **public infrastructure works** that shorten the length of the project and are supported by the affected community
5. works where a proponent demonstrates and justifies a **need to operate outside the recommended standard hours**.

There are no OOH works proposed for the Proposal.

#### 4.1.3 Summary of construction hours

Construction works for the Proposal are proposed to take place during the ICNG standard construction hours, which are:

- 7:00am to 6:00pm Monday to Friday
- 8:00am to 1:00pm on Saturday
- No work performed on Sunday and Public Holidays

## 4.2 Construction noise and vibration activities and assumptions

### 4.2.1 Construction activities and noise sources

Table 4-1 following summarises the likely plant and equipment and the assumed sound power levels for construction activities associated with the Proposal. The scenarios are based upon the activities provided in Table 1-1. The sound power levels for the majority of activities presented in Table 4-1 are based on maximum levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', ICNG, information from past projects and information held in the Renzo Tonin & Associates library files.

**Table 4-1: Noise modelling assumptions for construction - activities and equipment**

Scenario	Plant / Equipment	Operating weight kg	Assumed no. units	Sound Power Level (Lw re: 1pW), dB(A) L <sub>Aeq</sub>
S1 Site establishment & environmental controls	Franna/ mobile crane		1	99
	Trucks		4 per hour	106
	Hand tools including hammer or core drills		1	107
	<b>Assumed combined activity noise level</b>			<b>108</b>
S2 Ancillary facilities Including waste disposal	Franna crane	20 tonne	1	99
	Trucks		4 per hour	106
	Wheel loader		1	110
	Generator		1	94
	<b>Assumed combined activity noise level</b>			<b>110</b>
S3 Investigations	Franna crane	20 tonne	1	99
	Tracked excavator w bucket	19 tonne	1	103
	Hand tools including hammer or core drills		1	107
	<b>Assumed combined activity noise level</b>			<b>108</b>
S4 Structural works – Stage 1 (removing concrete channel)	Tracked excavator w bucket	19 tonne	1	107
	Concrete saw		1	119
	Tracked excavator w hydraulic hammer	19 tonne	1	119
	Franna/ mobile crane	20 tonne	1	99
	Trucks		4 per hour	106
	Hand tools including hammer or core drills		1	107
	<b>Assumed combined activity noise level</b>			<b>119</b>
S5 Dewatering	Pump		1	90

Scenario	Plant / Equipment	Operating weight kg	Assumed no. units	Sound Power Level (L <sub>w</sub> re: 1pW), dB(A)
				L <sub>Aeq</sub>
S6	Tracked excavator w bucket	19 tonne	1	107
Structural works – Stage 2 (asset protection/restoration, transition wall works and channel base extension)	Franna/ mobile crane	20 tonne	1	99
	Hand tools including hammer or core drills		1	107
	Concrete truck		1	108
	Concrete pump		1	103
	<b>Assumed combined activity noise level</b>			<b>112</b>
S7	Tracked excavator w bucket	19 tonne	1	107
Structural works – Stage 3 (bank protection works)	Small vibratory roller	4T	1	105
	Franna/ mobile crane		1	99
	<b>Assumed combined activity noise level</b>			<b>108</b>
S8 Permanent fence along East-west section	Hand tools		1	107
	Concrete truck		1	108
	Concrete pump		1	103
	<b>Assumed combined activity noise level</b>			<b>110</b>
S9 Site restoration	Hand tools		1	107
	Tracked excavator w bucket	19 tonne	1	107
	Franna/ mobile crane	20 tonne	1	99
	Trucks		4 per hour	106
	<b>Assumed combined activity noise level</b>			<b>110</b>

## Notes

1. Number of units operating at any one time may change on site. Assumptions in table are for modelling purposes, based on a conservative, but realistic estimate of the likely number of units operating concurrently for each activity.

### 4.3 Construction airborne noise assessment

Construction noise levels were predicted by modelling the noise sources, receiver locations, and operating activities across the construction scenarios based on the information presented Section 4.2.

#### 4.3.1 Noise prediction methodology

A noise model was developed for the Proposal using the CadnaA computer modelling program and noise levels were predicted using the noise propagation algorithm ISO 9613-2 (1996), which incorporates moderately adverse meteorological conditions, implemented in accordance with ISO/TR 17534-3 (2015).

The noise prediction model considers:

- Location of noise sources and sensitive receiver building locations
- Height of sources and receivers referenced to digital ground contours for the site and surrounding area

- Sound Power Levels (SWL) of plant and equipment likely to be used during the various construction activities
- Each noise-sensitive building in the Proposal has been assessed separately, considering all facades
- Separation distances between sources and receivers
- Acoustic shielding, potential reflections and attenuation from intervening structures, barriers and topography (natural and purpose built)
- Ground absorption between the source and receiver, typically assuming 0.5.

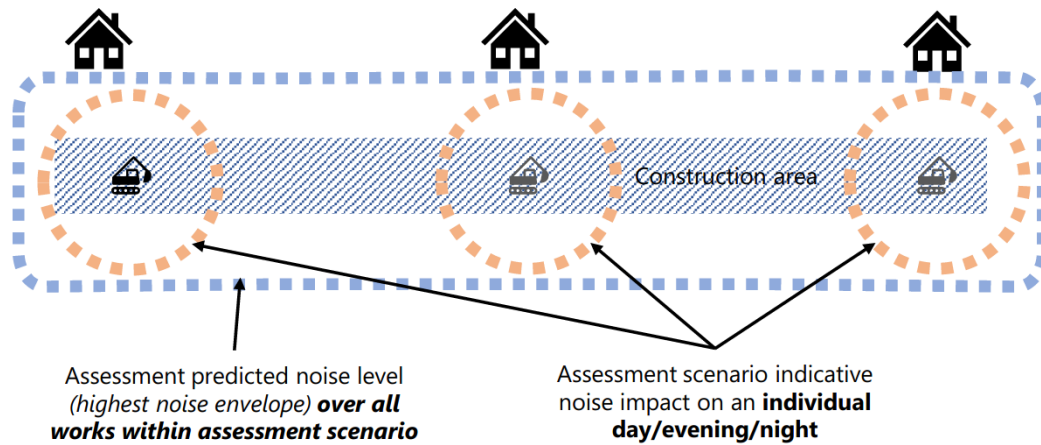
Construction noise levels are assessed at the most noise affected facade and floor level of a receiver building. Construction noise levels experienced at other points on the building may be lower.

The predicted levels are conservative and represent the equipment/plant operating simultaneously in any 15 minute period. Where plant items are not operating simultaneously, or for reduced times in a 15 minute period, noise impacts could be lower than predicted.

A 5 dB(A) penalty in accordance with the ICNG has been factored into the noise modelling levels where applicable to allow for particularly annoying activities, such as rock hammering, saw cutting and jack hammering.

Additionally, these noise levels assume that the assessed activities could occur anywhere within the assessed construction works area, with the predicted level based upon when works are at the closest point to each receiver. While in practice, noise intensive construction works would occur at different locations throughout the work area, resulting in differing noise levels at each receiver. This means that predicted noise levels are only likely to occur when works are at the closest point to each receiver. The noise impacts may be lower than predicted as the construction activities move around or progress around the construction site. This concept is demonstrated in Figure 4-1, and should be considered when reviewing the predicted noise levels in this assessment.

Figure 4-1: Predicted level are based works at the closest point of the entire works area



The worst affected receivers are typically the receivers with direct line-of-sight to the construction work area. Receivers located without direct line-of-sight to the construction area would typically be exposed to construction noise levels 5 to 10 dB(A) lower than the levels predicted for the worst affected receivers.

Section 4.3.2 presents the predicted noise levels each of the representative receiver locations for the various assessment scenarios for each stage of the Proposal. In addition, a summary of all assessed receivers is provided based on the level of predicted impact as shown in Table 4-2 below.

APPENDIX E presents receiver noise impact maps, which provide the predicted construction noise level compared with the Proposal NML (see Table 3-2 and Table 3-3) for all receivers within the study area. These maps are to give receivers an indication of the likely noise impact from the different stages of construction. Both APPENDIX E and the following sections colour code the predicted impact based upon Table 4-2 so that the amount the predicted noise level is over the NML can be reviewed.

Table 4-2: Key to the predicted construction noise results tables

Assessment	Time of day	Key		
L <sub>Aeq</sub> (15min)	Standard hours <sup>1</sup>	0-10 dB(A) over NML (light blue)	11-20 dB(A) over NML (mid blue)	>20 dB(A) above NML (dark blue)
		Clearly audible	Moderately intrusive	Highly intrusive

Notes: 1. Highly noise affected (HNA) which is greater than 75 dB(A) is shown with **Bold** text and applies to residential receiver buildings only during standard construction hours.

### 4.3.2 Construction noise results

#### 4.3.2.1 Representative receivers

The following tables provide the predicted construction noise levels at representative residential and other sensitive receivers (including commercial) within the study area. The predicted noise levels are colour coded based upon the level of exceedance of the NML as detailed in Table 4-2.

**Table 4-3: Predicted construction noise levels at representative residential receivers – Standard construction hours**

Representative receiver (Figure 2-1)	NML (day)	Predicted noise level for each scenario, LAeq, 15min, dB(A)								
		S1	S2	S3*	S4*	S5	S6*	S7*	S8*	S9*
RES_01	47	70	66	70	<b>81</b>	56	74	70	72	72
RES_02	47	63	54	63	74	49	67	63	65	65
RES_03	47	67	53	67	<b>78</b>	53	71	67	58	69
RES_04	47	60	56	60	71	46	64	60	56	62
RES_05	47	67	63	67	<b>78</b>	53	71	67	63	69
RES_06	47	48	45	48	59	34	52	48	45	50
RES_07	47	50	42	45	56	<30	49	45	47	52
RES_08	47	56	49	49	60	35	53	49	51	58
RES_09	47	57	55	55	65	40	58	55	56	59
RES_10	47	66	66	66	73	48	66	66	66	68

Notes: \* Includes construction noise from ancillary facilities

Highly noise affected (HNA) which is greater than 75 dB(A) is shown with **Bold** text and applies to residential receiver buildings.

**Table 4-4: Predicted construction noise levels at representative other sensitive receivers**

Representative receiver (Figure 2-1)	NML (day)	Predicted noise level for each scenario, LAeq, 15min, dB(A)								
		S1	S2	S3*	S4*	S5	S6*	S7*	S8*	S9*
OSR_1	55	47	45	47	58	<30	51	47	47	49
OSR_2	55	43	40	43	54	<30	47	43	43	45
OSR_3	70	78	78	78	<b>85</b>	60	78	78	78	80
OSR_4	65	62	59	59	62	37	59	59	59	64
OSR_5	50	47	47	47	57	<30	50	47	47	49
OSR_6	55	54	52	52	63	38	56	52	54	56
OSR_7	65	62	60	62	73	48	66	62	60	64

Notes:

\* Includes construction noise from ancillary facilities

#### 4.3.2.2 Summary of results

The following tables provide a summary of all assessed residential and other sensitive receivers (including commercial and industrial) within the study area. The level of exceedance is based upon the ranges shown in Table 4-2.

Table 4-5: Number of residential receivers over the noise management levels

Construction scenario	Day (standard hours)				
	L <sub>Aeq, 15minute</sub>				
	Highly noise affected > 75 dB(A)	1 - 10 dB(A) above NML	11 - 20 dB(A) above NML	> 20 dB(A) above NML	
S1	Site establishment & environmental controls		155	42	1
S2	Ancillary facilities		101	20	
S3	Investigations		148	40	1
S4	Structural works – Stage 1	11	639	152	40
S5	Dewatering		20		
S6	Structural works – Stage 2		242	67	13
S7	Structural works – Stage 3		148	40	1
S8	Establishment of mural fence		157	36	2
S9	Site restoration		190	60	11



Table 4-6: Number of other sensitive receivers (including commercial and industrial) over the noise management levels

Construction scenario		1 - 10 dB(A) above NML	11 - 20 dB(A) above NML	> 20 dB(A) above NML
Assessment reference				
S1	Site establishment & environmental controls	1	-	-
S2	Ancillary facilities	1	-	-
S3	Investigations	1	-	-
S4	Structural works – Stage 1	9	1	-
S5	Dewatering	-	-	-
S6	Structural works – Stage 2	4	-	-
S7	Structural works – Stage 3	1	-	-
S8	Establishment of mural fence	1	-	-
S9	Site restoration	3	-	-

## Notes

- Other sensitive receivers including commercial, industrial have been assessed against the respective NMLs

### 4.3.3 Discussion of results

#### 4.3.3.1 Residential receivers

During standard construction hours, the assessment found that a number of residential receivers located near to the construction work area have the potential to be noise affected (ie. > NML) by the works during various louder construction stages.

During most activities, nearby residences are generally predicted to be more than 20 dB(A) above the NML, which is considered highly intrusive. These residences are located on Blue Gum Road to the north and east, and Fraser Street to the west.

Impacts would be greatest during periods where high noise plant and equipment is being used, such as when concrete saws and rock breakers are being used for the stage 1 structural works, which represent a short duration of the overall proposed works. During this period, up to 11 residences are predicted to be highly noise affected. These residences are located at the western end of the residential townhouse development at 78 Blue Gum Road, and residences on the eastern side of Blue Gum Road, from 41 to 56 Blue Gum Road. As the works progress along the stormwater channel, they would move further away from some receivers as shown in Figure 4-1, where these residences would then no longer be highly noise affected.

Where typical works (excavating, concreting, general hand tools etc.) are occurring without the use of high noise generating plant and equipment (such as concrete saws and rock breakers), receivers are not predicted to be highly noise affected.

The north-western ancillary facility is located approximately 30 metres to the nearest dwellings on Fraser Street and Blue Gum Road. The south-eastern ancillary facility is approximately 50 metres from nearest dwellings on Blue Gum Road, and is directly adjacent to the KFC Jesmond. Both of these ancillary facilities would be used as laydown and stock piling areas. The southern ancillary facility would also be used for laydown and stock piling, whilst the main ancillary facility at the south-western side of the proposal site would be for sheds and alternative parking.

Noise impacts from use of the ancillary facilities to nearby residences on Fraser Street and Blue Gum Road would be highest during deliveries and when storing materials and equipment in the laydown areas. The noise impacts are based upon heavy machinery operating, which would not occur all the time and would only be as required. During periods when these machines are not operating, construction noise levels would be expected to be lower. Laydown areas and other fixed location noise generating equipment should be located as far as practicable from residences near to the compound. In addition, site sheds and structures should be positioned to provide acoustic shielding to the nearby residences where possible.

All assessed residences within the study area for each construction activity are shown on the noise maps in APPENDIX E.

In light of the predicted noise levels, it is recommended that a feasible and reasonable approach towards noise mitigation measures be applied to reduce noise levels as much as possible to mitigate the impact from construction noise. Further details on feasible and reasonable construction noise mitigation and management measures to reduce noise impacts are detailed in Section 4.6.

#### 4.3.3.2 Non-residential receivers

The predicted noise levels at the nearest non-residential receivers are generally predicted to be not more than 10 dB(A) above the NMLs. Up to 10 non-residential receivers are predicted to be impacted (ie. > NML) by the works. This would occur where high noise plant and equipment is being used, such as when concrete saws and rock breakers are being used for the stage 1 structural works. For most general works, noise levels are typically predicted to comply the NMLs at all except the closest receivers.

The most impacted receivers are the commercial receivers to the south of the works. The predicted noise levels are based on the worst case facade, which would be the rear facade of the KFC Jesmond, and the side facade of the major commercial development (which is solid with no windows). Noise levels KFC Jesmond are predicted to be up to 15 dB(A) above the NML during high noise generating activities when concrete saws and rock breakers are being used for the stage 1 structural works.

In addition, the predicted noise levels at the adjacent sports fields are predicted to be up to 12 dB(A) above the NMLs during high noise generating activities.

Feasible and reasonable mitigation and management measures to reduce noise impacts are detailed in Section 4.6.

## 4.4 Construction-related road traffic

The proposed construction packages does not include a large number of associated heavy vehicles movements. As part of the Proposal the following construction-related road traffic activities are expected:

- During peak periods, the highest levels of traffic generated during construction works is expected to be three heavy vehicles per hour (i.e. six vehicle movements) during the day period.

Construction vehicles are required to access the site via Mordue Parade as shown on the map on Figure 1-1. This route avoids the use of any local roads to access and depart from the site.

Mordue Parade is a sub-arterial road with a daytime noise goal of 60 dB(A)  $L_{Aeq,1hr}$ . Based on the on the proposed traffic volumes of up to three heavy vehicles per hour, construction related road traffic is predicted to comply with the road traffic noise goals.

## 4.5 Construction vibration assessment

The pattern of vibration radiation is very different to the pattern of airborne noise radiation and is very site specific as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver. Accordingly, based on a database containing vibration measurements from past projects and library information, Table 4-7 and Table 4-8 below presents the recommended minimum working distances for vibration intensive plant.

**Table 4-7: Minimum working distances (m) for cosmetic damage (continuous vibration)**

Plant item	Minimum working distance (m)		
	Reinforced or framed structures (e.g. commercial buildings) <sup>1</sup>	Unreinforced or light framed structures (e.g. residential buildings) <sup>1</sup>	Sensitive structures (e.g. heritage structures) <sup>2</sup>
Concrete saw	5	5	5
Place compactor/Wacker packer	5	5	5
Small percussive drill	5	5	5
10-20t excavator with hydraulic hammer attachment	5	5	10

Notes 1) Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.  
 2) A site inspection should determine whether a heritage structure is structurally unsound.  
 3) Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method.

**Table 4-8: Minimum working distances (m) for human annoyance (continuous vibration)**

Plant item	Minimum working distances (m)				
	Critical areas 0.28 mm/s	Residences		Offices 1.1 mm/s	Workshops 2.2 mm/s
		Day 0.56mm/s	Night 0.40 mm/s		
Concrete saw	15	10	10	5	5
Place compactor/Wacker packer	20	10	15	5	5
Small percussive drill	20	10	15	5	5
10-20t excavator with hydraulic hammer attachment	30	20	25	15	10

Vibration intensive works are not expected to be associated with the ancillary facilities.

### 4.5.1 Cosmetic damage

#### 4.5.1.1 Reinforced and unreinforced structures

The nearest residences dwellings to the proposal are approximately 25 metres to the north on Blue Gum Road, and 30 metres to the east on Blue Gum Road. The KFC Jesmond is the nearest structure to the proposed works which is approximately 15 metres to the south.

Given the above, there are no reinforced or unreinforced structures to be within the minimum working distance for cosmetic damage of 5 metres as identified in Table 4-7. The minimum working distances for cosmetic damage surrounding the works are shown on the map in APPENDIX F.

#### **4.5.1.2 Heritage structures**

There are no heritage structures that have been identified near to the proposed works.

#### **4.5.2 Human response**

The minimum working distance for residences during the day is 20 metres for an excavator with hydraulic hammer attachment. The nearest residences to the works are located approximately 25 metres to the north on Blue Gum Road. The KFC Jesmond is located approximately 15 metres to the south of the works, which is beyond the minimum working distance of 15 metres for an office.

Based on this, there are no receivers within the minimum working distances for human comfort. The minimum working distances for human comfort are shown on the map in APPENDIX F.

As all nearby receivers are predicted to comply with the relevant vibration criteria for cosmetic damage and human annoyance, vibration impacts have not been considered any further in this assessment.

### **4.6 Construction mitigation and management measures**

Based upon the assessment results, a number of the construction works scenarios are predicted to exceed the noise and vibration management levels. As such, all feasible and reasonable measures should be investigated to minimise the construction noise and vibration impacts on nearby sensitive receivers.

This section sets out the noise and vibration management measures to be considered and implemented if feasible and reasonable. These should be considered and implemented where feasible and reasonable where there is potential for the noise management levels presented in Section 3.1 and vibration management levels presented in Section 3.3 to be exceeded.

#### **4.6.1 Noise and vibration control measures**

Table 4-9 summarises actions that can be applied to manage the potential for noise to impact on sensitive receivers near the Proposal construction works, which are to be applied where reasonable and feasible.

**Table 4-9: Noise mitigation and management measures**

Action required	Applies to	Details	Estimated noise benefit
<b>At-source mitigation measures</b>			
Equipment selection	Airborne noise Vibration	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable.  Where loud plant and/or equipment are being used in construction works, where feasible and reasonable the selection of alternative quieter plant and/or equipment should be considered for tasks.	Variable. Minimise noise impact and reduce risk of annoyance.
Rental plant and equipment	Airborne noise	The noise levels of plant and equipment items are to be considered in rental decisions, with quieter and less noise/vibration emitting construction methods where feasible and reasonable.	Variable. Minimise noise impact and reduce risk of annoyance.
Use and siting of plant	Airborne noise Vibration	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided.  - The offset distance between noisy plant and adjacent sensitive receivers is to be maximised.  - Plant used intermittently to be throttled down or shut down.  - Noise-emitting plant to be directed away from sensitive receivers.	Up to 20 dB reduction + reduce vibration
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.  Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.	5-10 dB reduction
Minimise disturbance arising from delivery of goods	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers.  Select site access points and roads as far as possible away from sensitive receivers.  Dedicated loading/unloading areas to be shielded if close to sensitive receivers if possible.  Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.	Variable. Reduce noise/vibration impact + risk of annoyance.
Silencers on mobile plant	Airborne noise	Where possible reduce noise from mobile plant through additional fittings including:  - Residential grade mufflers  - Air Parking brake engagement is silenced.  Ensure plant including the silencer is well maintained.	0-20 dB reduction Reduce annoyance + sleep disturbance.
Prefabrication of materials off-site	Airborne noise	Where practicable, pre-fabricate and/or prepare materials off-site to reduce noise with special audible characteristics occurring on site. Materials can then be delivered to site for installation.	5-20 dB reduction Reduce noise/ vibration impact + risk of annoyance
Engine compression brakes	Airborne noise	Limit the use of engine compression brakes in residential areas.  Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.	5-20 dB reduction

Action required	Applies to	Details	Estimated noise benefit
<b>Path mitigation measures</b>			
Construction hoarding as noise barrier	Airborne noise	Any construction hoarding installed on each worksite shall be constructed as a noise barrier, where practicable to screen the work areas from nearby residences	Receiver <b>with</b> line of site of the works area: 5-10 dB reduction Receiver <b>without</b> line of site of the works area: 0-5 dB reduction
Site sheds	Airborne noise	Site sheds to be located within the ancillary facilities to provide shielding to nearby residences.	Receiver <b>with</b> line of site of the ancillary facility works area: 5-10 dB reduction
Laydown and stockpiling	Airborne noise	Locate laydown and stock piling as far from residences within the construction works areas.	Variable. Minimise noise impact and reduce risk of annoyance.
<b>Management measures</b>			
Construction Environmental Management Plan update	Airborne noise Vibration	The Construction Environmental Management Plan (CEMP) including at minimum relevant section for construction noise and vibration management must be prepared prior to the commencement of construction and regularly updated to account for changes in noise management issues and strategies.	-
Implement stakeholder consultation measures	Airborne noise	Periodic notification (monthly letterbox drop and website notification) detailing all upcoming construction activities delivered to sensitive receivers at least 7 days prior to commencement of relevant works.  In addition to Periodic Notification, the following strategies may be adopted to notify the community of upcoming works: <ul style="list-style-type: none"> <li>• Project Specific Website</li> <li>• Project Infoline</li> <li>• Email Distribution List</li> <li>• Web-based Surveys</li> <li>• Social Media</li> <li>• Community and Stakeholder Meetings.</li> </ul>	Keeps stakeholders informed of the likely impact.  Community may identify solution to assist in managing impacts.
Register of noise and vibration sensitive receivers	Airborne noise Vibration	A register of most affected noise and vibration sensitive receivers (NVSRs) would be kept on site. The register would include the following details for each NVSR: <ul style="list-style-type: none"> <li>• Address of receiver</li> <li>• Category of receiver (e.g. Residential, Commercial etc.)</li> <li>• Contact name and phone number.</li> </ul> The register may be included as part of the Project's Community Liaison Plan or similar document.	Assists with keeping stakeholders informed of the likely impact.  Assists with planning and reducing potential noise/ vibration impact + risk of annoyance

Action required	Applies to	Details	Estimated noise benefit
Site inductions	Airborne noise Vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: <ul style="list-style-type: none"> <li>All relevant project specific and standard noise and vibration mitigation measures</li> <li>Permissible hours of work</li> <li>Any limitations on noise generating activities with special audible characteristics</li> <li>Location of nearest sensitive receivers</li> <li>Construction employee parking areas</li> <li>Designated loading/unloading areas and procedures</li> <li>Site opening/closing times (including deliveries)</li> <li>Environmental incident procedures.</li> </ul>	Keeps construction workforce informed of actions required to minimise noise and vibration impact.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors. No excessive revving of plant and vehicle engines. Controlled release of compressed air.	0-20 dB reduction Reduce annoyance + sleep disturbance.
Verification monitoring	Airborne noise	In response to noise complaints, a noise monitoring program should be carried out for the duration of works in accordance with the Construction Noise and Vibration Management Plan (CNVMP) or CEMP and any approval conditions.	Minimises noise impacts

#### 4.6.2 Noise monitoring and management measures

The following approach could be adopted with regard to noise monitoring procedures during the construction works.

- In response to complaints where appropriate. Where the noise is identified to be from the Proposal and an understanding of the construction noise level would assist investigating and addressing with the complaint, noise monitoring must be carried out to confirm construction noise levels and verify predicted noise impacts. Reasonable and feasible noise reduction measures must be investigated, where necessary.

As part of construction planning, when a contractor is appointed and the specific construction methodology is known and the likely construction equipment are also known the potential construction impacts are to be reviewed to determine that they are consistent with those presented in this construction noise and vibration impact assessment and confirm that the associated mitigation and management measures are appropriate.

The attended measurements will need to be carried out by an appropriately trained person in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures.



## 5 Conclusion

This noise and vibration impact assessment has been prepared as part of the Review of Environmental Factors (REF) to describe and assess the noise and vibration impacts associated with the Stormwater Amenity Improvement: Jesmond, Dark Creek. The key findings of the assessment are detailed below.

### 5.1 Construction noise assessment

Noise emissions from the proposed construction works have been predicted and assessed against the relevant noise management levels set by the ICNG during the recommended standard hours for construction.

During standard construction hours, the assessment found that receivers located near to the construction works areas are likely to be noise affected by the works. During most activities, nearby residences are generally predicted to be more than 20 dB(A) above the NML, which is considered highly intrusive. These residences are located on Blue Gum Road to the north and east, and Fraser Street to the west.

Impacts would be greatest during periods where high noise plant and equipment is being used. During this period, up to 11 residences on Blue Gum Road are predicted to be highly noise affected (ie. > 75 dB(A)).

Where typical works (excavating, concreting, general hand tools etc.) are occurring without the use of high noise generating plant and equipment (such as concrete saws and rock breakers), receivers are not predicted to be highly noise affected.

Due to the predicted impacts determined in this assessment, recommendations to manage and/or minimise noise and vibration impacts where they occur have been provided in Section 4.6 and are to be reviewed and incorporated where feasible and reasonable.

### 5.2 Construction traffic noise assessment

Construction related road traffic noise has been assessed. All traffic would access the proposal site via Mordue Parade which is a sub-arterial road with a daytime noise goal of 60 dB(A)  $L_{Aeq,1hr}$ . Based on the proposed traffic volumes of up to three heavy vehicles per hour, construction related road traffic is predicted to comply with the road traffic noise goals.

### 5.3 Construction vibration assessment

Potential vibration impact on residential, other sensitive receivers and heritage structures has been reviewed against the relevant guidelines for cosmetic damage from vibration and for human disturbance.

There are no reinforced or unreinforced structures within the minimum working distance for cosmetic damage.

No heritages structures have been identified near to the construction works.

All nearby receivers are predicted to comply with the relevant vibration criteria for human annoyance from vibration.

## References

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3. British Standard (2009), *Code of practice for noise and vibration control on construction and open sites- Part 2: Vibration*, BS 5228-1:2009
4. NSW Department of Climate Change and Water (2011), *Road Noise Policy (RNP)*
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6. NSW Department of Environment Conservation (2006), *Assessing Vibration; a technical guideline (AVTG)*
7. NSW Environment Protection Authority (1999), *Environmental Criteria for Road Traffic Noise (ECRTN)*
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11. International Organization for Standardization (1996), *Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation*, ISO 9613-2:1996
12. International Organization for Standardization (2015), *Acoustics - Software for the calculation of sound outdoors - Part 3: Recommendations for quality assured implementation of ISO 9613-2 in software according to ISO 17534-1*, ISO/TR 17534-3:2015
13. British Standard (1993), *BS 7385: Part 2-1993 Evaluation and Measurement for Vibration in Buildings*
14. German Standard (2016), *DIN 4150-3: 2016-02, Structural vibration - Effects of vibration on structures*

## APPENDIX A Technical terms and concepts

### A.1 Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).		
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.		
Assessment period	The period in a day over which assessments are made.		
Assessment Point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.		
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).		
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our daytime environment:		
	threshold of hearing	0 dB	The faintest sound we can hear
		10 dB	Human breathing
	almost silent	20 dB	
		30 dB	Quiet bedroom or in a quiet national park location
	generally quiet	40 dB	Library
		50 dB	Typical office space or ambience in the city at night
	moderately loud	60 dB	CBD mall at lunch time
		70 dB	The sound of a car passing on the street
	loud	80 dB	Loud music played at home
		90 dB	The sound of a truck passing on the street
	very loud	100 dB	Indoor rock band concert
		110 dB	Operating a chainsaw or jackhammer
	extremely loud	120 dB	Jet plane take-off at 100m away
	threshold of pain	130 dB	
		140 dB	Military jet take-off at 25m away
dB(A)	A-weighted decibels. The A-weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.		
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.		

Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L <sub>Max</sub>	The maximum sound pressure level measured over a given period.
L <sub>Min</sub>	The minimum sound pressure level measured over a given period.
L <sub>1</sub>	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L <sub>10</sub>	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L <sub>90</sub>	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L <sub>eq</sub>	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

## A.2 Acoustic concepts

### A.2.1 Sound and noise

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound. Sound is a vibration that travels as an audible wave of pressure through the air from a source to a receiver location such as the human ear. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) is a unit of measurement used to express the ratio of a quantity to another on a logarithmic scale to make the wide range of sound pressure more manageable.

**Sound power** is the rate at which a source emits acoustic energy and is unaffected by the environment. It is a property of the source that is emitting acoustic energy.

In contrast, **sound pressure** is the effect, and it is affected by factors associated with the built and natural environment such as distance, direction, obstacles etc. The sound pressure is the acoustic energy or 'noise level' at a distance away from the noise source. The relationship between sound power and sound pressure can be explained by considering the analogy of an electric heater, which radiates heat into a room and temperature is the effect. Like sound pressure, temperature also reduces with distance from the source following the inverse square law.

In this technical working paper, **sound power level** is identified by the symbols **SWL** or  $L_w$ , while **sound pressure level** is represented by **SPL** or  $L_p$ , and both have the same scientific unit in dB.

### A.2.2 Individual's perception of sound

The loudness of sound depends on its sound pressure level. The A-weighted decibel [dB(A)] is generally used for the purposes of environmental noise impact assessment as it has been adjusted to account for the varying sensitivity of the human ear to different frequencies of sound. People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dB(A) is a good measure of the loudness of environmental noise to the human ear as it considers this frequency dependant sensitivity.

Different noise sources having the same dB(A) level generally sound equally loud. However, the frequency of a sound is what gives it a distinctive pitch or tone – for example, the rumble of distant thunder is an example of a low frequency sound and a whistle is an example of a high frequency sound. Most sounds we hear in our daily lives have sound pressure levels in the range of 30 to 90 dB(A). The following table provide some points of reference, measured in dB(A), of familiar sounds and those from construction activities.

**Table A-1 Perception of sound - familiar sounds and construction noise**

Common sounds	Construction noise	Sound pressure level
Leaf blower at operator's ear	Concrete saw or jack hammer 7 metres away	90 dB(A)
Airplane cabin during cruise (Airbus 321)	Excavator (with bucket) 7 metres away	80 dB(A)
General traffic noise kerbside next to Military Road	Towable compressor 7 metres away	75 dB(A)
Normal conversation at 1 metre		60 dB(A)
Outdoor air conditioning unit 1 metre away	Towable compressor 50 metres away	55 dB(A)
General office		50 dB(A)
Inside private office	Ground-borne noise from road header tunnel excavation between depths of 20 metres to 50 metres	40 dB(A)
Inside bedroom		30 dB(A)

In terms of sound perception, a change of 1 dB(A) or 2 dB(A) in the sound pressure level is difficult for most people to detect, while a 3 dB(A) to 5 dB(A) change corresponds to a small but noticeable change in loudness. An increase in sound level of 10 dB(A) is perceived as a doubling of loudness. However,

individuals may perceive the same sound differently since many factors can influence an individual's response, including:

- The specific characteristics of the noise (eg. frequency, intensity, duration of the noise event)
- Time of day noise events occur
- Individual sensitivities and lifestyle
- Reaction to an unfamiliar sound
- Understanding of whether the noise is avoidable and the notions of fairness.

### A.2.3 Environmental noise assessment indicators

Environmental noise is an accumulation of noise pollution that occurs outside and is most commonly attributed to various modes of transport as well as industrial and construction activities. Environmental noise has been shown to have an adverse effect on the quality of life, especially following long-term exposure. The focus of the present technical assessment is on annoyance and sleep disturbance as they constitute most of the burden related to the impact of environmental noise on health outcomes. Noise annoyance is defined by the World Health Organization as a feeling of displeasure, nuisance, disturbance or irritation caused by a specific sound. Sleep disturbance relates to difficulty with sleep initiation, consolidation as well as awakening and reduced quality of sleep.

In New South Wales, contemporary environmental noise assessment criteria for addressing noise annoyance and sleep disturbance are specified by the Environment Protection Authority (EPA). Potential road traffic noise impact is assessed in accordance with the NSW Road Noise Policy. For motorway and ventilation facilities that are permanently fixed, and associated noise emissions are long-term in nature, noise criteria have been adopted in accordance with the Noise Policy for Industry. For enabling construction activities which are temporary in nature and highly variable, EPA's Interim Construction Noise Guideline provides the underlying assessment principles for the determination of potential construction noise impact.

$L_{Aeq}$  - To protect against long-term repeated noise exposure, the indicator for assessing the cumulative noise exposure level over a specific time interval is the equivalent sound pressure level, denoted as  $L_{Aeq}$ . The  $L_{Aeq}$  indicator accounts for the total energy content from all sources of sound under consideration. The fact that the  $L_{Aeq}$  is a cumulative measure means that louder activities have greater influence of the  $L_{Aeq}$  level than do quieter ones, and activities that last longer in time have greater  $L_{Aeq}$  than do shorter ones. An increase in the number of events also increases the  $L_{Aeq}$ . Further, people react to the duration of noise events, judging longer events to be more annoying than shorter ones, assuming equal maximum noise levels.

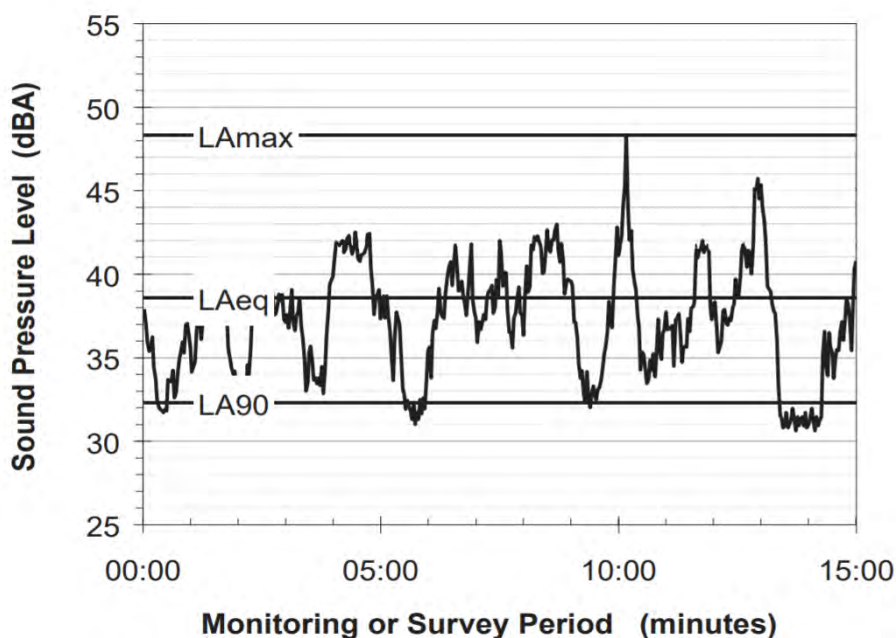
$L_{Amax}$  - It is important to note that even though  $L_{Aeq}$  levels are numerically lower than maximum noise levels (denoted as  $L_{Amax}$ ). None of the noise is ignored, just as all the rain that falls in the rain gauge in one hour counts toward the total. In the case of noisy but short-lived maximum noise events, which can

sometime result in immediate short-term awakening reaction, potential impact is assessed using the  $L_{Amax}$  indicator in which its emergence above the background noise environment is evaluated.

$L_{A90}$  - The  $L_{A90}$  is the level of noise that is present almost constantly, or for 90 percent of the time and is commonly referred to as the background noise. Typical examples of what types of noise may contribute to the background noise levels are continuously flowing traffic or air conditioner noise.

These three noise indicators of  $L_{Amax}$ ,  $L_{Aeq}$  and  $L_{A90}$  are presented in Figures A-1 for example noise monitoring survey period showing the sound pressure level of a varying noise environment such as environmental noise.

Figure A-1: Environmental noise assessment indicators

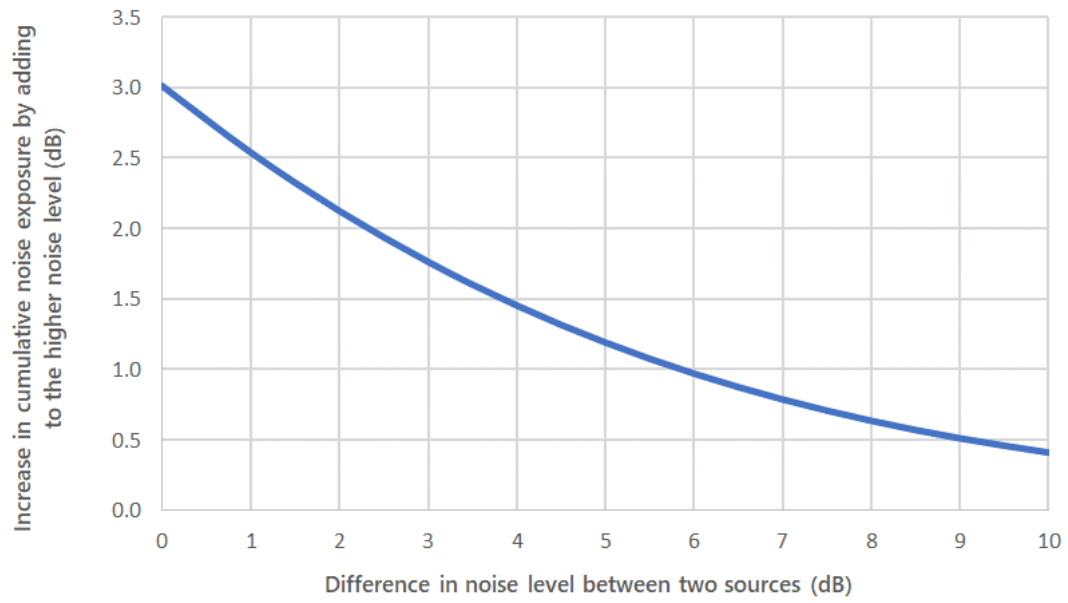


#### A.2.4 Cumulative sound exposure

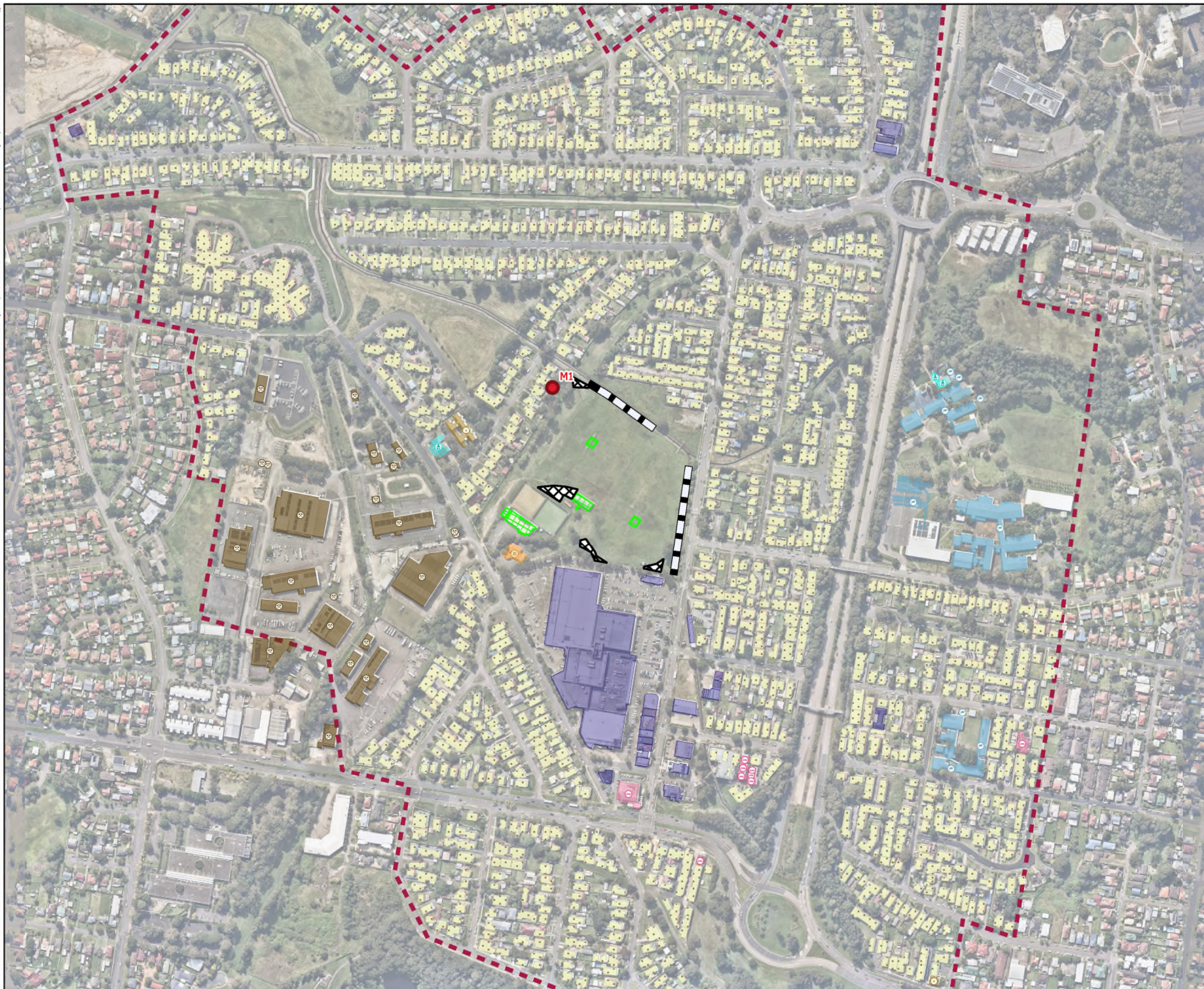
As illustrated in Figure A-2, for two activities that result in the same amount of acoustical energy or noise level at a receiver location, the cumulative sound exposure level would be 3 dB higher than the level of just one single activity. This is because the decibel (dB) scale is logarithmic. Conversely, if the activity closer to your home results in noise exposure level that is 10 dB higher than the activity occurring further away, the quieter works would contribute very little to the cumulative noise exposure level.



Figure A-2: Difference in noise level between two sources



## **APPENDIX B**      **Locality Map and Land Use Survey**



### LEGEND

**Noise Sensitive Receivers**

- Residential (Yellow dotted)
- Commercial (Purple solid)
- Industrial (Brown solid)
- Hotel/Motel/Hostel (Pink solid)
- Place of Worship (Orange circle with dot)
- Community centre (Yellow circle with dot)
- Childcare (Light blue circle with dot)
- Educational (Blue circle with dot)
- Recreational - Active (Green grid)

**Other Symbols:**

- Noise Monitoring Location (Red dot)
- Work areas (Black and white striped line)
- Ancillary Facilities (Black and white cross-hatch)
- Project Study Area (Red dashed line)



**STORMWATER AMENITY IMPROVEMENT PROJECT - JESMOND**

Landuse and Work Areas

REV	BY	DATE	DESCRIPTION	APPROVER
r0	SS	04/07/22	Prepare figures	RP

A3 Original Co-ordinate System: MGA Zone 56

0 50 100 150 200 250 m

1:5,500 At A3

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

CLIENT



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## APPENDIX C Noise monitoring methodology

### C.1 Noise monitoring equipment

A noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave Band Data
RTA06 (NTi Audio XL2)	Type 1	1/1 octaves

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 or 4231 calibrator. No significant drift in calibration was observed.

### C.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the INP. The Bureau of Meteorology (BOM) provided meteorological data, which is considered representative of the site, for the duration of the noise monitoring period. The data was modified to allow for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10 metres above ground level, and the microphone location, which is typically 1.5 metres above ground level (and less than 3 metres). The correction factor applied to the data was taken from Australian Standard AS1170.2 1989 Section 4.2.5.1.

### C.3 Noise vs time graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the  $L_{10}$ ,  $L_{90}$ , and  $L_{eq}$  levels. The statistical descriptors  $L_{10}$  and  $L_{90}$  measure the noise level exceeded for 10% and 90% of the sample measurement time. The  $L_{eq}$  level is the equivalent continuous noise level or the level averaged on an equal energy basis. The measurement sample periods are 15 minutes. The Noise - vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband results.

## C.4 Noise monitoring location

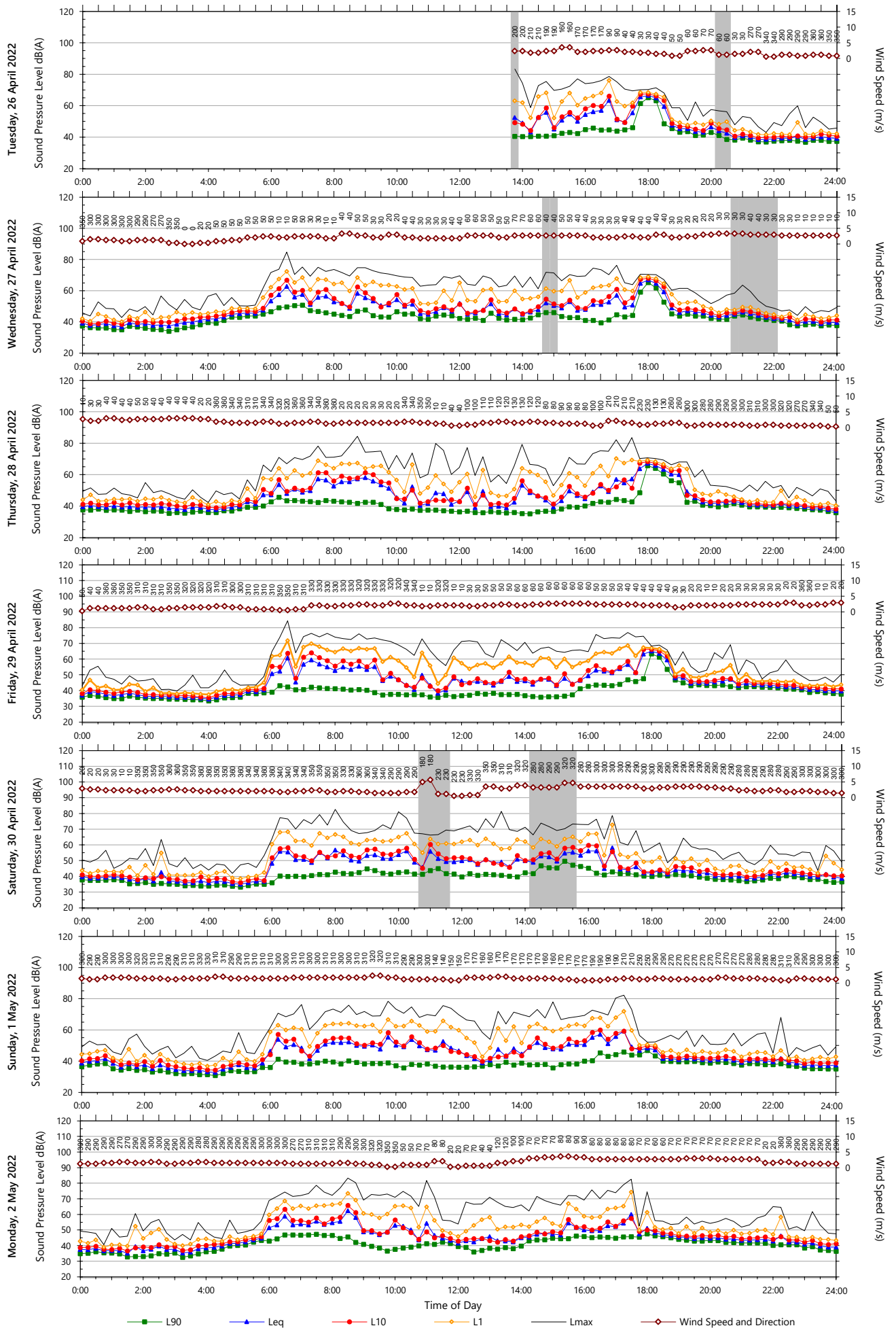
### C.4.1 M1 - 27 Fraser Street, Jesmond



## APPENDIX D **Unattended noise monitoring results**

Unattended Monitoring Results

Location: 27 Fraser Street, Jesmond

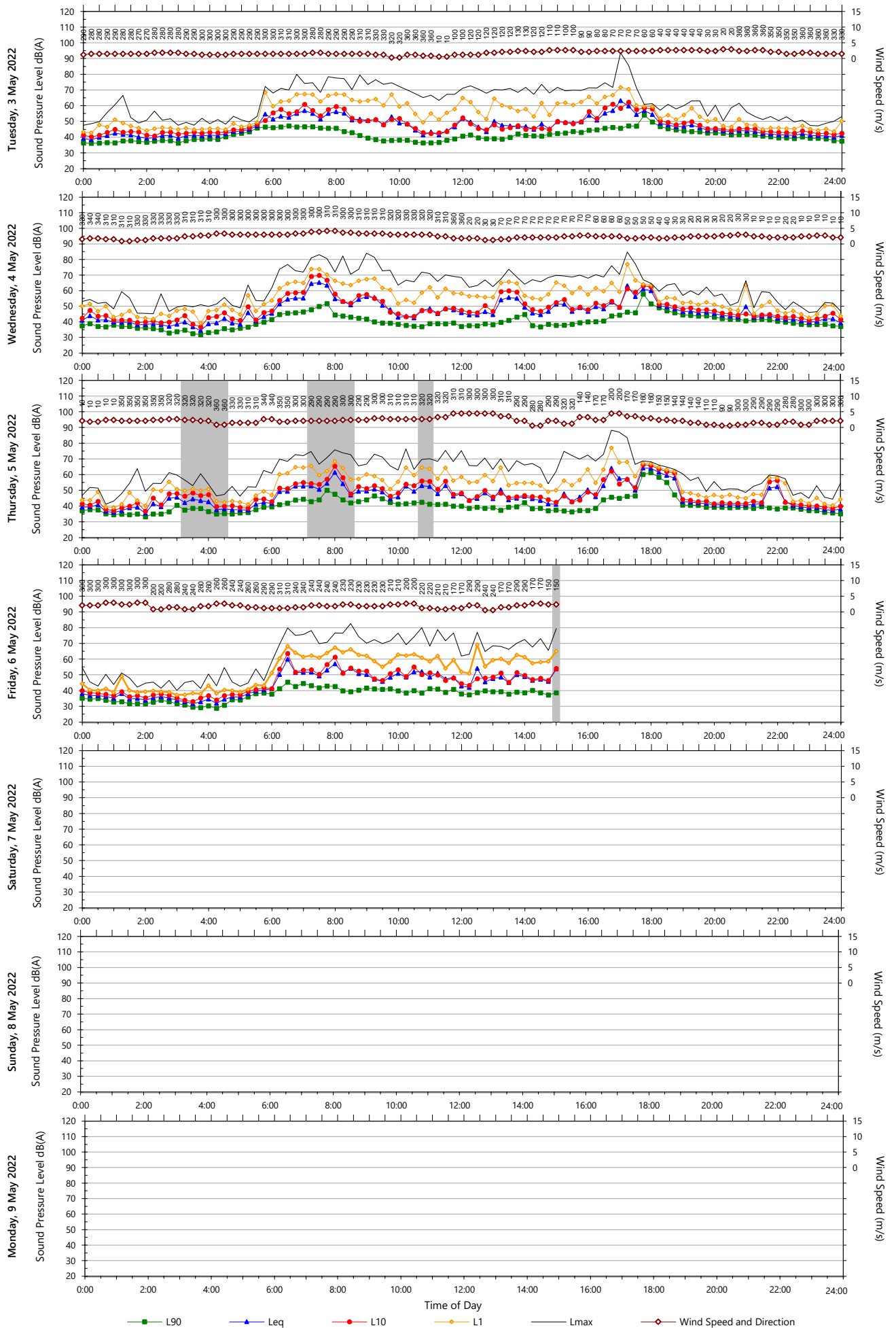


Data File: 2022-04-26\_SLM\_000\_123\_Rpt\_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Unattended Monitoring Results

Location: 27 Fraser Street, Jesmond

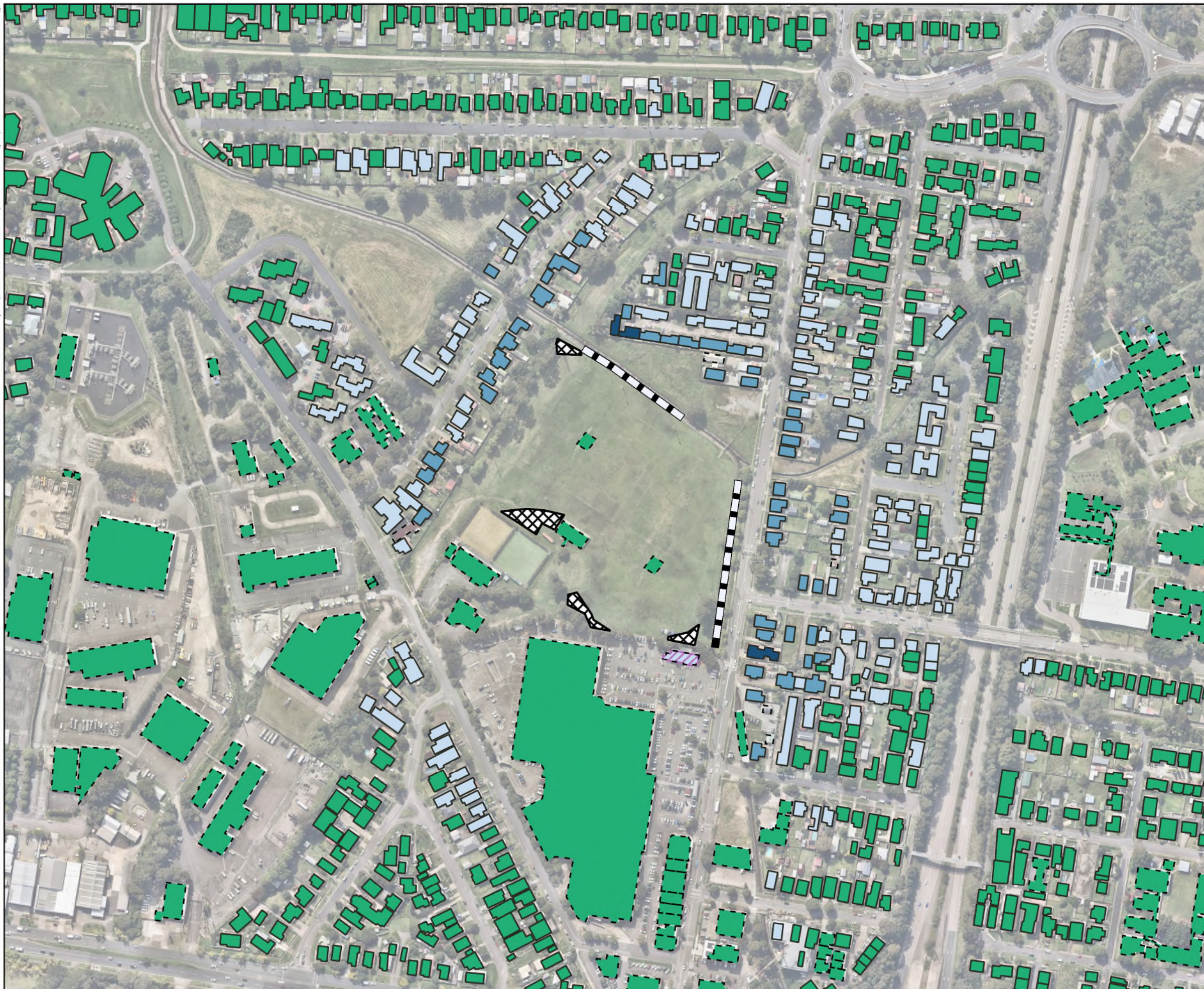


Data File: 2022-04-26\_SLM\_000\_123\_Rpt\_Report.txt

Template: QTE-26 Logger Graphs Program (r38)



## APPENDIX E Predicted construction noise impacts



### LEGEND

**Noise Sensitive Receivers**

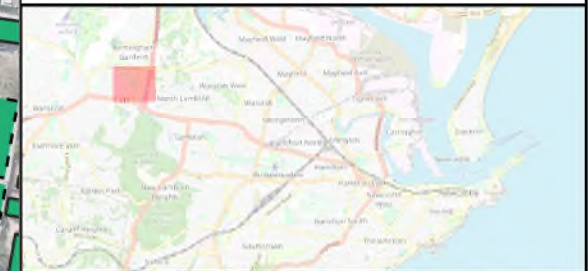
- Residential (white outline)
- Non-Residential (dashed outline)

**Work areas** (black and white hatched)

**Ancillary facilities** (cross-hatched)

**Site Establishment works  
Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (pink hatched)
- Compliance (green)
- 0 - 10 dBA Above NML (light blue)
- 10 - 20 dBA Above NML (medium blue)
- > 20 dBA above NML (dark blue)



..	..	..	..
..	..	..	..
..	..	..	..
..	..	..	..
r0	SS	06/07/22	RP
REV	BY	DATE	APPROVER
A3 Original			

0 40 80 120 160 200 m

1:3,500 At A3

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

CLIENT

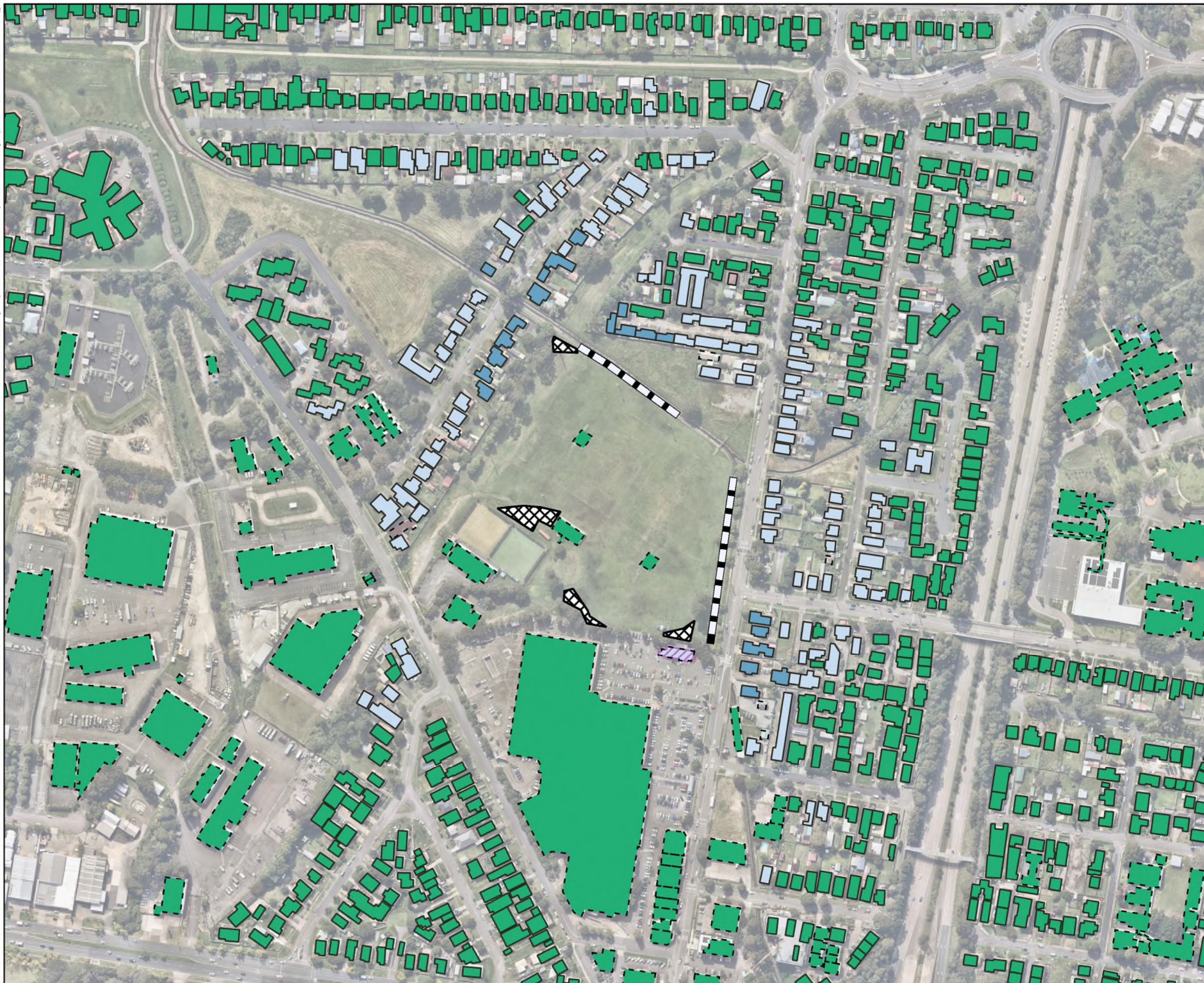
ACOUSTIC CONSULTANT

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STORMWATER AMENITY IMPROVEMENTT PROJECT - JESMOND

Maximum predicted Noise Exceedance for Site Establishment during Standard Daytime

Sheet 1 of 9



### LEGEND

**Noise Sensitive Receivers**

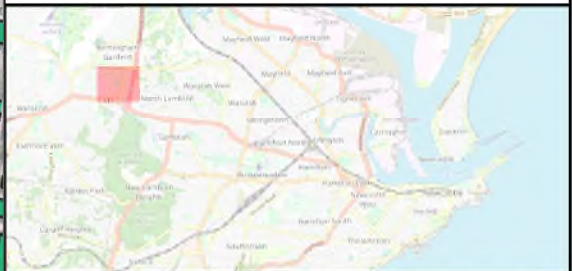
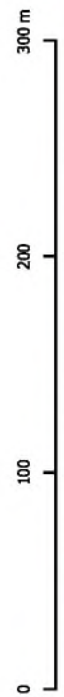
- Residential (white outline)
- Non-Residential (dashed outline)

**Work areas** (black and white hatched)

**Ancillary facilities** (cross-hatched)

**Ancillary facilities works Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (pink hatched)
- Compliance (green)
- 0 - 10 dBA Above NML (light blue)
- 10 - 20 dBA Above NML (medium blue)
- > 20 dBA above NML (dark blue)



..	..	..	..	..
r0	SS	06/07/22	Prepare figures	RP
REV	BY	DATE	DESCRIPTION	APPROVER
A3 Original			Co-ordinate System: MGA Zone 56	

0 40 80 120 160 200 m

1:3,500 At A3

CLIENT

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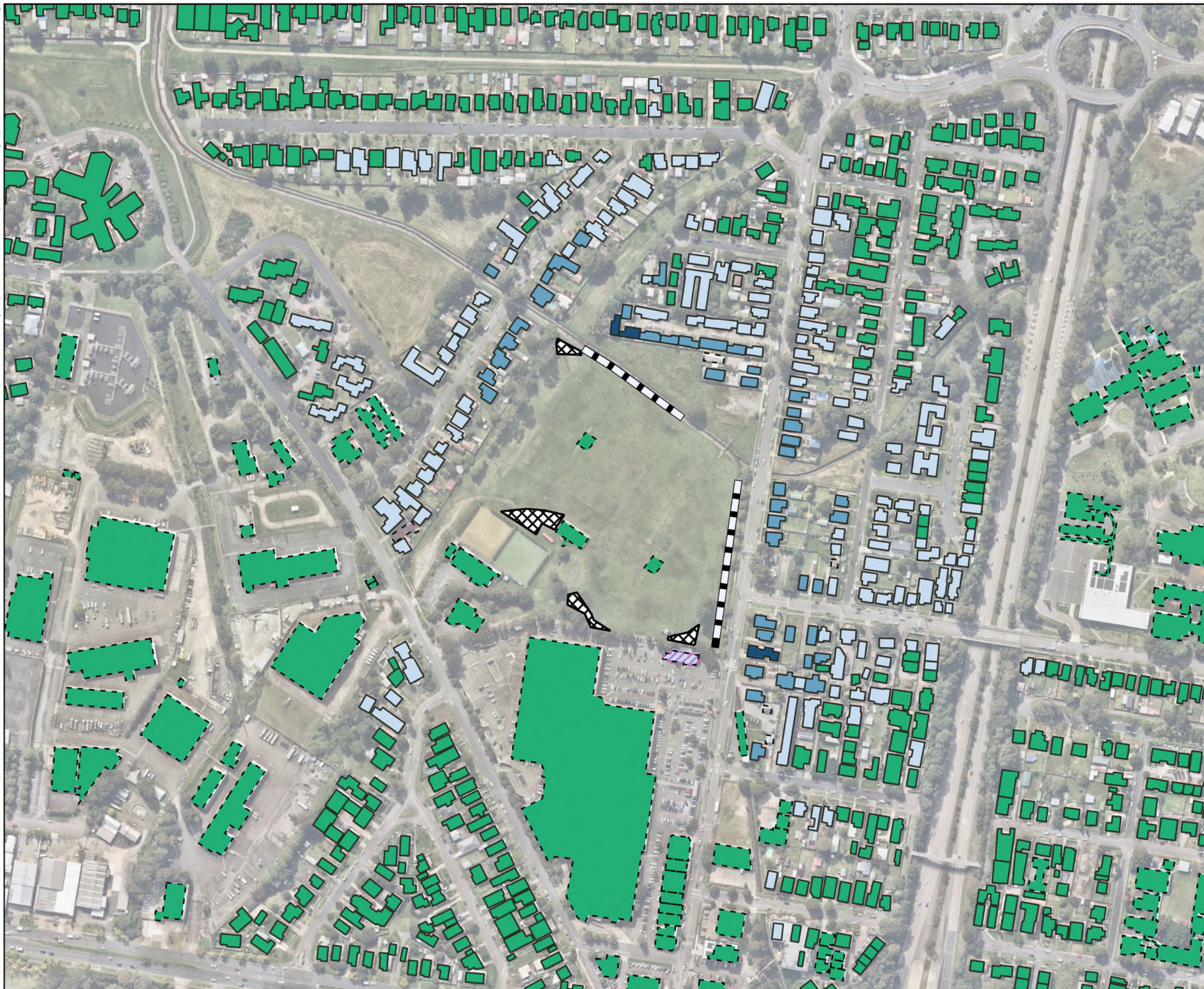
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STORMWATER AMENITY IMPROVEMENTT PROJECT - JESMOND

Maximum predicted Noise Exceedance for Ancillary facilities during Standard Daytime

Sheet 2 of 9



### LEGEND

**Noise Sensitive Receivers**

- Residential (White outline)
- Non-Residential (Dashed outline)

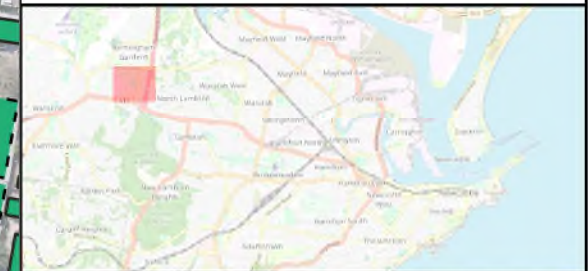
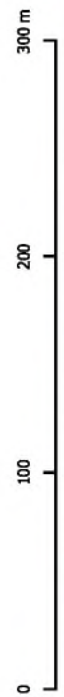
**Work areas** (Black and white hatched)

**Ancillary facilities** (Black and white cross-hatched)

**Investigations works**

**Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (Pink hatched)
- Compliance (Green)
- 0 - 10 dBA Above NML (Light Blue)
- 10 - 20 dBA Above NML (Medium Blue)
- > 20 dBA above NML (Dark Blue)



REV	BY	DATE	DESCRIPTION	APPROVER
r0	SS	06/07/22	Prepare figures	RP

A3 Original Co-ordinate System: MGA Zone 56

0 40 80 120 160 200 m

1:3,500 At A3

CLIENT

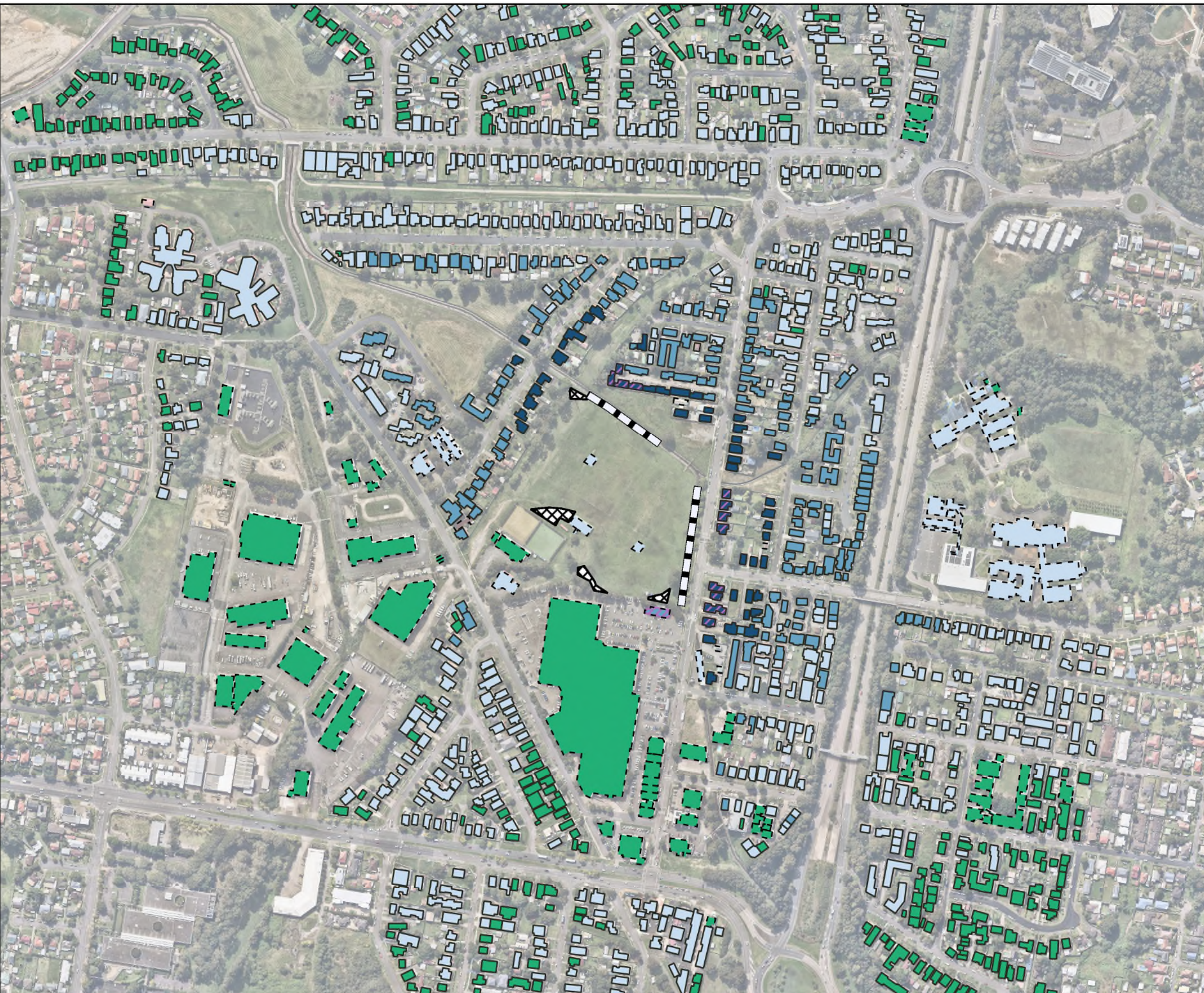
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STORMWATER AMENITY IMPROVEMENTT PROJECT - JESMOND

Maximum predicted Noise Exceedance for Investigations during Standard Daytime



### LEGEND

**Noise Sensitive Receivers**

- Residential (white outline)
- Non-Residential (dashed outline)

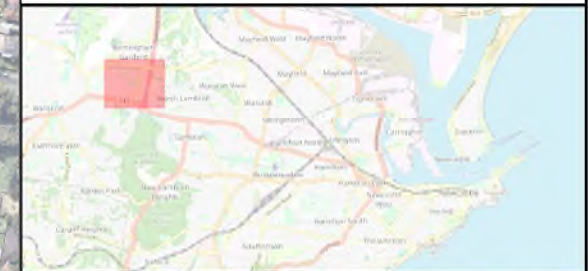
**Work areas** (black and white hatched rectangle)

**Ancillary facilities** (black and white hatched triangle)

**Structural Works - Stage 1 works**

**Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (pink hatched)
- Compliance (green)
- 0 - 10 dBA Above NML (light blue)
- 10 - 20 dBA Above NML (medium blue)
- > 20 dBA above NML (dark blue)



**STORMWATER AMENITY IMPROVEMENT PROJECT - JESMOND**

Maximum predicted Noise Exceedance for Structural Works - Stage 1 during Standard Daytime

REV	BY	DATE	DESCRIPTION	APPROVER
r0	SS	06/07/22	Prepare figures	RP

A3 Original Co-ordinate System: MGA Zone 56

0 60 120 180 240 300 m

1:5,000 At A3

CLIENT

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### LEGEND

**Noise Sensitive Receivers**

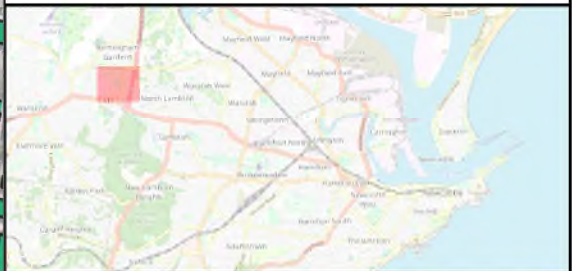
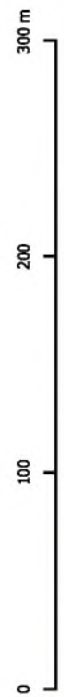
- Residential (white outline)
- Non-Residential (dashed outline)

**Work areas** (black and white hatched)

**Ancillary facilities** (cross-hatched)

**Dewatering works Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (pink hatched)
- Compliance (green)
- 0 - 10 dBA Above NML (light blue)
- 10 - 20 dBA Above NML (medium blue)
- > 20 dBA above NML (dark blue)



REV	BY	DATE	DESCRIPTION	APPROVER
r0	SS	06/07/22	Prepare figures	RP

A3 Original Co-ordinate System: MGA Zone 56

0 40 80 120 160 200 m

1:3,500 At A3

CLIENT

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STORMWATER AMENITY IMPROVEMENT PROJECT - JESMOND

Maximum predicted Noise Exceedance for Dewatering during Standard Daytime

Sheet 5 of 9



### LEGEND

**Noise Sensitive Receivers**

- Residential (White outline)
- Non-Residential (Black outline)

**Work areas** (Black and white hatched rectangle)

**Ancillary facilities** (Black and white hatched triangle)

**Structural Works - Stage 2 works**

**Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (Pink hatched)
- Compliance (Green)
- 0 - 10 dBA Above NML (Light Blue)
- 10 - 20 dBA Above NML (Medium Blue)
- > 20 dBA above NML (Dark Blue)



**STORMWATER AMENITY IMPROVEMENT PROJECT - JESMOND**

Maximum predicted Noise Exceedance for Structural Works - Stage 2 during Standard Daytime

..	..	..	..
..	..	..	..
..	..	..	..
..	..	..	..
r0	SS	06/07/22	RP
REV	BY	DATE	APPROVER
A3 Original			

0 50 100 150 200 250 m

1:4,000 At A3

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

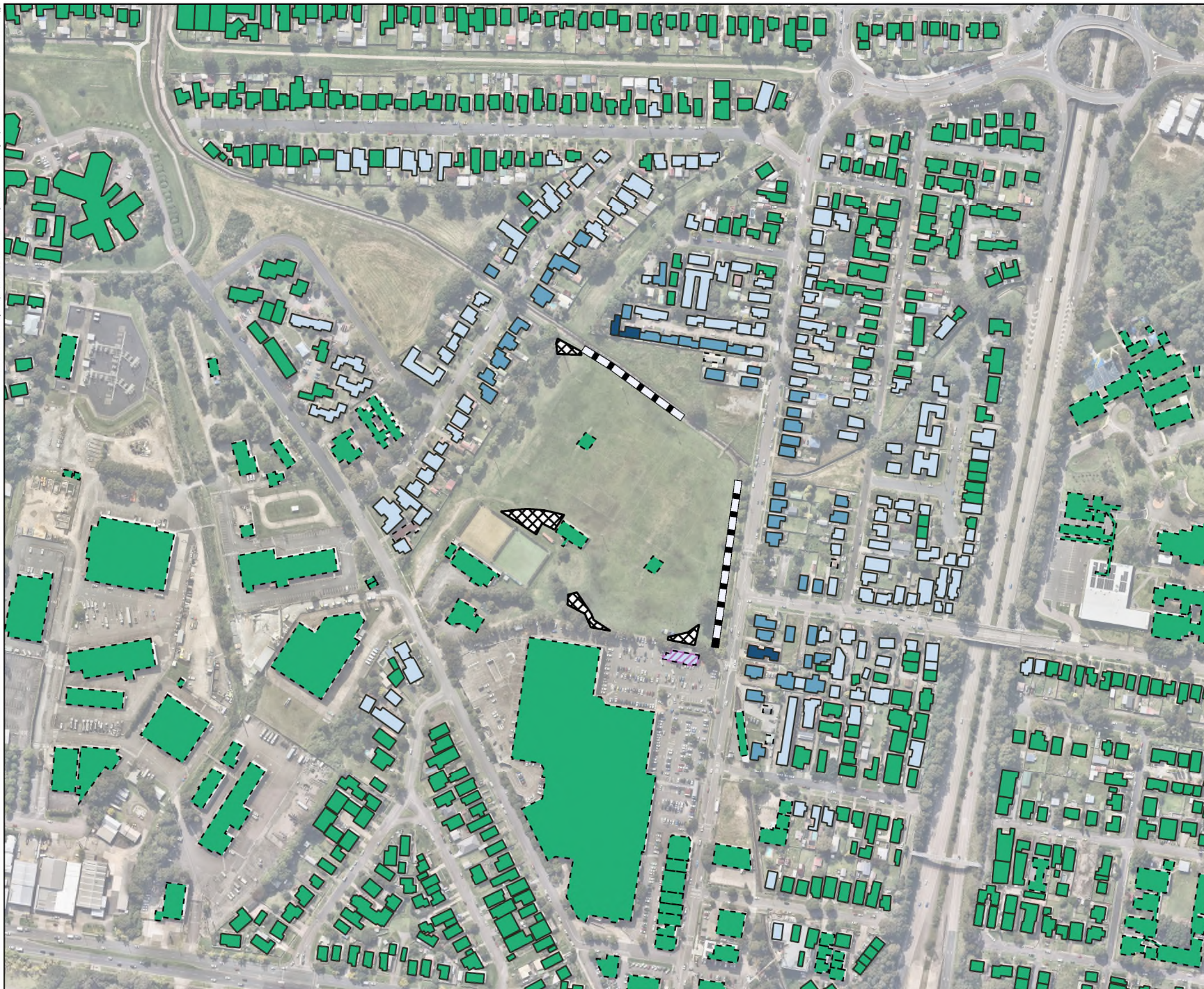
CLIENT



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### LEGEND

**Noise Sensitive Receivers**

- Residential (white outline)
- Non-Residential (dashed outline)

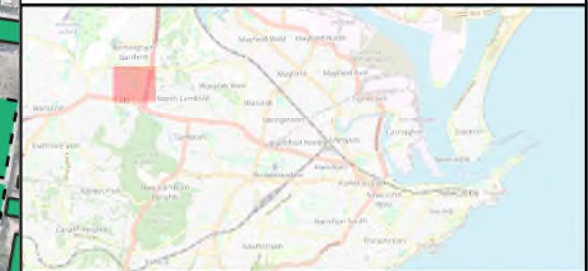
**Work areas** (black and white hatched rectangle)

**Ancillary facilities** (black and white hatched polygon)

**Structural Works - Stage 3 works**

**Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (pink hatched)
- Compliance (green)
- 0 - 10 dBA Above NML (light blue)
- 10 - 20 dBA Above NML (medium blue)
- > 20 dBA above NML (dark blue)



**STORMWATER AMENITY IMPROVEMENT PROJECT - JESMOND**

Maximum predicted Noise Exceedance for Structural Works - Stage 3 during Standard Daytime

REV	BY	DATE	DESCRIPTION	APPROVER
r0	SS	06/07/22	Prepare figures	RP

A3 Original Co-ordinate System: MGA Zone 56

0 40 80 120 160 200 m

1:3,500 At A3

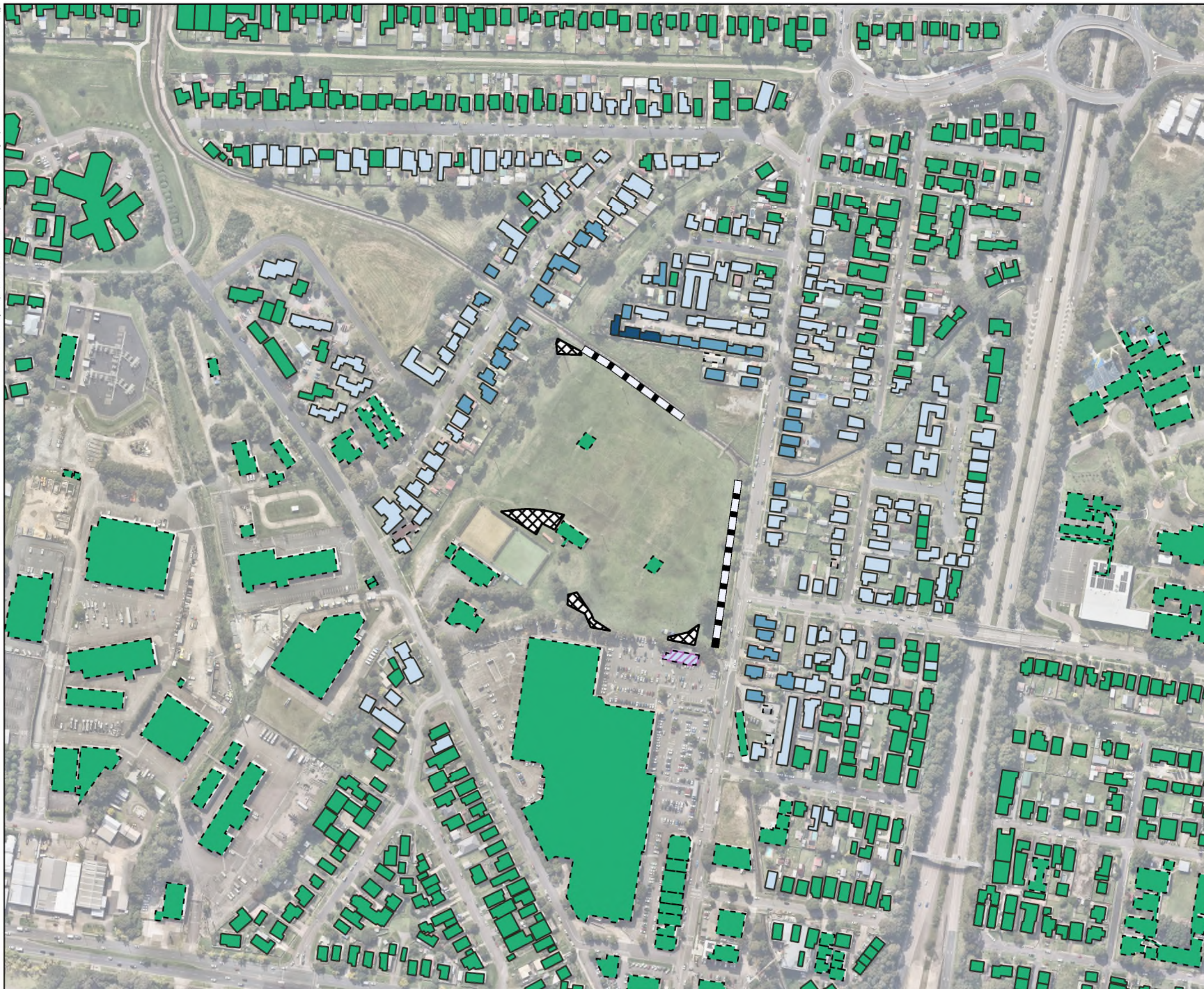
CLIENT

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### LEGEND

**Noise Sensitive Receivers**

- Residential (white outline)
- Non-Residential (dashed outline)

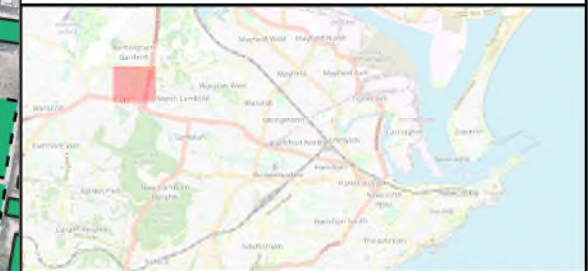
**Work areas** (black and white hatched)

**Ancillary facilities** (cross-hatched)

**Fence Installation works**

**Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (pink hatched)
- Compliance (green)
- 0 - 10 dBA Above NML (light blue)
- 10 - 20 dBA Above NML (medium blue)
- > 20 dBA above NML (dark blue)



..	..	..	..
..	..	..	..
..	..	..	..
..	..	..	..
r0	SS	06/07/22	RP
REV	BY	DATE	APPROVER
A3 Original			

0 40 80 120 160 200 m

1:3,500 At A3

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

CLIENT

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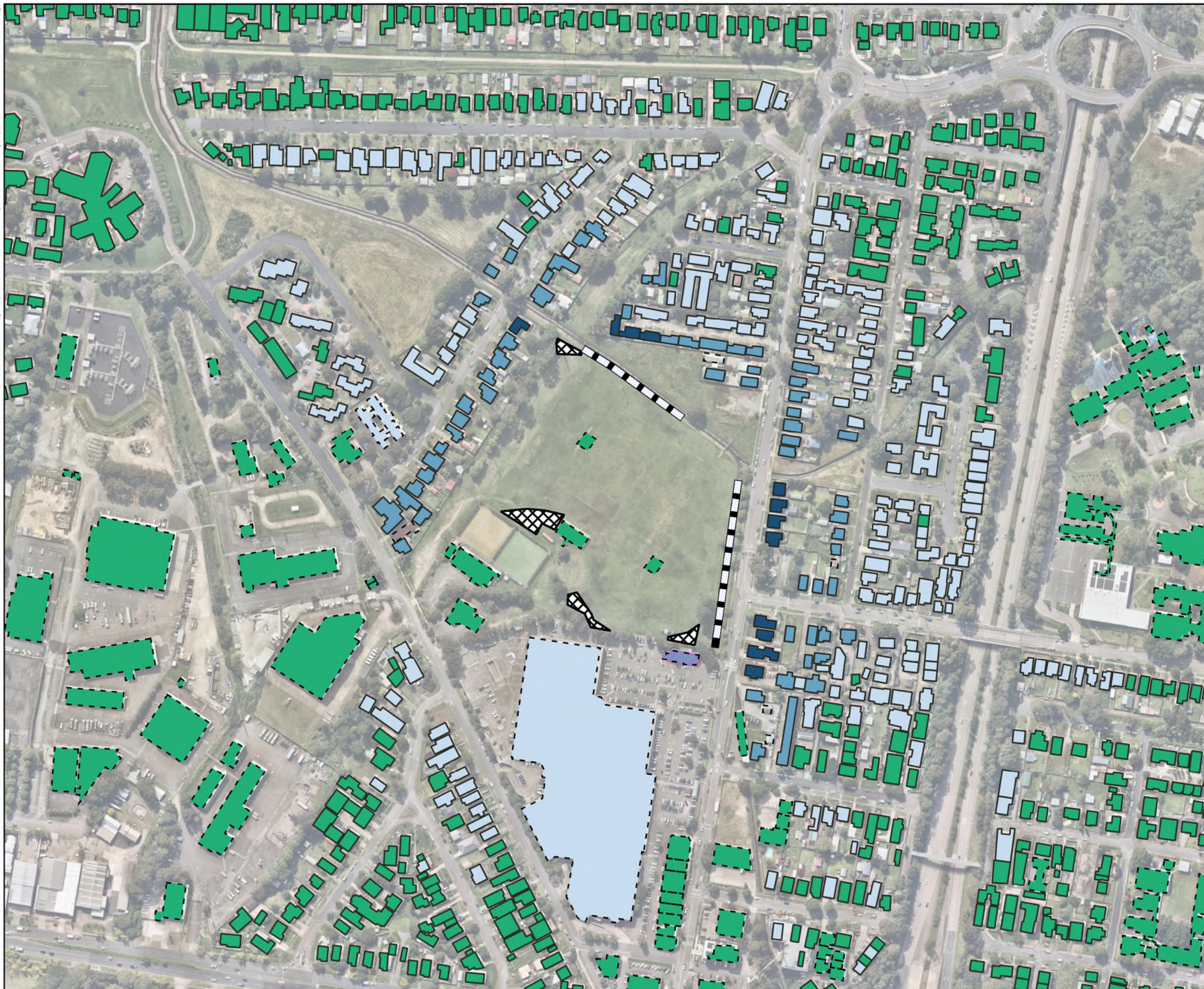
Ph (02) 8218 0500 Fax (02) 8218 0501

STORMWATER AMENITY IMPROVEMENTT PROJECT - JESMOND

Maximum predicted Noise Exceedance for Fence Installation during Standard Daytime

Sheet 8 of 9

300 m  
200  
100  
0



### LEGEND

**Noise Sensitive Receivers**

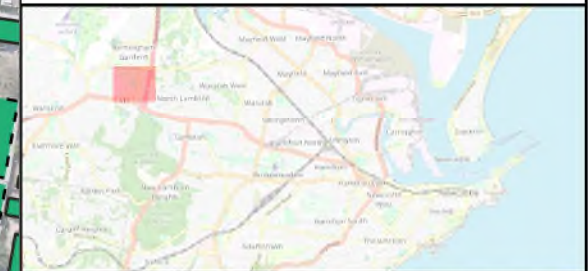
- Residential (white outline)
- Non-Residential (dashed outline)

**Work areas** (black and white hatched rectangle)

**Ancillary facilities** (black and white hatched polygon)

**Site Restoration works Noise Exceedance in dB(A)**

- Highly Noise Affected (>75 dBA) (pink hatched)
- Compliance (green)
- 0 - 10 dBA Above NML (light blue)
- 10 - 20 dBA Above NML (medium blue)
- > 20 dBA above NML (dark blue)



REV	BY	DATE	DESCRIPTION	APPROVER
r0	SS	06/07/22	Prepare figures	RP

A3 Original Co-ordinate System: MGA Zone 56

0 40 80 120 160 200 m

1:3,500 At A3

CLIENT

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STORMWATER AMENITY IMPROVEMENTT PROJECT - JESMOND

Maximum predicted Noise Exceedance for Site Restoration during Standard Daytime

## APPENDIX F Construction vibration minimum working distances

210 m  
140  
70  
0



### LEGEND

**Noise Sensitive Receivers**

- Residential (Yellow dots)
- Commercial (Purple)
- Industrial (Brown)
- Place of Worship (Brown circle with cross)
- Community centre (Orange circle with building icon)
- Childcare (Cyan circle with child icon)
- Recreational - Active (Green grid)

Work Areas (Black and white dashed line)

**MWD during Activity in Work Area**

- Cosmetic Damage to Reinforced and Unreinforced Structures (Red outline)
- Cosmetic Damage to Heritage Structures (Yellow outline)
- Residential Human Annoyance (Magenta outline)
- Office Human Annoyance (Cyan outline)



STORMWATER AMENITY IMPROVEMENT PROJECT - Jesmond

Minimum Working Distances during activity

REV	BY	DATE	DESCRIPTION	APPROVER
r0	SS	06/07/22	Prepare figures	RP

A3 Original  
 Co-ordinate System: MGA Zone 56

0 25 50 75 100 125 m

1:2,200 At A3

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

CLIENT



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