# SR39B STORMWATER AMENITY IMPROVEMENT WORKSN08 THROSBY CREEK, MAYFIELD AUGUST 2022

REVIEW OF ENVIRONMENTAL FACTORS





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Document status	Detail	Prepared by	Reviewed by	Date
V1	Draft for client	Sajana	Katie Schultz	3 June 2022
V2	review Update post review	Athukorala Sajana Athukorala	Katie Schultz	14 July 2022
V3	Draft final	Sajana Athukorala	Katie Schultz	1 August 2022
V4	Final	Sajana Athukorala	Katie Schultz	4 August 2022

#### **DISCLAIMERS**

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

# **TABLE OF CONTENTS**

tak	le of	definitions1
1	Intro	oduction2
2	Pro	oosal details3
	2.1	Proposal identification3
	2.2	Existing environment
	2.3	Proposal description5
3	Stat	utory context10
	3.1	Environmental planning instruments10
		Newcastle Local Environment Plan 2012
	3.2	Relevant legislation
		Environmental Planning & Assessment Act 1979
4	Con	sultation14
	4.1	State Environmental Planning Policy (Transport and Infrastructure) 2021 consultation 14
	4.2	T&ISEPP Consultation Letters
	4.3	Other consultation
	4.4	Department of Primary Industries
5	Env	ironmental issues identification17
	5.1	Topography, soils and geology17
	5.2	Hydrology and water quality19
	5.3	Biodiversity
	5.4	Noise and vibration
	5.5	Non-Aboriginal heritage
	5.6	Aboriginal heritage
	5.7	Traffic and access
	5.8	Visual environment
	5.9	Socioeconomic, land use and services

	5.10	Energy and air quality	33
	5.11	Waste and resource use	34
	5.12	Hazards and risks	35
	5.13	Cumulative impacts	35
6	Envi	ronmental safeguards and other requirements	36
	6.1	Mitigation measures	36
	6.2	Licensing and other requirements	42
7	Certi	fication	43
8	Refe	rences	44
Аp	pendi	x A	45
		Design drawings	45
Аp	pendi	х В	
		Clause 171(2) factors and matters of national environmental significance	
Аp	pendi	x C	
		Consultation Records	
Аp	pendi	x D	
		Database searches	
Аp	pendi	x E	
•	•	Flood Impact Assessment	
Αp	pendi	x F	
		Groundwater Dewatering Memorandum	
Δn	nendi <sup>,</sup>	x G	
<b></b> P	penan	Aboricultural Impact Assessment	
۸	n n n al!	·	
АÞ	pendi	Noise and Vibratian Impact Assessment	
		Noise and Vibration Impact Assessment	

# **TABLE OF DEFINITIONS**

Term	Definition
The Proposal	The stormwater amenity improvement works that are to be undertaken along the existing concrete-lined stormwater channel at Throsby Creek, Mayfield.  The amenity improvement works involves about 155m of stormwater amenity works including installation of weirs to create tidal pools, removal of concrete on the channel wall and installation of sandstone terraces along a 34m section of the channel, planting native plants, and installation of a mural along a fence
Proposal site	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 Mayfield area. Labelled as "Proposal site" in Figure 1 Site overview of the proposal.
Structural works	The structural works involve removal of the existing concrete stormwater channel walls, battering the sides of the stormwater channel back to a slope which facilitates sandstone terrace construction, and installation of rock revetment (riprap) on the channel sides. The works also include the installation of two weirs to create permanent tidal pools, and planting of native species within the revetment and along the top of the bank. Another structural item is the installation of mural panels onto an existing fence along the western bank.
Structural works extent	Extent of the structural works within the broader Proposal site. Labelled as "Main works area" and "Channel base works zone 1" in Figure 1 Site overview of the proposal.
Construction boundary	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.

#### 1 INTRODUCTION

Hunter Water Corporation (Hunter Water) propose to undertake amenity works along the concretelined stormwater channel at Throsby Creek, Mayfield including channel naturalisation, creating tidal pools, planting native plants, and installation of a mural along a fence (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. Throsby Creek, Mayfield 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 – Throsby Creek, Mayfield
Reference number	HW2018-1118/8/12.002
Proposal location	The proposal would be located within Throsby Creek. This section of Throsby Creek is located within Litchfield Park.  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 Mayfield within the Newcastle LGA, managed by the City of Newcastle (Council). The Proposal site is located within a recreational park, Litchfield Park, in Mayfield.

The Proposal site is characterised by a flat, grassed parkland with a concrete-lined stormwater channel running south through the Proposal site. The eastern extent of the Proposal site consists of industrial and commercial lots whereas the western extent is lined with residential developments. A major freight rail corridor exists directly south of the Proposal site.

No native vegetation communities are mapped within the Proposal site. Existing vegetation consists of both dispersed mature non-native and native trees. Throsby Creek is not considered a key fish habitat and does not contain any mapped distributions of threatened aquatic species. Overall salinity hazard is predominantly low for the majority of the Proposal site. The soil landscape the Proposal site lies within is considered a wind erosion hazard and water pollution hazard. No listed non-Aboriginal heritage items have been identified within close proximity of the Proposal site. No Aboriginal sites or places have been recorded in or near the Proposal site.



Figure 1 Site overview of the proposal

## 2.3 Proposal description

The Proposal would involve about 155m of amenity works along the Throsby Creek stormwater channel. The proposal would include replacing about 34 metres of concrete from the eastern bank of the channel with a constructed habitat zone consisting of sandstone terraces and native plantings.

The naturalisation works involves the following:

- removing the existing concrete stormwater channel wall
- battering the sides back to a slope which facilitates sandstone terrace construction
- installing rock revetment (rip-rap) and sandstone blocks on the channel sides
- installing two weirs to create permanent tidal pools
- planting native species within the revetment and along the top of the bank

Additionally, a mural would be created along 155m of the western bank. The mural will be painted directly onto the existing fence (channel side owned by Hunter Water).

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.

Construction works would include:

Construction activity	Description
Site establishment	<ul> <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>
Environmental controls	<ul> <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>
Investigations	pre-construction asset inspections.
Materials delivery	deliver fill materials to laydown areas
Structural works – Stage 1 (removing concrete channel)	<ul> <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 recently planted trees, turf and topsoil within Proposal site and move to stockpile</li> </ul>

Description of works

Construction methodology

	<ul> <li>following an arborist assessment, excavator to remove juvenile trees within works extent</li> <li>sawcut channel wall and undertake works along eastern bank within the Proposal site</li> <li>Excavate channel wall below base of channel (refer concept design in Appendix A) 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> </ul>
Dewatering	dewater groundwater or surface water within excavations using portable pumps as required and appropriate disposal
Waste disposal	<ul> <li>dispose of construction waste including spoil to a licensed waste facility</li> </ul>
Structural works – Stage 2 (asset protection/restoration, transition wall works)	<ul> <li>construct transition retaining walls         (sandstone logs) grouted to existing bank         wall</li> <li>sandstone logs to be grouted to the         concrete at the interface with the concrete         channel base</li> <li>construct cast in-situ concrete weirs in         channel including scabbling of concrete         and tie-in to existing channel base i.e.         install starter bars using hammer or core         drill</li> </ul>
Structural works – Stage 3 (bank protection works)	<ul> <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> </ul>
Mural installation (155m length)	construct fence along western bank offset from property fence line (breaks to be provided for rear access from properties). This includes excavating footing holes by hand, concrete pouring and fence installation
Site restoration	<ul> <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:

o fencing

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

Construction compounds

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	The following indicative plant and equipment would be required:	
Land tenure	The stormwater channel is located within an easement through a single land parcel owned by Council i.e. Litchfield 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).	
Commencement and expected duration of construction work	The proposed works are expected to commence in late 2022 and be completed by mid-2024.  Once operational, the construction contractor would inspect and maintain the works for 2 years following completion of construction (as part of the defects liability period).	
Hours of construction work	Working hours would be standard construction hours: <ul> <li>Monday to Friday – 7am to 6pm</li> <li>Saturday 8am to 1pm</li> <li>No work on Sundays or public holidays.</li> </ul> <li>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.</li> <li>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.</li>	
Proposal need	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.

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.

Hunter Water has investigated how they can help deliver on the region's vision. Our Hunter Water's stakeholders and customers have indicated a 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.

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.

Proposal objectives

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:

- o protect public safety
- o minimise negative community impacts
- o increase contribution to liveability outcomes for the community

Due to the modified nature of Throsby Creek in Mayfield, given its concrete channel walls, the Proposal site is appropriate for amenity improvement works. These works would provide residents and users of the park extended views of a more naturalised waterway and an attractive mural attached to a fence, created by local artists. This is aligned with stakeholder preferences for naturalisation of Hunter Water's concrete stormwater open channels.

One structural option as well as the 'do nothing' option were considered for the proposal:

- Options considered and justification
- o do nothing does not improve visual amenity
- option 1 replaces a section of concrete channel wall with sandstone terraces, includes weirs to create tidal pools in the channel, and a mural to create visual interest along the stormwater channel (the Proposal). This option provides the best visual impact.

Option 1 was selected as the preferred option maximise the improvements in visual impact. Option 1 to improve stormwater amenity through creek naturalisation and mural installation works at Throsby Creek, Mayfield best fulfills the Proposal's objectives.

#### 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 sites. 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 the 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 Throsby Creek which sits within the Proposal site is not mapped as key fish habitat. No marine vegetation exists within the waterway therefore, a section 205 permit under Part 7 of the FM Act is not 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 construction and operation is discussed in Section 5.3. As the Proposal site is not key fish habitat, and further is a concrete-lined channel, a Section 219 permit to obstruct fish passage under Part 7 of the FM Act is not required.

#### 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 of the relevant heritage items within 500m of the Proposal site provided in Appendix D.

# **Environment Projection 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, disruption 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?	
(Note: local heritage item means —	
(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	No
(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.)	
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: https://www.planning.nsw.gov.au/policy-and-legislation/coastal-management. Note the coastal vulnerability area has not yet been mapped.	No
Note: a certified coastal zone management plan is taken to be a certified coastal management program	

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

Yes

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	Yes/No
2.15 and 2.16 of T&ISEPP?	
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?	No
Note: The dark sky region is land within 200 kilometres of the Siding Spring Observatory.	
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?	No
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 Lockhart Local Environmental Plan 2012, Narrandera Local Environmental Plan 2013 and Urana Local Environmental Plan 2011.	
Is the proposal on land in a mine subsidence district within the meaning of the Coal Mine Subsidence Compensation Act 2017?	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?	No
Note: bush fire prone land means land recorded for the time being as bush fire prone land on a map certified under the Act, section 10.3(2).  Planning for Bush Fire Protection means the document entitled Planning for Bush Fire Protection, 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.	

# 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, Council have recommended the following:

- Consideration of the Crime Prevention Through Environmental Design (CPTED) impact of any erected or screened structure.
- A flood impact assessment to be prepared showing negligible impacts across the private properties adjoining Litchfield 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 Throsby Creek in Mayfield was the site preference prior to design development.

Consultation with Cricket NSW was additionally carried out to ensure that impacts to Litchfield park users are minimised during construction activities.

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	The Proposal would require excavation and ground disturbing works. As listed in Section 0, excavation works will include:  oremoving turf and topsoil along channel osaw cutting channel walls removing four juvenile gum trees within the structural works footprint and two newly planted trees within the construction access route oexcavating to required depth to facilitate placement of fill and rock revetment (rip-rap) (refer typical sections in concept design in Appendix A)  Mitigation measures listed in Section 6.1 will minimised potential erosion and sediment impacts.	N/A
Would the work require plant/vehicular movements on unsealed areas?	Yes	Access to the Proposal site would be via existing sealed roads (Myola Street and Moolcha Street) as shown in  Figure 1. Plant and vehicles would have to track into the Proposal site and creek channel across the park using temporary access tracks through Litchfield Park around existing cricket field boundaries.	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 the Hamilton soil landscape (Department of Planning, Industry and Environment, 2020). The Hamilton landscape soils are a wind erosion hazard and water pollution hazard.	eSPADE –25 April 2022

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		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.  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.	
Could the work impact on or have the potential to impact on Acid Sulphate Soils (ASS)?	No	The Proposal site is located within an ASS risk area and is mapped as 'L4' having a low probability of ASS >3m below ground surface (Naylor, Guidelines for the Use of Acid Sulfate Soil Risk Maps, 2nd ed., 1998). The Proposal is unlikely to impact on ASS given that the scope of works does not involve excavations >3m below ground surface. In the unlikely event that ASS is discovered, mitigation measures listed in Section 6.1 will appropriately address the risks.	Naylor, Guidelines for the Use of Acid Sulfate Soil Risk Maps, 2nd ed., 1998
Could the work impact on areas of known salinity risk?	No	The Proposal site is mapped as having a low overall salinity hazard, and mapped as low hazard due to land salinity, salt export and instream electrical conductivity (Department of Planning, Industry and Environment, 2020). One soil profile, approximately 480m south and one soil profile approximately 700m north of the Proposal site both indicate no salting evident.  Given that the extent of the structural works footprint occurs over an area with a low overall salinity hazard, impacts are not expected.	eSPADE 25 April 2022 Department of Planning, Industry and Environment, 2020
Could the work result in disturbance of contaminated land?	No	A search of the NSW Environment Protection Authority (EPA) contaminated land record of notices for the suburb of Mayfield returned no known contaminated sites in the vicinity of the Proposal site.  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 lead	NSW EPA contaminated land record of notices and list of notified NSW contaminated sites (as of 25 May 2022) Preliminary waste classification (Aurecon, 2021b) Geotechnical report (Aurecon, 2022)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		concentrations above General Solid Waste criteria for one sample. Further Toxicity Characteristic Leaching Procedure (TCLP) leachate testing was conducted which returned a reading of <10 μg/L. This TCLP lead analysis confirm the tested fill material to be below the SCC1/TCLP1 threshold criteria and can be assigned a 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.	

# 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	The Proposal would directly impact a small section of Throsby Creek by replacing the existing concrete channel wall with sandstone and plantings. The works also include the installation of two weirs to create permanent tidal pools. During construction, there is a potential for exposed soils to be eroded during storm events potentially resulting in water quality impacts to Throsby Creek associated with sedimentation downstream.  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	Water Management (General) Regulation 2018 Controlled activity approval exemptions Fact Sheet, (Department of Planning, Industry and Environment 2021)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		Section 6.1. The works would also be staged and completed in sections to minimise these risks during construction.	
		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 Throsby Creek as a result of works within waterfront land are outlined in Section 6.1.	
Is the work located on flood prone land? Could the work result in impacts to	Yes	The Proposal is located within a small extent of flood prone land in the Throsby Creek floodplain.	Flood impact assessment (Appendix E)
flooding regimes and flows?		A flood impact assessment was undertaken (refer	
Could the work be impacted by flooding?		APPENDIX E), where the bank-full flow (the approximate flow that results in the concrete channel flowing at full capacity), 10% Annual Exceedance Probability (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.	
		The flood impact assessment of the modelled works indicates there is potential for some minor localised changes in the 1% AEP and PMF flood levels at the transitions of the structural works and immediately upstream of the weirs. There are no adverse impacts to private properties and only a minor impact (<20mm) adjacent the pedestrian bridge on Moolcha Street in the 1% AEP event. There are no adverse impacts in the PMF event.	
		During the 10% AEP event, flood afflux mapping shows localised impacts within the channel for the extent of the proposed structural works. This impact extends up to the lot boundaries from the corner of 31 Moolcha Street to 35 Moolcha Street. A 12mm impact encroaches into the 33 Moolcha Street boundary over a very small area (0.5 m <sup>2</sup> in	

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		extent), and the impact reaches a 25mm increase in flood depth adjacent the lot boundaries.  It should be noted that the 1% AEP flood level (existing and proposed) sits below the finished floor levels of these properties between 31 to 35	
		Moolcha Street. A comparison has been made between flood levels and floor levels provided by NCC. As such, any possible impact within the property boundaries that may result from flows between the 10% and 1% AEP events will not result in worsening of flooding causing above floor flooding on any lots in the vicinity of the works.	
		Comparisons of flow hydrographs for existing case and the Proposal were run which indicate that while there does appear to be minor local flood impacts over the site works, the flow behaviour between existing and proposed scenarios are effectively the same, and flood plain storage remains effectively unchanged.	
		The model velocity results were used to confirm scour protection measures, such that no damage is likely to occur to works during flood events once all works are complete and stabilisation planting has been established.	
Would the work be likely to encounter groundwater or require discharge of accumulated water?	Yes	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.	Groundwater dewatering memorandum (Appendix F)
		The required drawdown, based on the measured groundwater level (1.3m BGL) and the maximum depth of excavation works (2.0m BGL) is approximately 0.7m. Using a conservative approach and accounting for potential variability, 1.2m has been adopted as the required drawdown value. It was estimated that a total of 0.23 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.	
		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	

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		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 Throsby 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.	
		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.	
		Any dewatering requires a Water Supply Works (WSW) approval. The groundwater assessment estimated that around 0.23 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.	
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	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).	Arboricultural impact assessment (Appendix G)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		The Proposal would require the removal of four juvenile low-retention value gum trees within the structural works footprint. These trees are newly planted Eucalyptus species and are indicated as Trees 6 to 9 on the Tree Management Plan within Appendix G. Additionally, two newly planted trees assessed as having a high risk of death or failure are within the required construction access and would be removed to facilitate works. These are indicated as Trees 13 and 14 in Appendix G. The arborist has noted that retention of significant boundary tree cover (Eucalyptus species) will ensure there is little impact on the wider setting.  Appropriate mitigation measures identified by the arborist to mitigate and minimise impacts to vegetation will be listed and addressed in Section 6.1.	
Would the work occur within the Tree Protection Zone of any trees? (Defined as: 12 x diameter of the trunk at 1.4m high)	Yes	The Proposal would require works or access within tree protection zones (refer to the Tree Management Plan within Appendix A). The arborist has assessed the requirements for access and works within the TPZ, 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 little 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 other existing tree protection zones within the Proposal site as indicated in Figure 1.	Arboricultural impact assessment (Appendix G)
Could the work impact directly or indirectly on <i>Biodiversity Conservation Act 2016 or 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?	No	The NSW BioNet Atlas was reviewed in June 2022 for species listed under the BC Act that have the potential to occur within 100km² of the Proposal site.  The NSW BioNet Atlas identified no records within the Proposal site, however, the search returned records of Category 2 species within 10km of the Proposal site. Category 2 species are considered to be at serious risk of threats such as disturbance or exploitation. Given the significant distance between the Proposal site and the threatened species record, no impacts are expected.	NSW BioNet Atlas search 30 June 2022

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		Given that the Proposal would only require removal of six juvenile recently planted trees, no impacts to any BC Act or FM Act listed species or threatened ecological communities would be expected.  The mitigation measures in the AIA have been included in Section 6.1 would be implemented to minimise any adverse biodiversity impacts.	
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 62 threatened species, 46 migratory species and four listed threatened ecological communities within one kilometre of the proposal. The recorded threatened fauna species include 32 birds, two fish, two frogs, seven mammals, five reptiles, one shark species and 13 plant species. Within the Proposal site, there are no matters of national environmental significance or other matters protected by the EPBC Act.	Protected Matters database 30 June 2022
		No EPBC Act listed threatened species, ecological communities and migratory species would be impacted as a result of the Proposal.	
Could the work impact (directly or indirectly) on areas mapped in the Resilience and Hazards SEPP, littoral rainforests, marine parks, national parks estate, biodiversity stewardship sites or wilderness areas?	No	Under the Resilience and Hazards SEPP, the following mapped areas of littoral rainforests, marine parks, national parks estate, biodiversity stewardship site or wilderness area are near the Proposal.  However, the Proposal site sits within areas mapped as 'Coastal Use Area' and 'Coastal Environment Area' under the Resilience and Hazards SEPP. Given the minor nature of works proposed, the Proposal is not likely to cause an adverse impact within the coastal use area nor the coastal environmental area on the following:	SEPP Coastal Management 2018 ePlanning spatial viewer in September 2021 (Updated 30 June 2022)
		<ul> <li>existing public open space and safe access to and along the foreshore, beach, headland or rock platform</li> <li>overshadowing, wind funnelling and the loss of views from public places to foreshores</li> <li>the visual amenity and scenic qualities of the coast</li> <li>Aboriginal cultural heritage, practices and places</li> <li>cultural and built environment heritage</li> <li>the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment</li> <li>coastal environmental values and natural coastal processes</li> <li>the water quality of the marine estate (within the meaning of the <i>Marine Estate Management Act 2014</i>)</li> </ul>	

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		<ul> <li>marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms</li> <li>the use of the surf zone</li> <li>The mitigation measures detailed in Section 6.1 would be implemented to ensure any potential adverse impacts are avoided as a result of the Proposal.</li> </ul>	
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 Throsby Creek is not mapped as Key Fish Habitat (KFH) for its fullest extent within the Proposal site, however KFH is mapped approximately 460m downstream of the site.	Fisheries NSW Spatial Data Portal in September 2021
		The proposed weirs are set at an elevation such that the tide will inundate the weir during the majority of high tides. Baseflow within the channel (likely to be permanent as a result of groundwater seepage due to low lying catchment) will also replenish water levels within low tides. As such fish are likely to be able to swim over the weir. A maintenance release pipe will also be installed in case any issues are identified. The pipe (150mm diameter) is sufficient to allow the species of fish which would reside this far up the stormwater channel to swim through it. Therefore it is considered that fish passage would not be impacted by the proposal.	
Would the work have potential to displace fauna or create a barrier to fauna movements?	No	The Proposal requires removal of six juvenile planted trees and the installation of two weirs in the stormwater channel to create permanent tidal pools. However, this is unlikely to displace fauna or create a barrier to fauna movements. The juvenile trees did not previously provide	N/A

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		habitat to fauna and the installation of weirs is not expected to impact stormwater channel flow significantly enough to impact aquatic fauna movements.	

# 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	A noise and vibration impact assessment (NVIA) was undertaken by Renzo Tonin in April 2022 (Appendix G) to assess the potential noise and vibration impacts of the Proposal on the surrounding environment and sensitive receivers.	NVIA (Appendix H)
		A desktop land use survey was carried out to identify sensitive receivers in the vicinity of the Proposal. Neary sensitive receivers included residential lots, an educational facility, commercial facilities and active recreation areas. These receivers are further detailed in Appendix H.	
Could the proposal result in construction noise impacts for longer than three weeks, or outside of standard working hours? Was a quantitative noise assessment undertaken?	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 around the proposed works. A summary of the unattended noise monitoring results are included in Appendix H.	NVIA (Appendix H)
		Given the Proposal will result in construction for a significant duration longer than three weeks, a quantitative assessment has been carried out. No construction works are proposed outside of standard working hours.	
Could the proposal result in noise impacts on receivers during construction?	Yes	During standard construction hours, residential receivers located near the Proposal site are likely to be affected by works. Nearby residences are likely to experience highly intrusive levels of noise – greater than 20 dB(A) above the Noise Management Level during most activities. These residences are located along Moolcha Street to the south of the Proposal site, Myola Street to the north-west and Maitland Road to the north-east.	NVIA (Appendix H)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		Noise impacts would be greatest during usage of high noise generating plant and equipment, such as concrete saws and rock breakers, within stage 1 of the structural works. During this period, 3 residences along Moolcha Street are predicted to be highly noise affected (i.e. > 75 dB(A)).	
		Where typical works are occurring without the use of high noise generating plant and equipment, receivers are not predicted to be highly noise affected.	
		Up to 29 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. The most impacted receivers are the commercial receivers on Maitland Road to the north of the works. Noise levels are predicted to exceed the NMLs at several buildings at the Tafe NSW Newcastle campus during periods where high noise generating plant and equipment is in use. However, in general, construction noise is predicted to comply with the NMLs.	
		For typical construction works, receivers beyond approximately 30m are not predicted to be highly noise affected.	
		Construction related traffic noise via Myola Street, a local road, is predicted to comply with the road traffic noise goals given the rate of traffic volume (three heavy vehicles per hour). There may be minor exceedances where four or more movements per hour are required during peak periods.  Mitigation measures have been provided in the NVIA (Appendix H) to	
		ensure impacts are minimised as far as practicable.	ND (10 / A
Could the proposal result in noise impacts on receivers during operation?		Operation of 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	NVIA (Appendix H)
Could the proposal result in vibration impacts on nearby properties or infrastructure?		During the stage 1 structural works, which uses an excavator with a hydraulic hammer attachment, the nearest structures on Moolcha Street are approximately 15-20m from the works. These structures are further away than the minimum working distance for cosmetic damage and will therefore not be impacted.	NVIA (Appendix H)

Risk identification Yes/No	Description of potential impact	Source and date (if relevant)
	There are no residences within the minimum working distances for human comfort from vibration.	
	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.	

# 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	The search of the heritage registers identified no heritage items within the Proposal site and seven heritage items within 500m of the Proposal site (mapped in Appendix D):  Dangar Park, Heritage Item ID 2171288, located approximately 90m north east of the site at 21A Maitland Road, Mayfield and is of local heritage significance under the Newcastle LEP.  Date Palms, Heritage Item ID 2171122, located approximately 90m north east of the site at 21A Maitland Road, Mayfield and is of local heritage significance under the Newcastle LEP.  Tighes Hill TAFE College, Heritage Item ID 2170905, located approximately 70m south of the site at 266 Maitland Road, Tighes Hill and is of local heritage significance under the Newcastle LEP.  Royal Oak Hotel, Heritage Item ID 2170844, located approximately 245m south east of the site at 207 Maitland Road, Tighes Hill and is of local heritage significance under the Newcastle LEP.  Islington Park, located approximately 340m south east of the site at Maitland Road, Tighes Hill and is of local	NSW Heritage database (inventory) Newcastle Local Environmental Plan 2012
		heritage significance under the Newcastle LEP.  Styx Creek Bridge, Heritage Item ID 2176146, located approximately 400m south of the site at Maitland Road,	

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		Tighes Hill and is of local heritage significance under the Newcastle LEP.  Immaculate Heart of Mary Church, Heritage Item ID 2171403, located approximately 480m south east of the site at 16 Tighes Terrace, Tighes Hill and is of local heritage significance under the Newcastle LEP.  These heritage items are all located over 50m from the Proposal site and are therefore not likely to be directly or indirectly impacted by the proposal, including from ground-borne vibration. Mitigation measures listed in Section 6.1 will mitigate and minimise any potential impacts to the listed heritage items.	
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:  o 0 aboriginal sites are recorded in or near the Proposal site o 0 aboriginal places have been declared in or near the Proposal site	AHIMS searched on 1 September 2021

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
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	No known Aboriginal heritage sites have been identified within the site or within one kilometre of the site. Construction involving ground disturbances is limited to the extent of the structural works footprint. 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.	N/A

# 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?	Yes	The Proposal is located adjacent to Myola Street which is a public road. 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
		Access for construction plant and vehicles to the Proposal site would be through Myola Street. Access for construction of the mural will be through Moolcha Street and is to be accessed by foot only.	
		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. However, given the narrow (single lane) width of Myola Street, there is potential for impacts or disruptions to local traffic as a result of the Proposal works.	
		A Traffic and Pedestrian Management Plan would be prepared by the contractor to manage construction traffic.	

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
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 to manage construction traffic.	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	The Proposal would be visible from residences and road users close to the vicinity of the Proposal site on Moolcha Street and Myola Street during construction.	N/A
		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.	
		The works would also be visible to people undertaking recreational and sporting activities in the park area. However, these receivers are transient and impacts would be considered minor and temporary.	
Would the proposal result in permanent changes to the visual environment through installation of any above ground infrastructure or removal of vegetation?	Yes	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.	N/A

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
Would the work be located in an area of high scenic value?	No	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.	N/A
Would the work require additional lighting during construction or operation?	No	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.  There is no lighting included in the Proposal and so there would be no new lighting during operation.	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?	Yes	The Proposal has potential to impact access to private property along the narrow lane section of Myola Street during vehicular movements in the construction phase. The Proposal site is located within Litchfield Park and would be accessed by residential streets. Access around the Proposal site would be maintained to the greatest extent possible.  A Traffic and Pedestrian Management Plan would be prepared by the contractor to manage construction traffic and reduce impacts to nearby private properties as far as practicable.	N/A
Could the work impact busy commercial areas or local businesses?	Yes	Given the close proximity of local businesses along Myola Street, there is potential for indirect noise and vibration, and traffic impacts as a result of the Proposal.  Mitigation measures listed in Section 6.1 will ensure any indirect impacts are minimised or avoided as best as possible.	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	N/A

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		of the naturalised channel is considered to somewhat compensate for the reduced land area.	
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-term potential for air quality impacts once the disturbed areas are stabilised.	N/A
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 that the Proposal would generate around 324m³ 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, runoff would not be expected, but if excess water is generated it would be captured and removed from site for appropriate disposal.  Excavation works are likely to encounter groundwater, and therefore the Proposal is expected to generate some wastewater. Water treatment options may enable the water to not be classified as 'wastewater'.  Disposal options for extracted groundwater include discharge to Throsby Creek or the stormwater system, discharge to sewer or offsite disposal at a licensed wastewater facility.	Appendix F
Would the work result in asbestos, contaminated soils or other hazardous waste?	Yes	No asbestos or other hazardous waste is expected to be generated from this Proposal. However, given that the Proposal is in an ASS risk area there is a low possibility of discovering ASS >3m below ground level. Due to the elevated risk of encountering ASS during excavation works, mitigation measures listed in Section 6.1 will be applied to appropriately manage the risks.  As identified in Section 5.1, whilst elevated lead concentrations were observed in one of the boreholes within the Proposal site, further testing provided a preliminary waste classification of General Solid Waste (non-putrescible) 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	Preliminary waste classification (Aurecon, 2021b)

Risk identification	Yes/No	Description of potential impact	Source and date (if relevant)
		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)
Could impacts from other projects interact with the proposal?	No	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 Ackeron Street and Barenya Street) are not anticipated.	City of Newcastle Development Application Tracker – 27 May 2022

### 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	A Construction Environmental Management Plan (CEMP) will be prepared prior to commencement of work and will address the following:  Any requirements associated with statutory approvals  Details of how the project will implement the identified safeguards outlined in the REF  Issue-specific environmental management plans  Roles and responsibilities  Communication requirements  Induction and training requirements  Procedures for monitoring and evaluating environmental performance, and for corrective action  Reporting requirements and record-keeping  Procedures for emergency, incident and hazard management  Procedures for audit and review.
	G2	The endorsed CEMP will be implemented during the undertaking of the activity.  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 seven 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.
	<b>S</b> 2	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:  • be installed prior to disturbance commencing

Aspect	Ref no.	Mitigation measure
		<ul> <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.
	HWQ5	A Flow Management Plan will set out the construction approach for working in the Throsby 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 will be tested to demonstrate whether it is suitable for release to the environment (either to Throsby 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.
	HWQ6	A Dewatering Management Plan will be incorporated into the Contractor's CEMP to document requirements for dewatering during the project.
Biodiversity	В1	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.
	В3	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.
	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
	В9	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	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:  • a description of the works and why they are being undertaken  • details of the works that will be noisy  • work hours and expected duration  • what is being done to minimise the impacts (e.g. respite periods)  • 24 hour contact number.
	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	<ul> <li>Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided.</li> <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> <li>Noise-emitting plant to be directed away from sensitive receivers.</li> </ul>
	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

Aspect	Ref no.	Mitigation measure
	NV6	<ul> <li>Minimise disturbance arising from stockpiling, laydown and deliveries:</li> <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> <li>Consider locating site sheds to shield nearby residences from airborne noise</li> </ul>
	NV7	Personnel will be inducted and trained in noise control measures to reduce impacts on receivers during inductions and toolbox talks.
	NV8	A register of most affected noise and vibration sensitive receivers (NVSR) would be kept on site. The register would include the following details for each NVSR:  Address of receiver  Category of receiver (e.g. Residential, Commercial etc.)  Contact name and phone number.
	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 Hunter Water Archaeologist would advise the Heritage Office and the relevant Aboriginal parties so that appropriate management strategies can be identified.

Aspect	Ref no.	Mitigation measure
	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.
	TA4	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> <li>Apply water (or alternate measures) to exposed surfaces that are generating dust</li> </ul>
		<ul> <li>Appropriately cover loads on trucks transporting material to and from the construction site</li> </ul>
		<ul> <li>Securely fix tailgates of road transport trucks prior to loading and immediately after unloading</li> <li>Avoid dust generating works during strong winds</li> </ul>
		Prevent where possible, or remove, mud and dirt being tracked onto sealed road surfaces.

Aspect	Ref no.	Mitigation measure
Waste and Resource Use	WR1	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 & Resource Recovery Act 2001):
		<ul> <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> </ul>
		disposal is undertaken as a last resort.
	WR2	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.
	WR3	Segregate and label waste to improve recycling opportunities, avoid cross contamination and reduce disposal costs.
	WR4	All temporary erosion and sediment control devices will be removed from the site at the completion of the works of when the site(s) are restored/stabilised.
Hazard and Risk	HR1	Emergency contacts will be kept in an easily accessible location. All workers will be advised of these contact details and procedures.

# 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

Sajana

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: Reviewed by:

Sajana Athukorala Katie Schultz

Consultant Manager

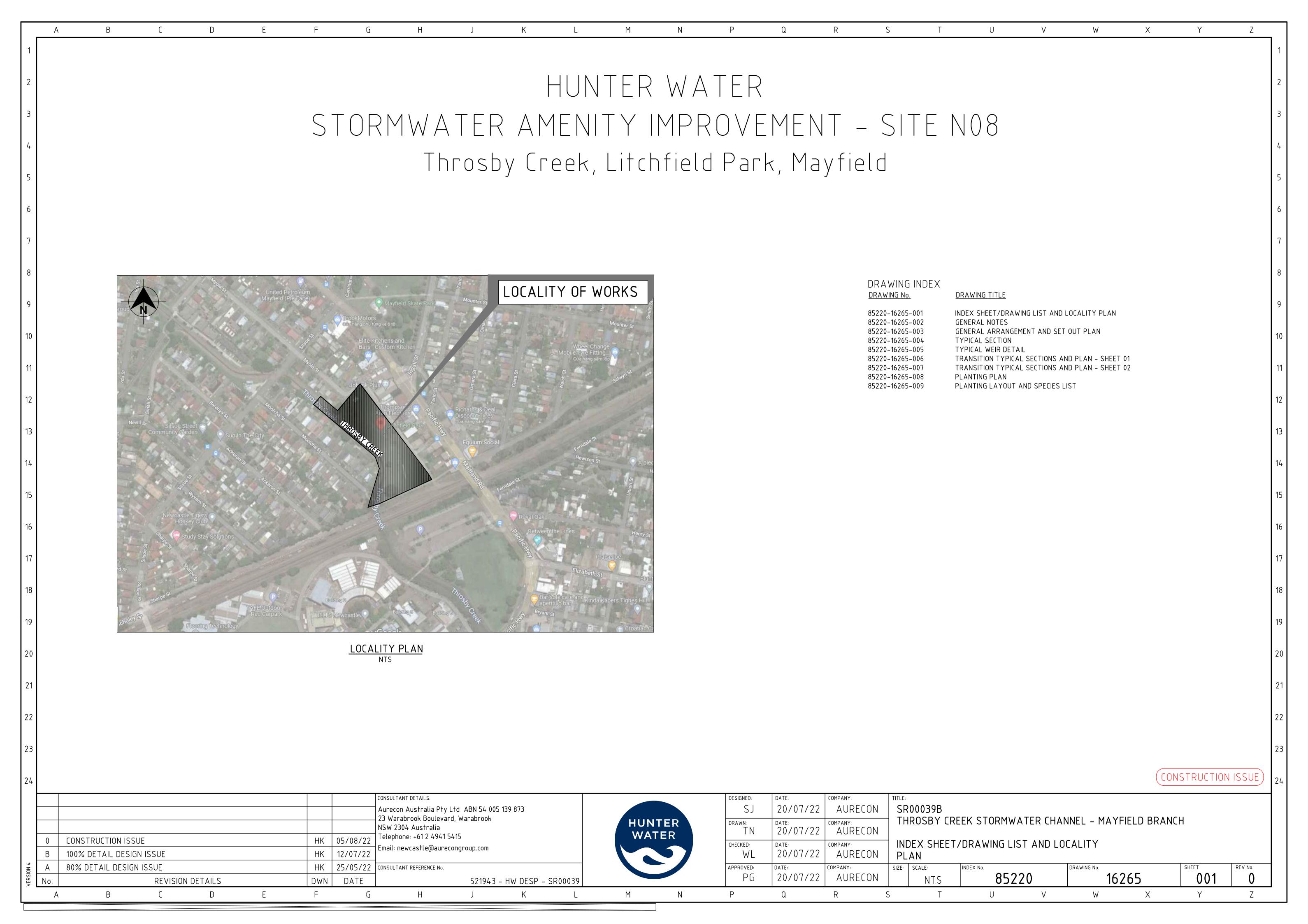
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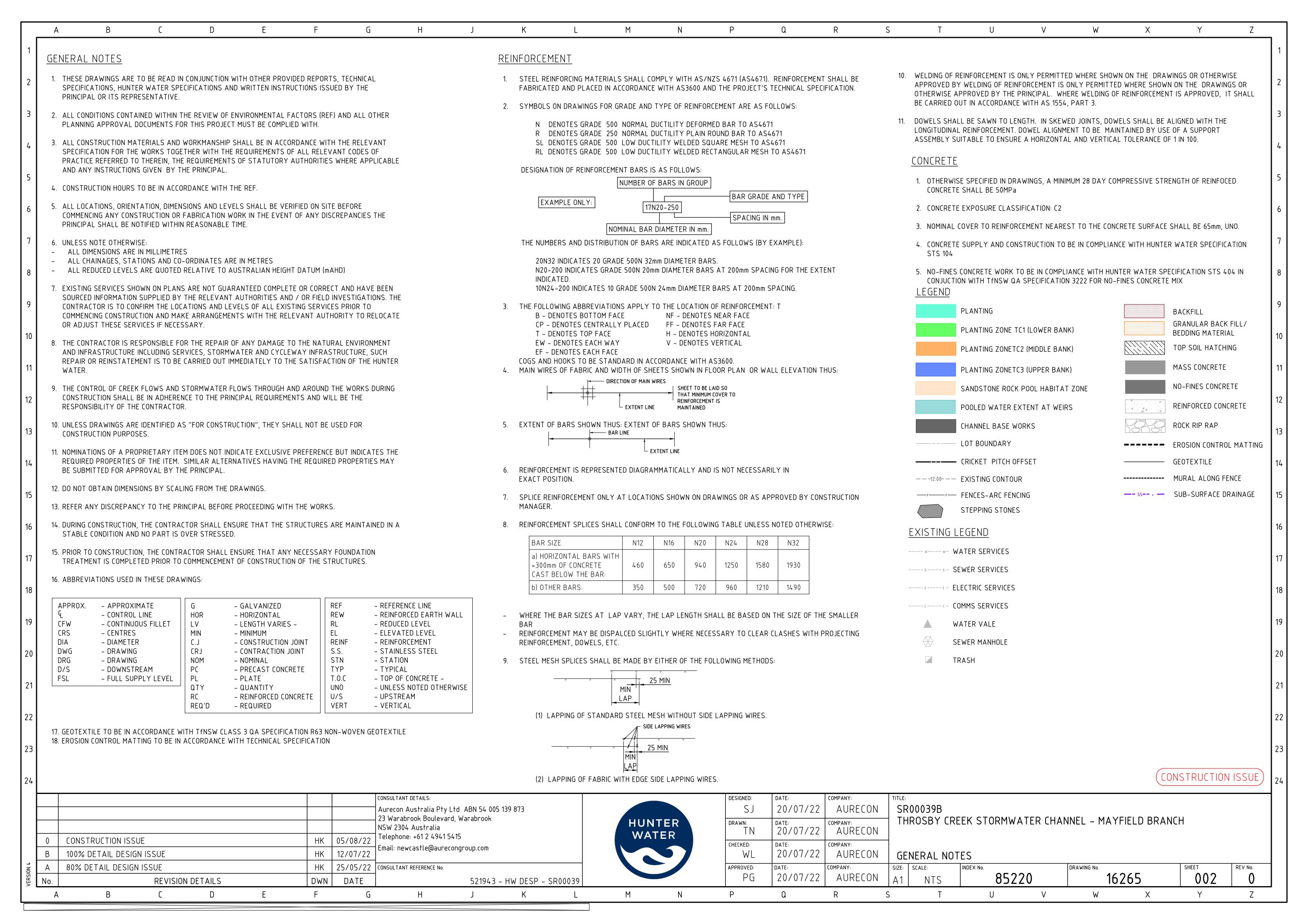
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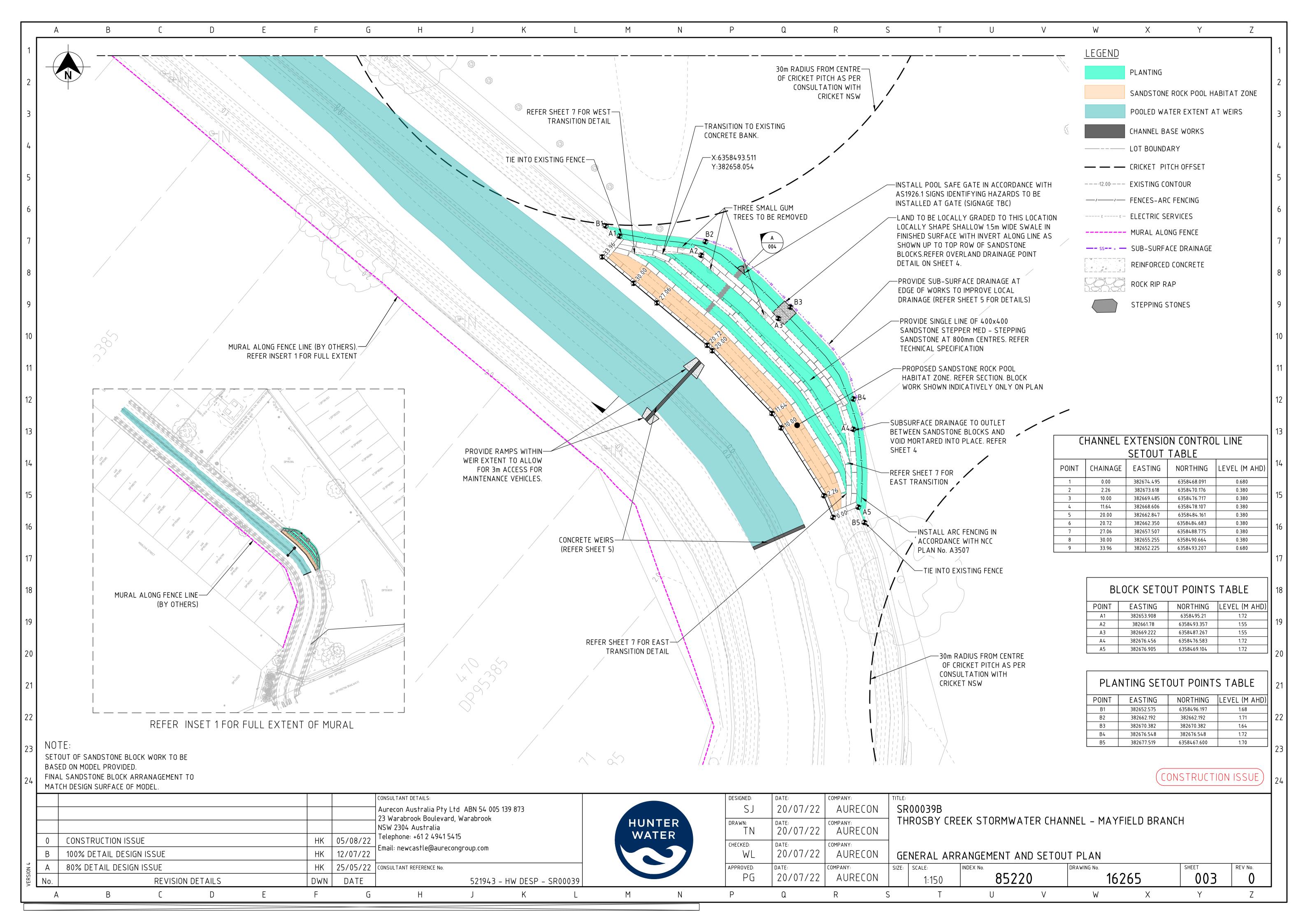
# **APPENDIX A**

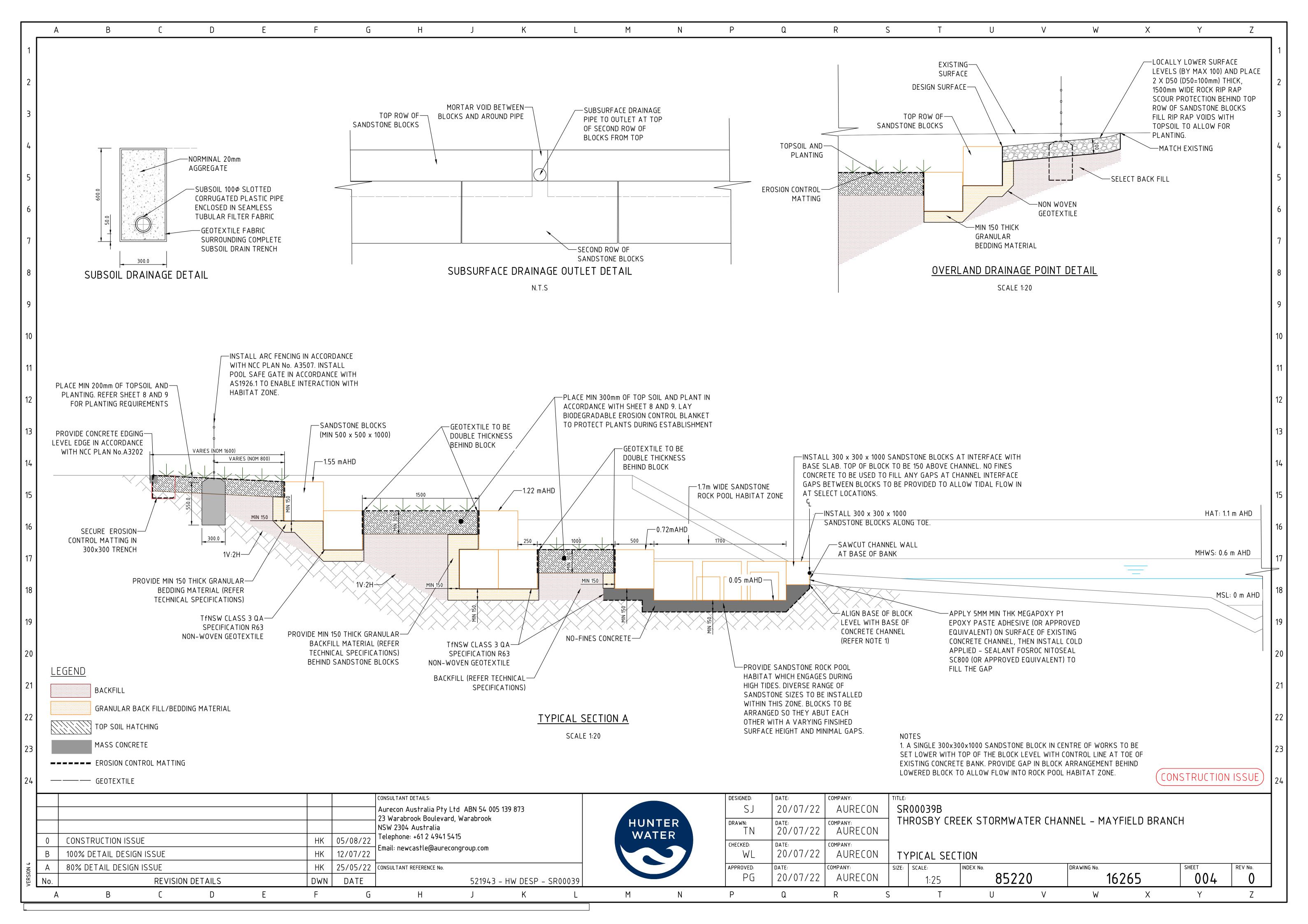
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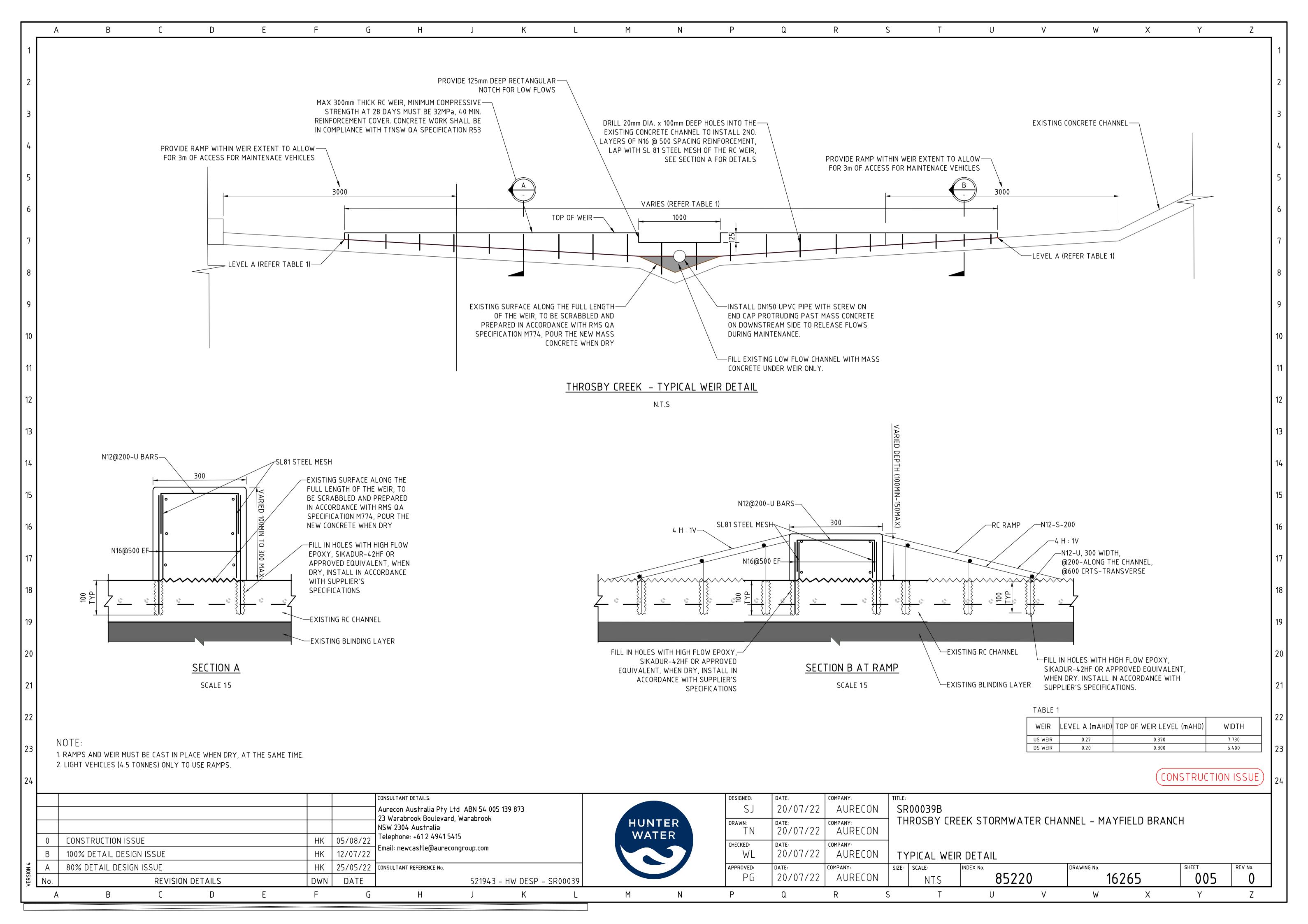
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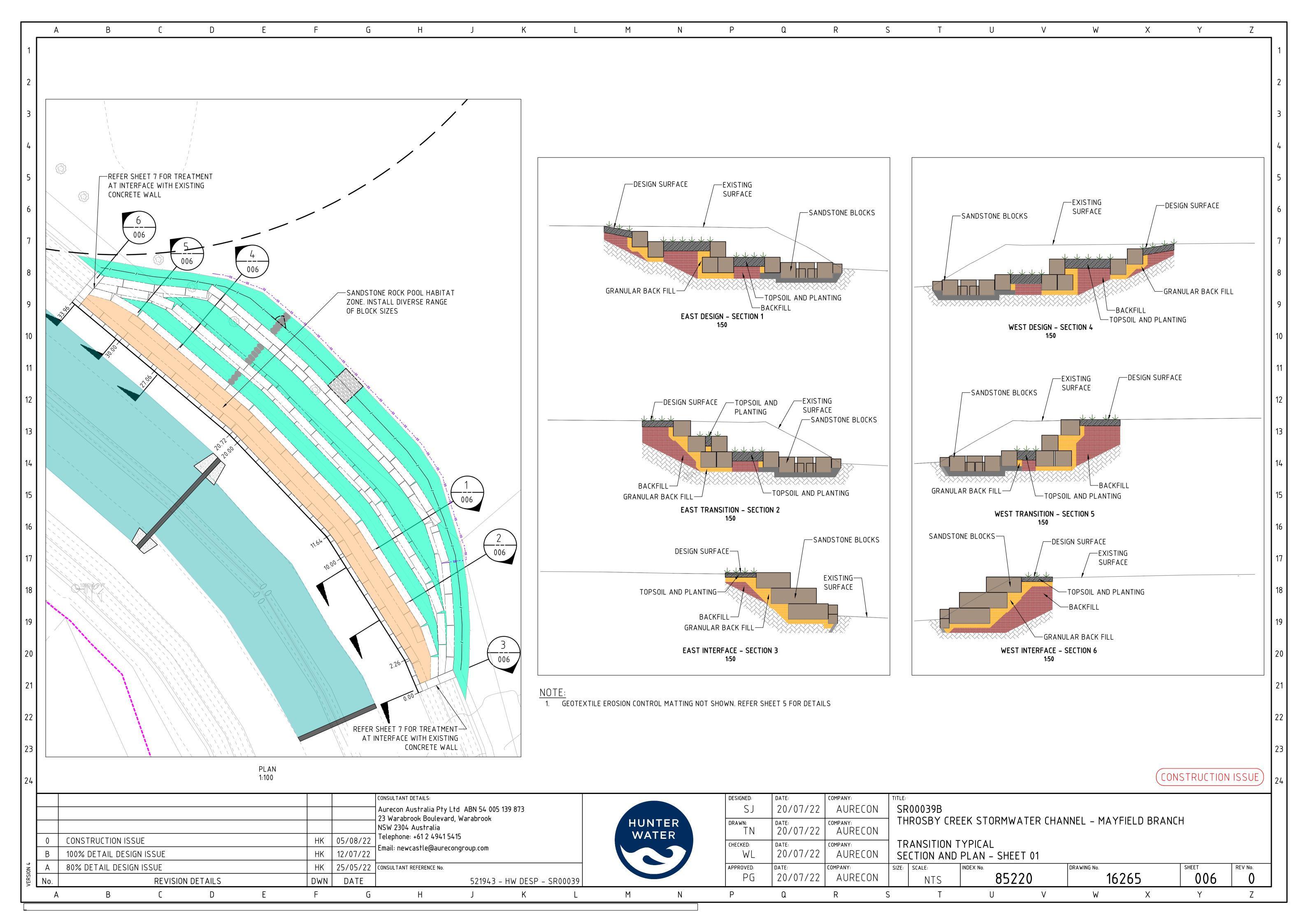


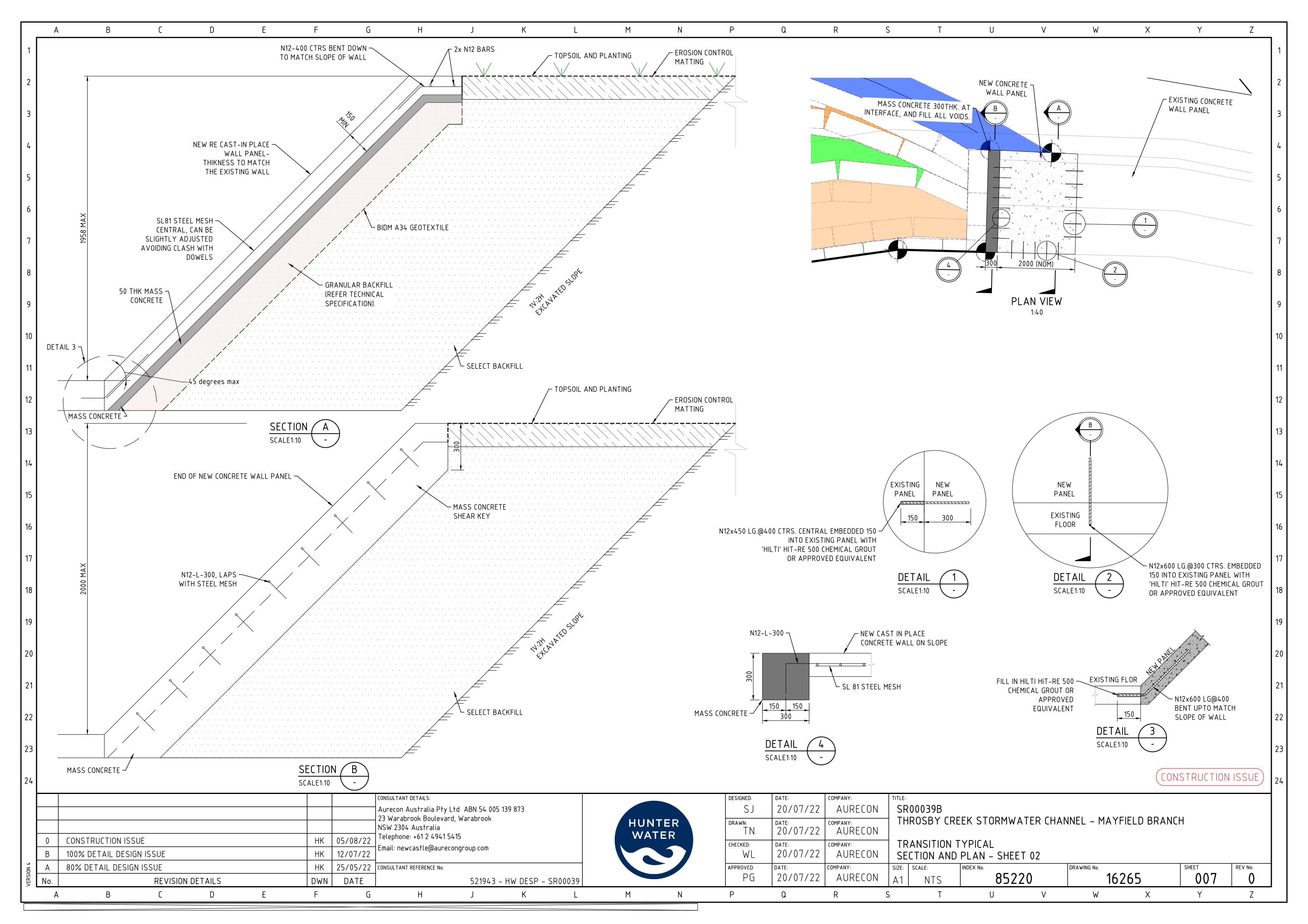


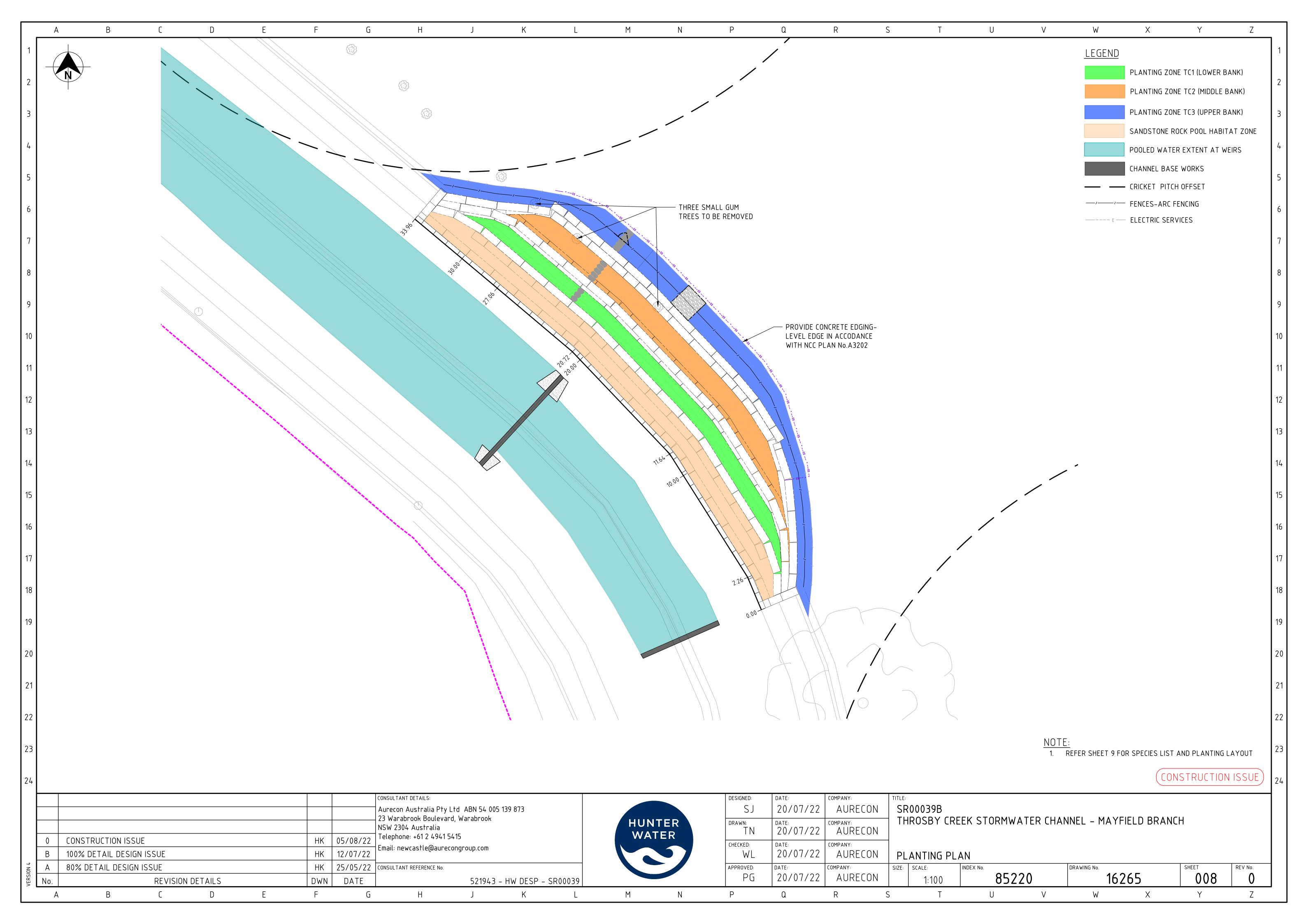


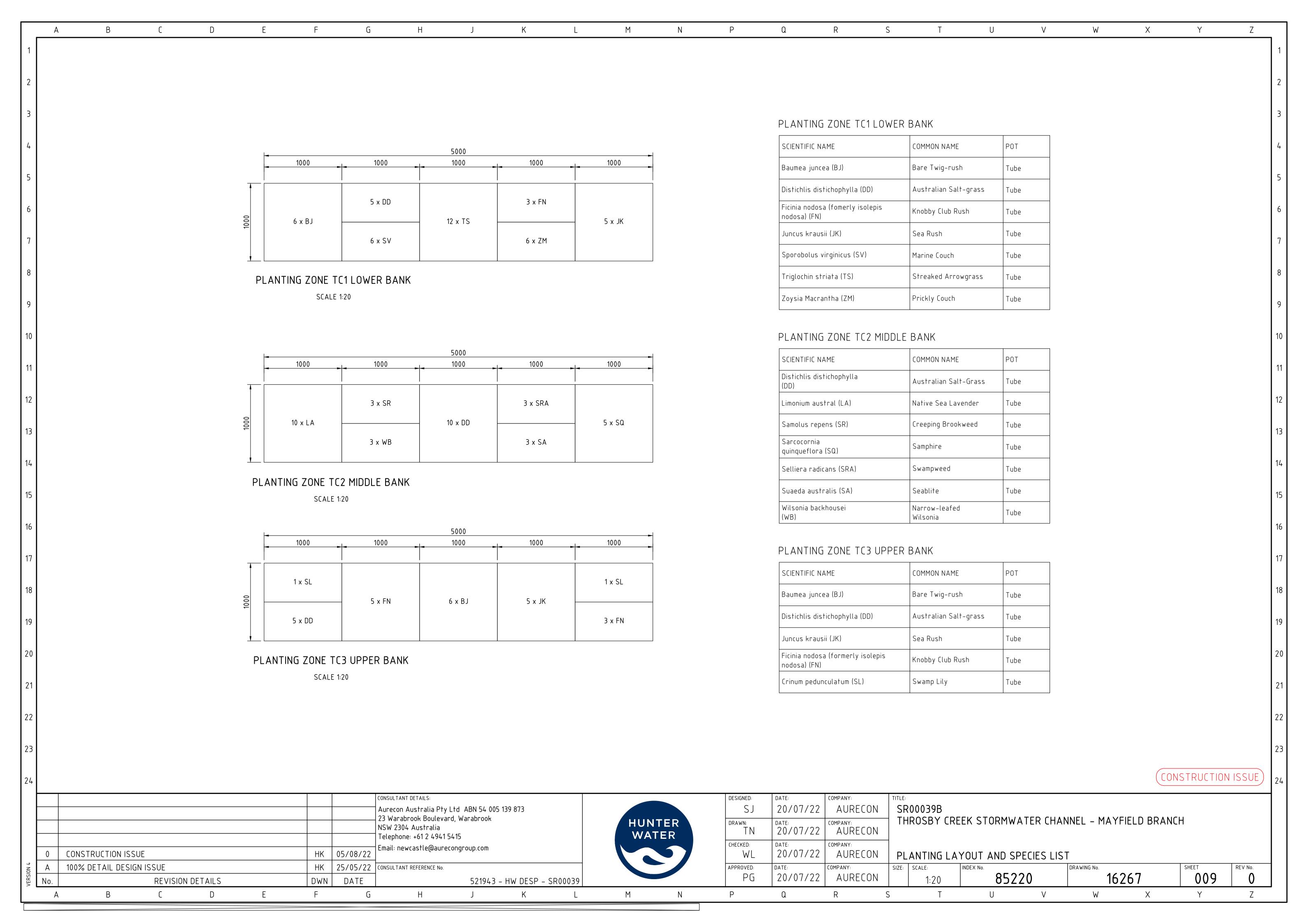












#### **APPENDIX B**

### 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
(a) the environmental impact on a community?  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.  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.  Measures have been proposed to minimise these potential impacts (refer to Section 6.1).	Short-term negative
(b) the transformation of a locality?  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.  The Proposal would result in improved amenity for the stormwater system by replacing the concrete channel banks with natural materials and providing planting adjacent to Myall Road. Thus increasing the value of the waterway and encouraging more recreational activity by the local community.	Short-term, minor, negative  Long-term, minor, positive
(c) the environmental impact on the ecosystems of a locality?  The Proposal would not result in the removal of any vegetation or impact on the ecosystems of a locality.	Nil
(d) reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?  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.  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.	Short-term, minor, negative  Long-term, minor, positive

Factor	Impact
<ul> <li>(e) the effects on a locality, place or building that has –         <ol> <li>aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance</li> <li>other special value for present or future generations</li> </ol> </li> <li>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.</li> </ul>	Nil
(f) impact on habitat of any protected animals (within the meaning of the <i>Biodiversity Conservation Act 2016</i> )?  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.	Nil
(g) the endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?  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.	Nil
(h) long-term effects on the environment?  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.	Long-term, positive
(i) degradation of the quality of the environment?  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.	Short-term, minor, negative
(j) risk to the safety of the environment?  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.	Short-term, minor, negative
(k) reduction in the range of beneficial uses of the environment?  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.	Long-term, positive
(I) pollution of the environment?  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.  Short-term noise and air quality impacts (dust and exhaust emissions) would be expected during the construction of the Proposal. Management	Short-term, minor, negative

Factor	Impact
of noise and air quality impacts would be carried out in accordance with the safeguards and management measures summarised in Section 6.	
The operation of the Proposal would not alter the air quality from the existing conditions.	
(m) environmental problems associated with the disposal of waste?	Nil
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.	
Issues associated with the disposal of waste are not expected.	
(n) increased demands on resources, natural or otherwise which are, or are likely to become, in short supply?	Nil
The Proposal would not result in an increase in demand for resources which are, or are likely to become, short in supply.	
(o) the cumulative environmental effect with other existing or likely future activities?	Nil
Given the minor nature and duration of the Proposal, cumulative impacts would not be expected with identified developments.	
(p) the impact on coastal processes and coastal hazards, including those under projected climate change conditions?	Nil
The Proposal is not located within a coastal area and would not result in any impact on coastal processes and coastal hazards.	
(q) applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1	Long-term, positive
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.	
(r) other relevant environmental factors	Nil
No other relevant environmental factors.	

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

# **APPENDIX C**

**Consultation Records** 



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: HW2018-1118/8/10.002

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, Throsby Creek, located within Litchfield Park, Mayfield

Hunter Water Corporation (Hunter Water) is currently preparing a Review of Environmental Factors (REF) for proposed stormwater amenity works along 155m of the Throsby Creek stormwater channel within Litchfield Park in Mayfield (the Proposal). The Throsby 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 1-3 and include:

- Replacement of approximately 35m of concrete bank from the eastern bank of the channel with a constructed habitat zone consisting of sandstone terraces and native plantings; and
- A mural created along 155m of the western bank involves constructing a new fence, offset from the existing property fences with the mural attached to the fence.

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 and 2, the proposed works are limited to the extent of Litchfield Park. At this stage, vegetation impacts anticipated for the Proposal are the removal of three juvenile gum trees that are of limited amenity value.

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.

Yours faithfully,

Shaun Murphy Project Manager

Asset Solutions – Hunter Water Corporation

shaun.murphy@hunterwater.com.au





Figure 1 Site Overview - Throsby Creek, Mayfield



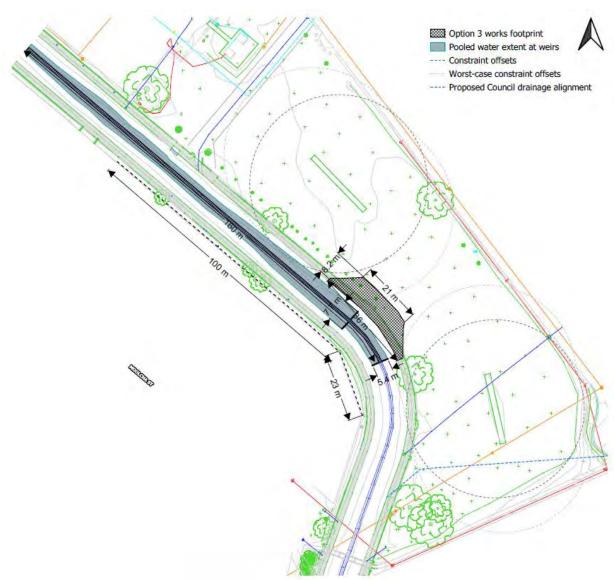


Figure 2 Extent of Works



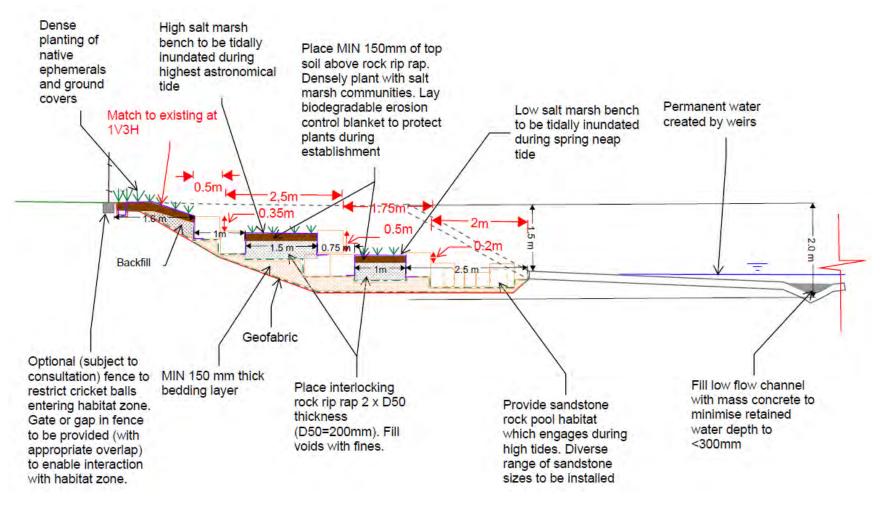


Figure 3 Structural Works



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: HW2018-1118/8/10.005

Subsidence Advisory NSW PO Box 488G Newcastle NSW 2300

To Whom it may concern,

Consultation regarding proposed stormwater amenity improvement at one of Hunter Water's stormwater systems, Throsby Creek, located within Litchfield Park, Mayfield

Hunter Water Corporation (Hunter Water) is currently preparing a Review of Environmental Factors (REF) for proposed stormwater amenity works along 155m of the Throsby Creek stormwater channel within Litchfield Park in Mayfield (the Proposal). The Throsby 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 Subsidence Advisory New South Wales (SANSW) of its intentions to carry out works associated with the Proposal. Hunter Water are required to consult with the SANSW under clause 2.15(2)(f) due to proposed developments in a mine subsidence district.

Hunter Water's proposed scope of works are illustrated in Figures 1-3 and include:

- Replacement of approximately 35m of concrete bank from the eastern bank of the channel with a constructed habitat zone consisting of sandstone terraces and native plantings; and
- A mural created along 155m of the western bank involves constructing a new fence, offset from the existing property fences with the mural attached to the fence.

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 and 2, the proposed works are limited to the extent of Litchfield Park. At this stage, vegetation impacts anticipated for the Proposal are the removal of three juvenile gum trees that are of limited amenity value.

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 SANSW 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, <a href="mailto:shaun.murphy@hunterwater.com.au">shaun.murphy@hunterwater.com.au</a>.

Yours faithfully,

Shaun Murphy Project Manager

Asset Solutions – Hunter Water Corporation

shaun.murphy@hunterwater.com.au





Figure 1 Site Overview - Throsby Creek, Mayfield



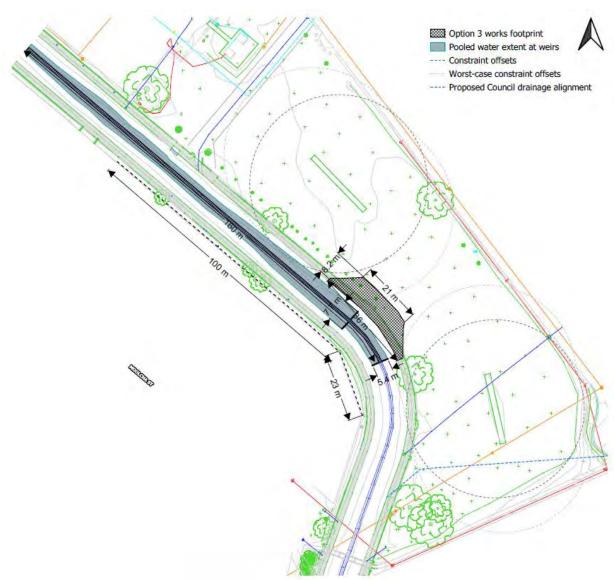


Figure 2 Extent of Works



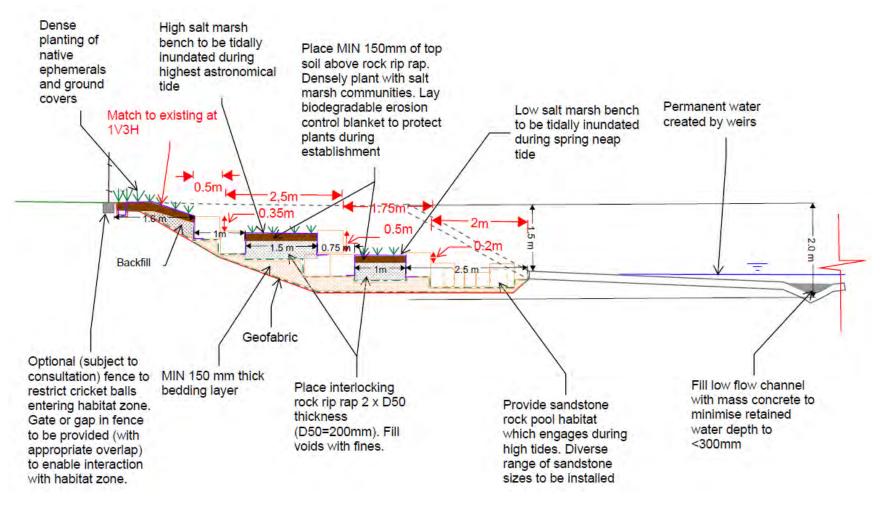


Figure 3 Structural Works



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

12 April 2022 Our Ref: HW2018-1118/8/10.007

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, Throsby Creek, located within Litchfield Park, Mayfield

Hunter Water Corporation (Hunter Water) is currently preparing a Review of Environmental Factors (REF) for proposed stormwater amenity works along 155m of the Throsby Creek stormwater channel within Litchfield Park in Mayfield (the Proposal). The Throsby 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 and 2 and include:

- Replacement of approximately 35m of concrete bank from the eastern bank of the channel with a constructed habitat zone consisting of sandstone terraces and native plantings; and
- A mural created along 155m of the western bank involves constructing a new fence, offset from the existing property fences with the mural attached to the fence.

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 and 2, the proposed works are limited to the extent of Litchfield Park. At this stage, vegetation impacts anticipated for the Proposal are the removal of three juvenile gum trees that are of limited amenity value.

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, <a href="mailto:shaun.murphy@hunterwater.com.au">shaun.murphy@hunterwater.com.au</a>.

Yours faithfully,

Shaun Murphy Project Manager

Asset Solutions – Hunter Water Corporation

shaun.murphy@hunterwater.com.au



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



Figure 1 Site Overview - Throsby Creek, Mayfield



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

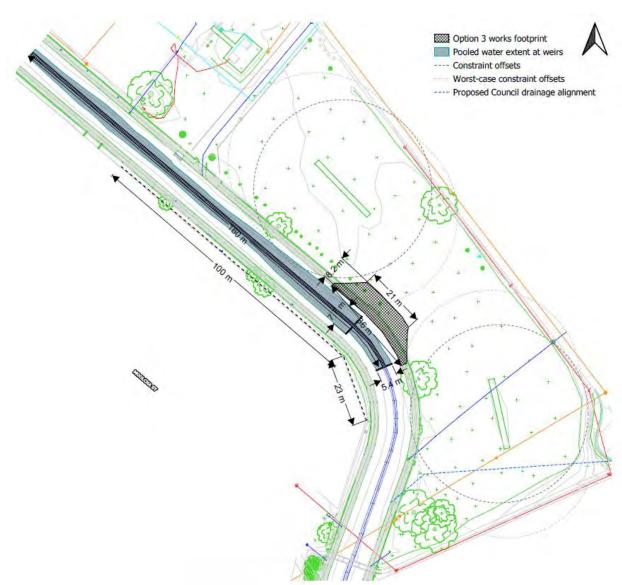


Figure 2 Extent of Works



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

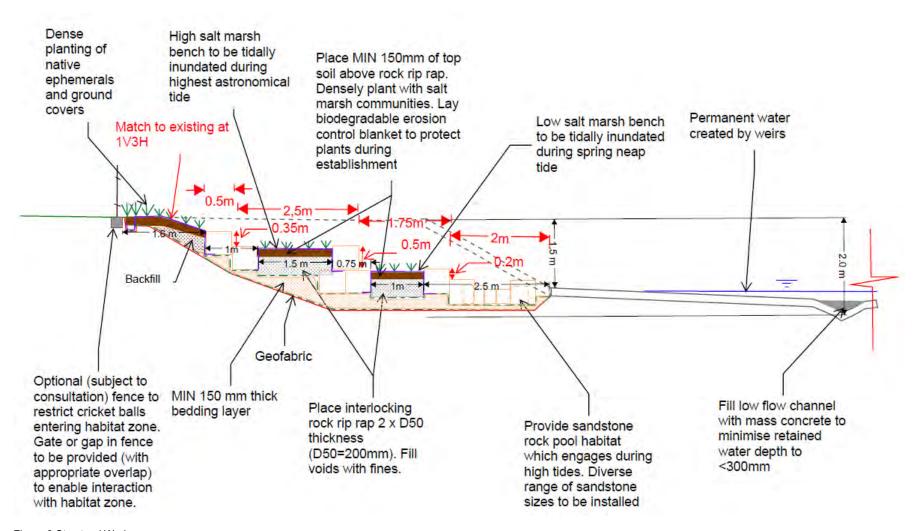


Figure 3 Structural Works

Assets & Projects.LJones Reference: OT2022/01078

Phone: 4974 6118



newcastle.nsw.gov.au

9 May 2022

Shaun Murphy
Project Manager
Asset Solutions – Hunter Water Corporation

Email: <a href="mailto:shaun.murphy@hunterwater.com.au">shaun.murphy@hunterwater.com.au</a>

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.

Yours faithfully

Robert Dudgeon

**ACTING MANAGER ASSETS AND PROJECTS** 





Our Ref: ID 1605

Your Ref: HW2018-1118/8/10.007

20 April 2022

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

Via email: shaun.murphy@hunterwater.com.au 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 Throsby 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 Throsby Creek, Litchfield Park, Mayfield.

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 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** 



Aurecon - Neutral Bay Date: 29 August 2021

PO Box 538

Neutral Bay New South Wales 2089

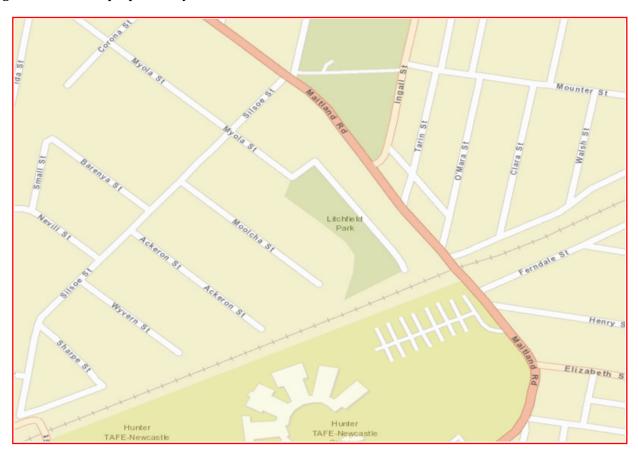
Attention: Claire Mcgarity

Email: claire.mcgarity@aurecongroup.com

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lat, Long From: -32.91, 151.74 - Lat, Long To: -32.9, 151.75, conducted by Claire Mcgarity on 29 August 2021.

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:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

#### 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) 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 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.

ABN 34 945 244 274

Email: ahims@environment.nsw.gov.au

Web: www.heritage.nsw.gov.au

• This search can form part of your due diligence and remains valid for 12 months.



WGS\_1984\_Web\_Mercator\_Auxiliary\_Sphere

© Latitude Geographics Group Ltd.

## Your Organization | Site N08 - Throsby Creek Litchfield Park, Mayfield



Bourke Moree Coffs
Bourke Tamworth Part N
Dubbo Newcastle
Wentworth Bathurst Sydney
Canberra Wollongo
Wagga Wagga
Abury Eden

### 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)
- Aboriginal Place
  - Cluster (label denotes number)
- State Heritage Register
  - Cluster (label denotes number)
- Interim Heritage Order
  - Cluster (label denotes number)

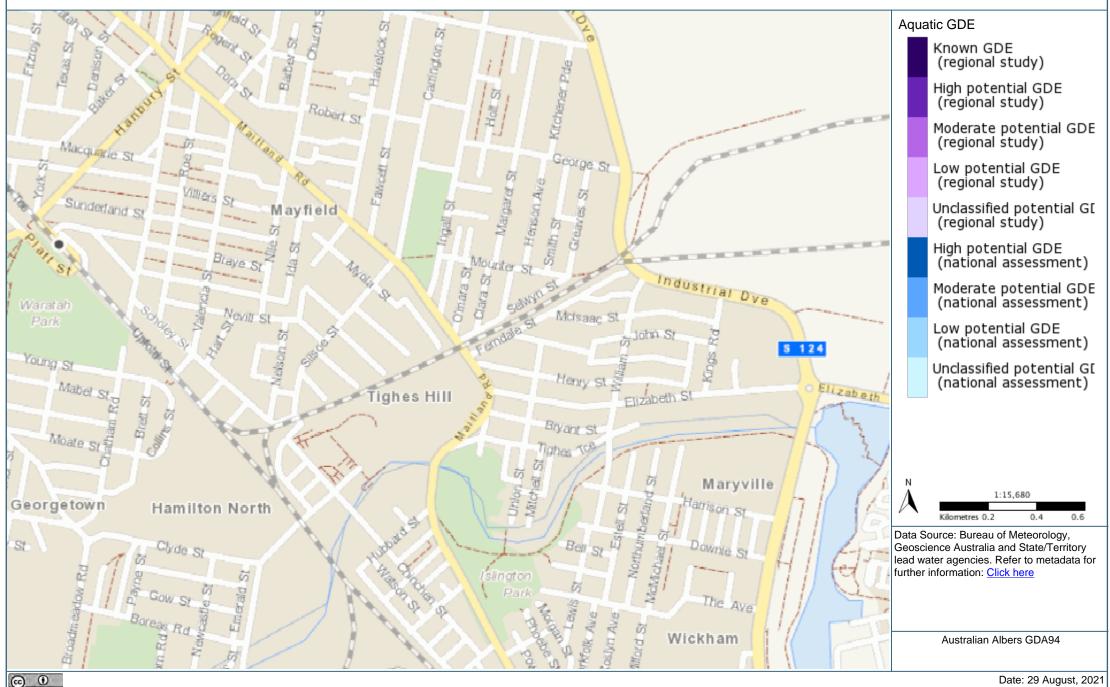
Notes

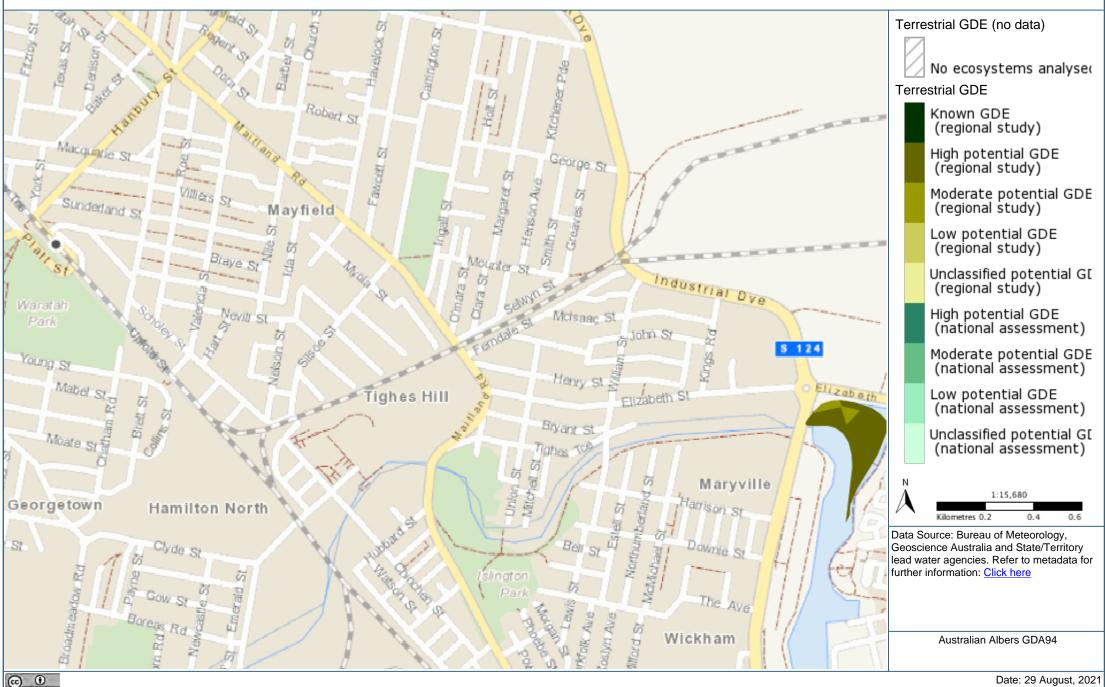
reference only. Data layers that appear on this map may or may not be accurate,

current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION



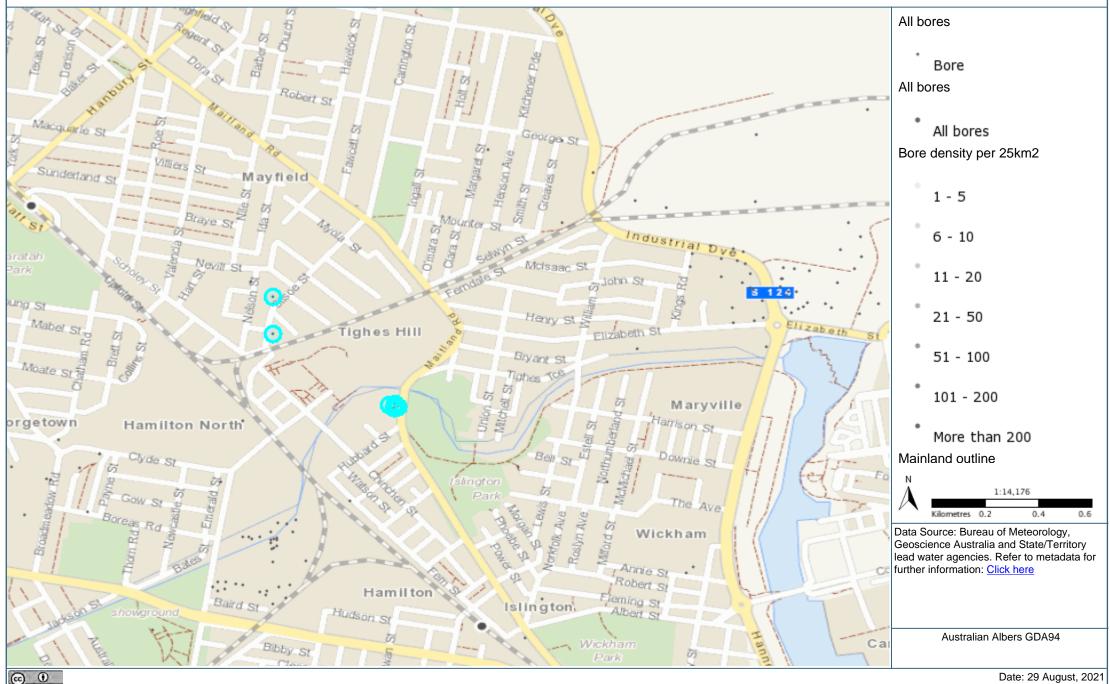




### Australian Groundwater Explorer

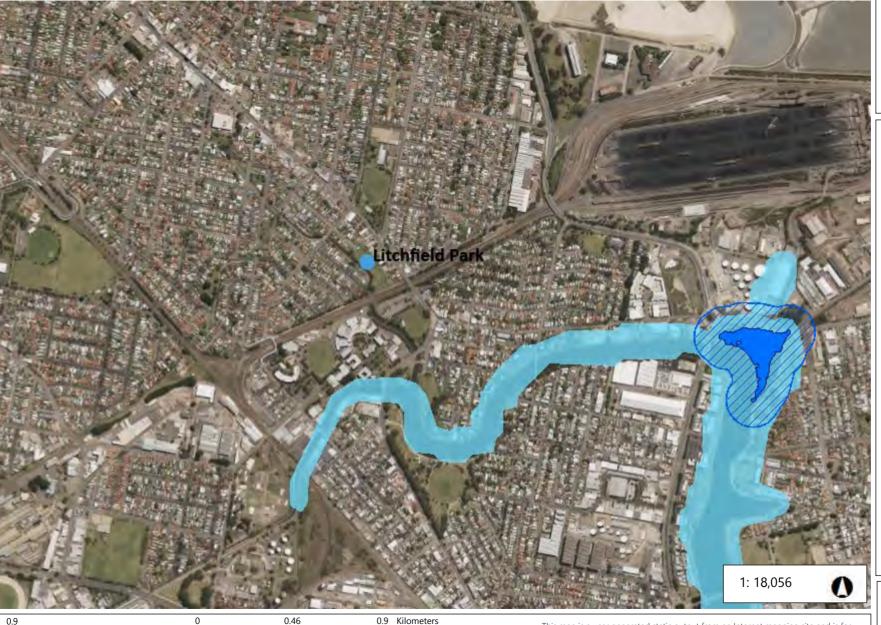
N08 Groundwater Bores





### N80 - Throsby Creek Litchfield Park







### Legend

- Key Fish Habitat Central Rive
- 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
- Olive Percille
- Oxleyan Pygmy Perch
- Southern Purple Spotted Gudg
- River Blackfish
- Silver Perch
- Trout Cod
- Coastal Wetlands
- Proximity Area for Coastal Wet

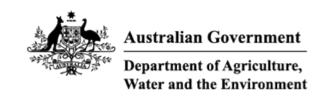
Notes

WGS\_1984\_Web\_Mercator\_Auxiliary\_Sphere © Department of Trade and Investment NSW

30-Aug-2021

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION



# **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: 30-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 <u>Administrative Guidelines on Significance</u>.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	62
Listed Migratory Species:	46

## 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 <u>permit</u> 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.

Commonwealth Lands:	5
Commonwealth Heritage Places:	None
Listed Marine Species:	50
Whales and Other Cetaceans:	1
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

### **Extra Information**

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

State and Territory Reserves:	None
Regional Forest Agreements:	1
Nationally Important Wetlands:	1
EPBC Act Referrals:	13
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	1
Geological and Bioregional Assessments:	None

## **Details**

## Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands)		[Resource Information]
Ramsar Site Name	Proximity	Buffer Status
Hunter estuary wetlands	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
Central Hunter Valley eucalypt forest and woodland	Critically Endangered	Community may occurln feature area within area
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community may occurIn feature area within area
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Endangered	Community may occurln buffer area only within area
River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	Critically Endangered	Community likely to In feature area occur within 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
BIRD			
Anthochaera phrygia			
Regent Honeyeater [82338]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat likely to occur within area	In feature area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area	In feature area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
<u>Diomedea epomophora</u> Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
<u>Diomedea exulans</u> Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area	In buffer area only
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Pycnoptilus floccosus Pilotbird [525]	Vulnerable	Species or species habitat may occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area	In feature area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In buffer area only
FISH			
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Thunnus maccoyii	0 ,		
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area	In buffer area only
FROG			
Litoria aurea			
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area	In feature area
Mixophyes balbus			
Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat may occur within area	In feature area
MAMMAL			
<u>Chalinolobus dwyeri</u>			
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Dasyurus maculatus maculatus (SE mair	nland population)		
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
Petauroides volans			
Greater Glider [254]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Petaurus australis australis			
Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Phascolarctos cinereus (combined popul	ations of Old_NSW and th	ne ACT)	
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
Potorous tridactylus tridactylus Long-nosed Potoroo (northern) [66645]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Pteropus poliocephalus			
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
PLANT			
,			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Angophora inopina Charmhaven Apple [64832]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Longlegs [2119]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Commersonia prostrata  Dwarf Kerrawang [87152]	Endangered	Species or species habitat may occur within area	In feature area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Eucalyptus camfieldii Camfield's Stringybark [15460]	Vulnerable	Species or species habitat may occur within area	In feature area
Euphrasia arguta [4325]	Critically Endangered	Species or species habitat may occur within area	In feature area
Grevillea shiressii [19186]	Vulnerable	Species or species habitat may occur within area	In feature area
Persicaria elatior Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Prasophyllum sp. Wybong (C.Phelps OR a leek-orchid [81964]	G 5269) Critically Endangered	Species or species habitat may occur within area	In feature area
Rhodamnia rubescens Scrub Turpentine, Brown Malletwood [15763]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Rhodomyrtus psidioides Native Guava [19162]	Critically Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Syzygium paniculatum			
Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Tetratheca juncea Black-eyed Susan [21407]	Vulnerable	Species or species habitat likely to occur within area	In feature area
REPTILE			
Caretta caretta			
Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area	In buffer area only
Chelonia mydas			
Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Dermochelys coriacea			
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area	In buffer area only
Eretmochelys imbricata			
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Natator depressus			
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
SHARK			
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area	In buffer area only
Listed Migratory Species		[ Res	source Information ]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds	<del>G-</del>		
Anous stolidus			
Common Noddy [825]		Species or species habitat likely to occur within area	In feature area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat likely to occur within area	In buffer area only
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area	In buffer area only
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
<u>Diomedea epomophora</u> Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
<u>Diomedea sanfordi</u> Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area	In buffer area only
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area	In feature area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area	In buffer area only
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Migratory Marine Species			
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area	In buffer area only
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Dermochelys coriacea	-		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area	In buffer area only
Eretmochelys imbricata			
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Lamna nasus			
Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area	In buffer area only
Mobula alfredi as Manta alfredi			
Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat may occur within area	In buffer area only
Mobula birostris as Manta birostris			
Giant Manta Ray [90034]		Species or species habitat may occur within area	In buffer area only
Natator depressus			
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Sousa sahulensis as Sousa chinensis			
Australian Humpback Dolphin [87942]		Species or species habitat likely to occur within area	In buffer area only
Migratory Terrestrial Species			
<u>Cuculus optatus</u>			
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
Hirundapus caudacutus			
White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area	In feature area
Monarcha melanopsis			
Black-faced Monarch [609]		Species or species habitat known to occur within area	In feature area
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area	In feature area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area	In feature area
Symposiachrus trivirgatus as Monarcha t Spectacled Monarch [83946]	<u>rivirgatus</u>	Species or species habitat likely to occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area	In feature area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Pandion haliaetus			
Osprey [952]		Species or species habitat known to occur within area	In buffer area only
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely 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.

department for further information.		
Commonwealth Land Name	State	Buffer Status
Communications, Information Technology and the Arts - Australian Postal	Corporation	
Commonwealth Land - Australian Postal Commission [11680]	NSW	In buffer area only
Communications, Information Technology and the Arts - Telstra Corporation	on Limited	
Commonwealth Land - Australian Telecommunications Commission [1168	1]NSW	In buffer area only
Defence		
Commonwealth Land - Defence Service Homes Corporation [11679]	NSW	In buffer area only
Defence - Defence Housing Authority		
Commonwealth Land - Director of War Service Homes [11683]	NSW	In buffer area only
Unknown		
Commonwealth Land - [11684]	NSW	In buffer area only

Listed Marine Species		[Res	source Information ]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Anous stolidus			
Common Noddy [825]		Species or species habitat likely to occur within area	In feature area

Apus pacificus Fork-tailed Swift [678] Species or species habitat likely to occur within area overfly marine area  Ardenna grisea as Puffinus griseus Sooty Shearwater [82651] Species or species habitat likely to occur within area Bubulcus ibis as Ardea ibis Cattle Egret [66521] Breeding likely to occur within area Occur within area  Calidris acuminata Sharp-tailed Sandpiper [874] Species or species habitat known to occur within area Occur within area  Calidris canutus Red Knot, Knot [855] Endangered Species or species habitat known to occur within area Overfly marine area  Calidris ferruginea Curlew Sandpiper [856] Critically Endangered Species or species habitat known to occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat may occur within area overfly marine area  In feature area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat known to occur within area Overfly marine area  Calonectris leucomelas Streaked Shearwater [1077]	Scientific Name	Threatened Category	Presence Text	Buffer Status
Ardenna grisea as Puffinus griseus Sooty Sheanwater [82651] Species or species habitat likely to occur within area  Bubulcus ibis as Ardea ibis Cattle Egret [66521] Breeding likely to occur within area Occur within area Occur within area Occur within area  Calidris acuminata Sharp-tailed Sandpiper [874] Species or species habitat known to occur within area Calidris canutus Red Knot, Knot [855] Endangered Species or species habitat known to occur within area Overfly marine area  Calidris ferruginea Curlew Sandpiper [856] Critically Endangered Species or species habitat known to occur within area Overfly marine area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat may occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat known to occur within area overfly marine area  Calonectris leucomelas Streaked Shearwater [1077] In feature area only habitat known to occur within area overfly marine area  In feature area only habitat known to occur within area overfly marine area  In feature area only habitat known to occur within area overfly marine area  In feature area only habitat known to occur within area overfly marine area  Calonectris leucomelas  Species or species habitat known to occur within area overfly marine area		<b>3</b> ,		In feature area
Sooty Shearwater [82651]  Species or species habitat likely to occur within area  Bubulcus ibis as Ardea ibis Cattle Egret [66521]  Breeding likely to occur within area overfly marine area  Calidris acuminata Sharp-tailed Sandpiper [874]  Species or species habitat known to occur within area overfly marine area  Calidris canutus Red Knot, Knot [855]  Endangered  Species or species habitat known to occur within area overfly marine area  Calidris ferruginea Curlew Sandpiper [856]  Critically Endangered  Species or species habitat known to occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858]  Species or species habitat may occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858]  Species or species habitat known to occur within area overfly marine area  In feature area  Species or species habitat known to occur within area overfly marine area  Calonectris leucomelas  Streaked Shearwater [1077]			within area overfly	
Calidris acuminata Sharp-tailed Sandpiper [874]  Calidris canutus Red Knot, Knot [855]  Calidris ferruginea Curlew Sandpiper [856]  Critically Endangered  Calidris melanotos Pectoral Sandpiper [858]  Calonectris leucomelas Streaked Shearwater [1077]  Breeding likely to occur within area overfly marine area  In feature area			habitat likely to occur	•
Sharp-tailed Sandpiper [874] Species or species habitat known to occur within area  Calidris canutus Red Knot, Knot [855] Endangered Species or species habitat known to occur within area Overfly marine area  Calidris ferruginea Curlew Sandpiper [856] Critically Endangered Species or species habitat may occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat known to occur within area overfly marine area  Calonectris leucomelas Streaked Shearwater [1077] In feature area Species or species habitat known to occur within area overfly marine area  In feature area In feature area In feature area In feature area Abitat known to occur within area overfly marine area  Species or species habitat known to			occur within area	In feature area
Calidris canutus Red Knot, Knot [855] Endangered Species or species habitat known to occur within area overfly marine area  Calidris ferruginea Curlew Sandpiper [856] Critically Endangered Species or species habitat may occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat may occur within area overfly marine area  Calonectris leucomelas Streaked Shearwater [1077] Species or species habitat known to occur within area overfly marine area  In feature area In feature area In feature area In feature area In feature area			Snecies or species	In feature area
Red Knot, Knot [855] Endangered Species or species habitat known to occur within area overfly marine area  Calidris ferruginea Curlew Sandpiper [856] Critically Endangered Species or species habitat may occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat may occur within area overfly marine area  In feature area  In feature area  In feature area  In feature area  Species or species habitat known to occur within area overfly marine area  Calonectris leucomelas Streaked Shearwater [1077] Species or species habitat known to			habitat known to	in routuro aroa
Calidris ferruginea Curlew Sandpiper [856] Critically Endangered Species or species habitat may occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat known to occur within area overfly marine area  Calonectris leucomelas Streaked Shearwater [1077] Species or species habitat known to occur within area overfly marine area  In feature area  In feature area  In feature area  In feature area  Species or species habitat known to occur within area overfly marine area  In buffer area only habitat known to		Endangered	•	In feature area
Curlew Sandpiper [856]  Critically Endangered Species or species habitat may occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858]  Species or species habitat known to occur within area overfly marine area  Calonectris leucomelas Streaked Shearwater [1077]  Species or species overfly marine area  In feature area  Species overfly marine area			occur within area	
habitat may occur within area overfly marine area  Calidris melanotos Pectoral Sandpiper [858] Species or species habitat known to occur within area overfly marine area  Calonectris leucomelas Streaked Shearwater [1077] Species or species habitat known to		Critically Endangered	Species or species	In feature area
Pectoral Sandpiper [858]  Species or species habitat known to occur within area overfly marine area  Calonectris leucomelas  Streaked Shearwater [1077]  Species or species or species habitat known to occur within area overfly marine area  In feature area  In feature area  Note that the provided Habitat known to built for the		The same of the sa	habitat may occur within area overfly	
habitat known to occur within area overfly marine area  Calonectris leucomelas  Streaked Shearwater [1077]  Species or species In buffer area only habitat known to			Species or species	In feature area
Streaked Shearwater [1077]  Species or species In buffer area only habitat known to			habitat known to occur within area	
habitat known to			Species or species	In huffer area only
occur within area	Otreaked Orieatwater [1077]			in buller area offing
Charadrius leschenaultii  Greater Sand Plover, Large Sand Plover Vulnerable  [877]  Species or species In feature area habitat known to	Greater Sand Plover, Large Sand Plover	Vulnerable	habitat known to	In feature area
occur within area	Diamendae suting develo		occur within area	
Diomedea antipodensis  Antipodean Albatross [64458]  Vulnerable  Foraging, feeding or In buffer area only related behaviour likely to occur within area	•	Vulnerable	related behaviour likely to occur within	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Diomedea antipodensis gibsoni as Diomedea antipodensis gibsoni as Diomedea Gibson's Albatross [82270]	<u>edea gibsoni</u> Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
<u>Diomedea exulans</u> Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
<u>Diomedea sanfordi</u> Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area	In buffer area only
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area	In feature area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area	
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area overfly marine area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area	In feature area
Neophema chrysostoma Blue-winged Parrot [726]		Species or species habitat may occur within area overfly marine area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area	In buffer area only
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area	In buffer area only
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area	In feature area
Rostratula australis as Rostratula bengh	alensis (sensu lato)		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area
Symposiachrus trivirgatus as Monarcha	trivirgatus		
Spectacled Monarch [83946]		Species or species habitat likely to occur within area overfly marine area	In feature area
Thalassarche bulleri			
Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche bulleri platei as Thalassar	che sp. nov.		
Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche cauta			
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche eremita			
Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche impavida			
Campbell Albatross, Campbell Black- browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche melanophris			
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area overfly marine area	In feature area
Reptile			
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area	In buffer area only
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Whales and Other Cetaceans		[Res	source Information ]
Current Scientific Name	Status	Type of Presence	Buffer Status
Mammal			
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Species or species habitat likely to occur within area	In buffer area only

## **Extra Information**

## Regional Forest Agreements

[ Resource Information ]

Note that all areas with completed RFAs have been included.

RFA Name
State Buffer Status
North East NSW RFA
New South Wales In feature area

Nationally Important Wetlands		[ Resource Information ]
Wetland Name	State	Buffer Status
Kooragang Nature Reserve	NSW	In buffer area only

EPBC Act Referrals			[ Resou	rce Information 1
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Hunter River south arm dredging	2003/950	Controlled Action	Post-Approval	In buffer area only
Port Site and Materials Handling Development	2001/242	Controlled Action	Completed	In feature area
Protech Cold Mill Facility	2001/274	Controlled Action	Post-Approval	In feature area
River Dredging Operations	2001/249	Controlled Action	Completed	In feature area
Not controlled action				
Fort Scratchley refurbishment works	2005/2283	Not Controlled Action	Completed	In feature area
Fort Scratchley site remediation	2005/2075	Not Controlled Action	Completed	In feature area
Geological exploration and historical research of convict coal mines beneath For	2004/1421	Not Controlled Action	Completed	In feature area
Green & Golden Bell Frog Habitat Enhancement Project	2004/1795	Not Controlled Action	Completed	In feature area
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
sale of property located at 96, Hunter Street	2003/1097	Not Controlled Action	Completed	In feature area
Sandgate Rail Grade Separation	2005/1948	Not Controlled Action	Completed	In feature area
Tomago to Tomaree Electricity Supply Upgrade	2003/1023	Not Controlled Action	Completed	In feature area

## Not controlled action (particular manner)

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action (particular mann	er)			
Rehabilitation of Hexham Swamp	2003/1244	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Bioregional Assessments			
SubRegion	BioRegion	Website	Buffer Status
Hunter	Northern Sydney Basin	BA website	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

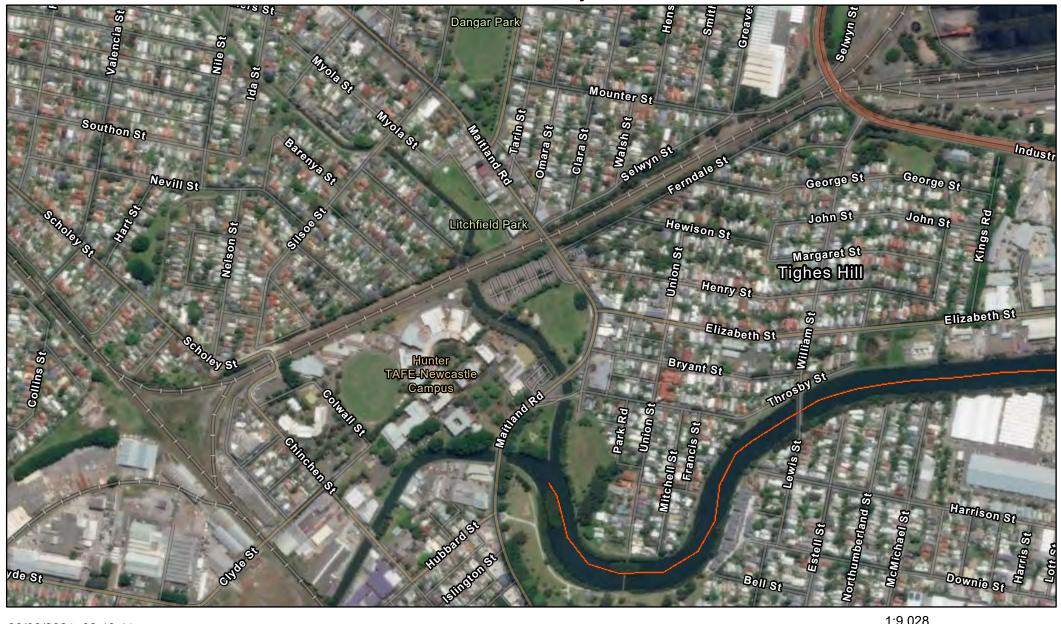
The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

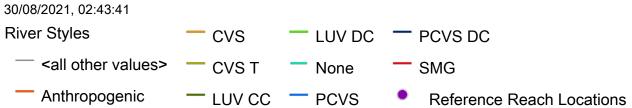
# Please feel free to provide feedback via the Contact Us page.

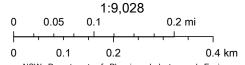
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**NSW River Styles** 

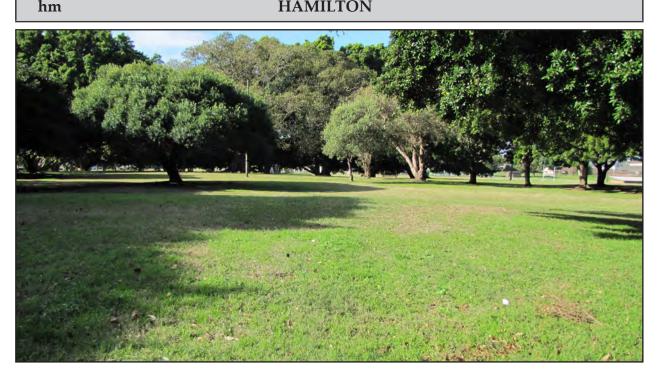






Water - NSW Department of Planning, Industry and Environment, Esri Community Maps Contributors, Esri, HERE, Garmin, METI/NASA, USGS, Maxar

### **HAMILTON**



Landscape—level to gently undulating well-drained plain on Quaternary deposits in the Hunter Plain region. Slopes are <2%, elevation is up to 12 m, local relief is <1 m. Completely cleared.

Landscape Variant—hma—recently incised channel

Soils—deep (>15 cm), well-drained weak Podzols (Uc2.32, Uc2.34), with some deep (>100 cm), welldrained Brown Podzolic Soils (Db1.21) on fans.

Qualities and Limitations—wind erosion hazard, ground water pollution hazard, strong acidity, noncohesive soils.

### **LOCATION**

Level to gently undulating plain on Quaternary age sands and clays in the Lower Hunter Plain region in the south of the area. Examples include the suburbs surrounding greater Newcastle: Newcastle West, The Junction, Hamilton, Broadmeadow. Type location is at Hamilton (Area reference 3 **82**5\*\*E, 63 **56**5\*\*N).

### **LANDSCAPE**

### Geology and Regolith

Quaternary sand overlying clay deposits. Sediment depth is up to 38 m, comprising 1-3 m of sand which is generally underlain by stiff estuarine clay (Coffey Partners International Pty Ltd 1990).

### Topography

Level to undulating, broad (to 5 km), well-drained sand plain. Slope gradients are commonly <2%. Elevation is up to 12 m. Local relief <1 m. Occasional low dunes occur, for example, at Cooks Hill.

### Vegetation

Completely cleared for urban development.

#### Land Use

Comprises a large portion of suburban Newcastle. Some light industrial areas, particularly at Wickham and Newcastle West.

### **Existing Land Degradation**

Non-existent due to extensive urbanisation.

### **Landscape Variants**

The areas marked as **hma** on the map are a recently incised channel cut into the Hamilton soil landscape. Part of the channel has been excavated by human activity.

#### **Included Soil Landscapes**

Small areas of fill (see Disturbed Terrain) have been included within the Hamilton soil landscape, particularly in association with commercial and business complexes.

### **SOILS**

### **Dominant Soil Materials**

### hm1 - Brownish black speckled loamy sand (topsoil - A horizon)

brownish black (10YR 2/2, 10YR 2/3) Colour

**Texture** coarse loamy sand

Structure single-grained, but occasionally sufficient

organic matter is present to form very

weak 2-5 mm crumb peds sandy, occasionally rough ped

**Fabric** Field pH slightly acid to neutral (pH 6.0-7.0)

Coarse fragments absent

**Roots** common, fine to large

**Exposed** 

condition loose, soft
Permeability very high

**Type location** Islington Park, Islington (Grid Ref. 3

828\*\*E, 63 575\*\*N). Soil Data System card

445, 30-50 cm

hm2-Loose, pale coarse sand (topsoil-A, horizon)

Colour

dull yellow orange (10YR 7/2) to greyish yellow brown (10YR 4/2) when moist,

commonly bleached when dry

**Texture** coarse sand Structure single-grained

Fabric sandy

Field pH slightly acid (pH 6.0–6.5)

Coarse

fragments absent

**Roots** common, fine to large

Exposed

condition loose
Permeability very high

Type location Islington Park, Islington (Grid Ref. 3

828\*\*E, 63 575\*\*N). Soil Data System card

445, 50-80 cm

hm3-Brown to orange soft sandy pan (subsoil-B

horizon)

Colour dark brown (10YR 3/3) to dull yellow

orange (10YR 6/3)

Texture fine sand-clayey coarse sand

**Structure** single-grained

Fabric sandy

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

Coarse

**fragments** occasionally few fine charcoal fragments

Roots absent

Exposed

condition loose, sandyPermeability very high

**Type location** Islington Park, Islington (Grid Ref. 3

828\*\*E, 63 575\*\*N). Soil Data System card

445, 80->120 cm

#### **Associated Soil Materials**

**Moderately structured brown sandy clay loam.** This is a well-structured sandy clay loam with 2–5 mm crumb

peds, which occurs as a topsoil (A horizon) on alluvial fan deposits from the surrounding hard rock.

**Moderately pedal brown silty clay.** A well-structured silty to medium clay, with 5–10 mm polyhedral peds, occurs as a subsoil (B horizon) on alluvial fan deposits.

**Black earthy coarse loamy sand.** This is a coarse loamy sand with common sub-angular gravel fragments. It occurs as a shallow layer of fill (A horizon) over **hm1**.

### Occurrence and Relationships

Commonly. 20–60 cm brownish black speckled loamy sand (hm1) overlies 15 -30 cm loose, pale, coarse sand (hm2), which in turn overlies >60 cm brown-orange soft, sandy pan (hm3). The moderately pedal brown silty clay may underlie hm3. Occasionally, 30–>200 cm black earthy coarse loamy sand overlies hm1. Soil boundaries are clear. Total soil depth is >150 cm [well-drained weak Podzols (Uc2.32, Uc2.34)].

On alluvial fan deposits which drain from adjacent hardrock. Up to 20 cm moderately structured brown sandy clay loam overlies >80 cm moderately pedal brown silty clay. Soil boundaries are clear. Total soil depth is >100 cm [imperfectly drained Brown Podzolic Soils (Db1.12)].

#### **QUALITIES AND LIMITATIONS**

### **Landscape Limitations**

Seasonal waterlogging (localised, fan deposits)

Wind erosion hazard Non-cohesive soils

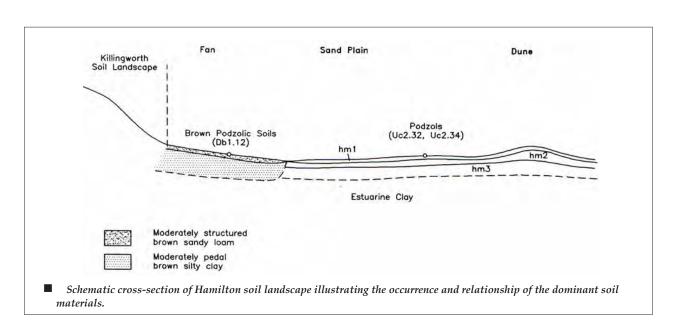
Foundation hazard (localised, deep clay deposits)

High run-on (localised, alluvial fans) Ground water pollution hazard

### Landscape Limitations—hma

Wind erosion hazard Non-cohesive soils High run-on Flood hazard Foundation hazard

Ground water pollution hazard



### **Soil Limitations**

**hm1** High permeability

Strong acidity

Low available water-holding capacity

hm2 High permeability

Strong acidity Very low fertility

Low available water-holding capacity

hm3 High permeability

Very strong acidity

High potential aluminium toxicity

Very low fertility

Low available water-holding capacity

### **Fertility**

**Soil Materials as Plant Growth Media.** Suitability as growth media is moderate for **hm1**, low for **hm2**, **hm3**. Topsoil (**hm1**) has low organic matter, low nutrient storage capacity and low water retention capability, but is a good medium for root growth.

**Soil Profile Fertility.** Suitability as a growth medium is moderate for deep, well-drained Podzols, with regular irrigation and fertiliser inputs. Soil volumes for root penetration are high.

### **Erodibility**

	K factor	Non-concentrated	Concentrated	Wind
		flows	flows	
hm1	0.015	low	low	high
hm2	0.016	low	low	high
hm3	0.009	very low	low	high

### **Erosion Hazard**

	Non-concentrated	Concentrated	Wind
	flows	flows	
grazing	slight	low	low
cultivation	low	moderate	moderate
urban	low	moderate	moderate

#### **Foundation Hazard**

Generally low, but may be moderate on clay fan deposits. Landscape variant **hma** has high limitations. Topsoil depth is 20–60 cm. Total soil depth is >150 cm.

#### **Urban Capability**

Generally low limitations for urban development. Landscape variant **hma** has high limitations.

#### **Rural Capability**

Generally low limitations for cultivation and grazing.

### **Sustainable Land Management Recommendations**

Not applicable, as this soil landscape has been completely urbanised.

#### Soil Conservation Earthworks

High limitations for earthworks due to highly permeable soil materials. Moderate limitations on alluvial fans. Soils tested have earthworks categories J for hm1 and hm2 and I for hm3. Soils tested have earthworks categories J for hm1 and hm2 and I for hm3.

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: -32.86 West: 151.70 East: 151.80 South: -32.96] returned a total of 10,456 records of 73 species.

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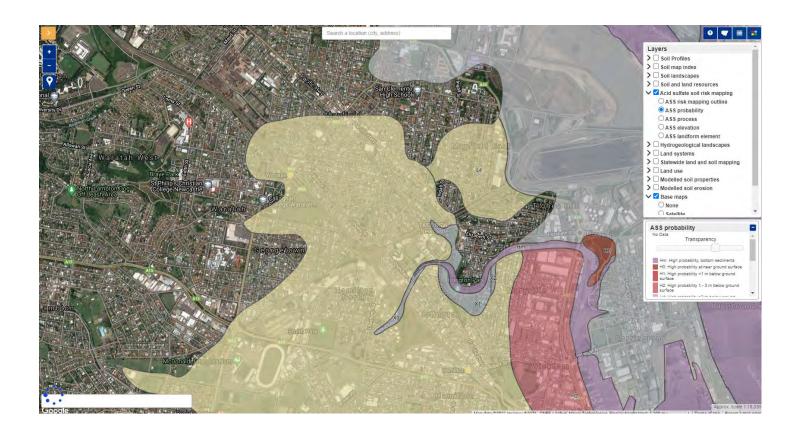
Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records	
Animalia Animalia	Amphibia Reptilia	Hylidae Cheloniidae	3166 2004	Litoria aurea Caretta caretta		Green and Golden Bell Frog Loggerhead Turtle	E1,P E1,P	V E	3880 4	* H • H
Animalia	Reptilia	Cheloniidae	2007	Chelonia mydas		Green Turtle	V,P	V	3	•
Animalia	Reptilia	Cheloniidae	2008	Eretmochelys imbricata		Hawksbill Turtle	Р	V	2	•
Animalia	Aves	Anseranatidae	0199	Anseranas semipalmata		Magpie Goose	V,P		33	:
Animalia	Aves	Columbidae	0025	Ptilinopus magnificus		Wompoo Fruit-Dove	V,P		2	•
Animalia	Aves	Columbidae	0023	Ptilinopus superbus		Superb Fruit-Dove	V,P		3	•
Animalia	Aves	Apodidae	0334	Hirundapus caudacutus		White-throated Needletail	Р	V,C,J,K	1	•
Animalia	Aves	Diomedeidae	0086	Diomedea exulans		Wandering Albatross	E1,P	Ε	1	•
Animalia	Aves	Diomedeidae	0091	Thalassarche cauta		Shy Albatross	V,P	V	1	•
Animalia	Aves	Procellariidae	0072	Ardenna carneipes		Flesh-footed Shearwater	V,P	J,K	1	•
Animalia	Aves	Procellariidae	0929	Macronectes giganteus		Southern Giant Petrel	E1,P	Е	4	:
Animalia	Aves	Procellariidae	0971	Pterodroma solandri		Providence Petrel	V,P		2	•
Animalia	Aves	Sulidae	0105	Sula dactylatra		Masked Booby	V,P	J,K	1	1
Animalia	Aves	Ciconiidae	0183	Ephippiorhynchus asiaticus		Black-necked Stork	E1,P		31	i
Animalia	Aves	Ardeidae	0197	Botaurus poiciloptilus		Australasian Bittern	E1,P	E	15	* H • H
Animalia	Aves	Accipitridae	0218	Circus assimilis		Spotted Harrier	V,P		5	
Animalia	Aves	Accipitridae	0226	Haliaeetus leucogaster		White-bellied Sea-Eagle	V,P		38	•
Animalia	Aves	Accipitridae	0225	Hieraaetus morphnoides		Little Eagle	V,P		3	•
Animalia	Aves	Accipitridae	0230	^^Lophoictinia isura		Square-tailed Kite	V,P,3		1	Me He He
Animalia	Aves	Accipitridae	8739	^^Pandion cristatus		Eastern Osprey	V,P,3		14	•
Animalia	Aves	Burhinidae	0174	Burhinus grallarius		Bush Stone-curlew	E1,P		2	•
Animalia	Aves	Haematopodid ae	0131	Haematopus fuliginosus		Sooty Oystercatcher	V,P		25	i
Animalia	Aves	Haematopodid ae	0130	Haematopus longirostris		Pied Oystercatcher	E1,P		29	i
Animalia	Aves	Charadriidae	0141	Charadrius leschenaultii		Greater Sand-plover	V,P	V,C,J,K	6	•
Animalia	Aves	Charadriidae	0139	Charadrius mongolus		Lesser Sand-plover	V,P	E,C,J,K	178	**
Animalia	Aves	Jacanidae	0171	Irediparra gallinacea		Comb-crested Jacana	V,P		3	•
Animalia	Aves	Scolopacidae	0164	Calidris canutus		Red Knot	Р	E,C,J,K	191	•
Animalia	Aves	Scolopacidae	0161	Calidris ferruginea		Curlew Sandpiper	E1,P	CE,C,J,K	1910	•
Animalia	Aves	Scolopacidae	0165	Calidris tenuirostris		Great Knot	V,P	CE,C,J,K	34	• 11 • 11
Animalia	Aves	Scolopacidae	0167	Limicola falcinellus		Broad-billed Sandpiper	V,P	C,J,K	41	•
Animalia	Aves	Scolopacidae	0152	Limosa limosa		Black-tailed Godwit	V,P	C,J,K	290	•
Animalia	Aves	Scolopacidae	0149	Numenius madagascariensis		Eastern Curlew	Р	CE,C,J,K	138	i
Animalia	Aves	Scolopacidae	0160	Xenus cinereus		Terek Sandpiper	V,P	C,J,K	474	•
Animalia	Aves	Laridae	0120	Onychoprion fuscata		Sooty Tern	V,P		1	•
Animalia	Aves	Laridae	0117	Sternula albifrons		Little Tern	E1,P	C,J,K	300	40 HO HO
Animalia	Aves	Psittacidae	0260	Glossopsitta pusilla		Little Lorikeet	V,P		3	
Animalia	Aves	Psittacidae	0309	^^Lathamus discolor		Swift Parrot	E1,P,3	CE	2	•
Animalia	Aves	Psittacidae	0302	^^Neophema pulchella		Turquoise Parrot	V,P,3		2	•
Animalia	Aves	Strigidae	0246	^^Ninox connivens		Barking Owl	V,P,3		1	•
Animalia	Aves	Strigidae	0248	^^Ninox strenua		Powerful Owl	V,P,3		41	•
Animalia	Aves	Tytonidae	0252	^^Tyto longimembris		Eastern Grass Owl	V,P,3		2	•
Animalia	Aves	Tytonidae	0250	^^Tyto novaehollandiae		Masked Owl	V,P,3		1	•
Animalia	Aves	Tytonidae	9924	^^Tyto tenebricosa		Sooty Owl	V,P,3		4	•
Animalia	Aves	Meliphagidae	0448	Epthianura albifrons		White-fronted Chat	V,P		59	
Animalia	Aves	Pomatostomida e	8388	Pomatostomus temporalis temporalis		Grey-crowned Babbler (eastern subspecies)	V,P		1	i
Animalia	Aves	Neosittidae	0549	Daphoenositta chrysoptera		Varied Sittella	V,P		1	i
Animalia	Aves	Estrildidae	0652	Stagonopleura guttata		Diamond Firetail	V,P		1	•
Animalia	Mammalia	Phascolarctidae	1162	Phascolarctos cinereus		Koala	V,P	V	8	•
Animalia	Mammalia	Burramyidae	1150	Cercartetus nanus		Eastern Pygmy-possum	V,P		2	•
Animalia	Mammalia	Petauridae	1137	Petaurus norfolcensis		Squirrel Glider	V,P		3	•
Animalia	Mammalia	Pteropodidae	1280	Pteropus poliocephalus		Grey-headed Flying-fox	V,P	V	285	•
Animalia	Mammalia	Emballonuridae	1321	Saccolaimus flaviventris		Yellow-bellied Sheathtail-bat	V,P		3	
Animalia	Mammalia	Molossidae	1329	Micronomus norfolkensis		Eastern Coastal Free-tailed Bat	V,P		22	i
Animalia	Mammalia	Vespertilionida e	1372	Falsistrellus tasmaniensis		Eastern False Pipistrelle	V,P		2	i
Animalia	Mammalia	Vespertilionida e	1357	Myotis macropus		Southern Myotis	V,P		17	i
Animalia	Mammalia	Vespertilionida e	1361	Scoteanax rueppellii		Greater Broad-nosed Bat	V,P		11	i
Animalia	Mammalia	Miniopteridae	1346	Miniopterus australis		Little Bent-winged Bat	V,P		28	•

Animalia	Mammalia	Miniopteridae	3330	Miniopterus orianae oceanensis	Large Bent-winged Bat	V,P		27	$\mathbf{i}$
Animalia	Mammalia	Dugongidae	1558	Dugong dugon	Dugong	E1,P		2	•
Animalia	Mammalia	Otariidae	1543	Arctocephalus forsteri	New Zealand Fur-seal	V,P		1	•
Animalia	Mammalia	Otariidae	1882	Arctocephalus pusillus doriferus	Australian Fur-seal	V,P		2	i
Animalia	Mammalia	Balaenopterida e	1575	Megaptera novaeangliae	Humpback Whale	V,P	V	2	i
Plantae	Flora	Asteraceae	1643	Rutidosis heterogama	Heath Wrinklewort	V	V	12	*
Plantae	Flora	Elaeocarpaceae	6206	Tetratheca juncea	Black-eyed Susan	V	V	180	•
Plantae	Flora	Fabaceae (Faboideae)	11644	Pultenaea maritima	Coast Headland Pea	V		4	i
Plantae	Flora	Myrtaceae	6809	Melaleuca biconvexa	Biconvex Paperbark	V	V	1	•
Plantae	Flora	Myrtaceae	4283	Rhodamnia rubescens	Scrub Turpentine	E4A		5	•
Plantae	Flora	Myrtaceae	4293	Syzygium paniculatum	Magenta Lilly Pilly	E1	V	1	•
Plantae	Flora	Orchidaceae	9027	^Diuris praecox	Rough Doubletail	V,P,2	V	1988	•
Plantae	Flora	Polygonaceae	15213	Muehlenbeckia sp. Mt Norman	Scrambling Lignum	V		1	i
Plantae	Flora	Proteaceae	5400	Grevillea shiressii		V	V	40	•
Plantae	Flora	Zannichelliacea	6339	Zannichellia palustris		E1		24	i
		e							
NSW Statu	NSW Status								
1 Sensitivity Class 1 (Sensitive Species Data Policy)									
	2 Sensitivity Class 2 (Sensitive Species Data Policy)								
3	3 Sensitivity Class 3 (Sensitive Species Data Policy)								

- **CC** Collapsed Ecological Community (Biodiversity Conservation Act 2016)
- **CH** Critical Habitat (Biodiversity Conservation Act 2016)
- E1 Endangered (Biodiversity Conservation Act 2016)
- E2 Endangered Population (Biodiversity Conservation Act 2016)
- E3 Endangered Ecological Community (Biodiversity Conservation Act 2016)
- E4 Presumed Extinct (Biodiversity Conservation Act 2016)
- **E4A** Critically Endangered (Biodiversity Conservation Act 2016)
- **E4B** Critically Endangered Ecological Community (Biodiversity Conservation Act 2016)
- **EW** Extinct in the Wild (Biodiversity Conservation Act 2016)
- FCE Critically Endangered Fish (Fisheries Management Act 1994)
- FE Endangered Fish (Fisheries Management Act 1994)
- FEC Endangered Ecological Community of Fish (Fisheries Management Act 1994)
- **FEP** Endangered Population of Fish (Fisheries Management Act 1994)
- FKTP Key Threatening Process of Fish (Fisheries Management Act 1994)
  - **FP** Protected Fish (Fisheries Management Act 1994)
  - **FV** Vulnerable Fish (Fisheries Management Act 1994)
  - **FX** Extinct Fish (Fisheries Management Act 1994)
- KTP Key Threatening Process (Biodiversity Conservation Act 2016)
  - P Protected (National Parks & Wildlife Act 1974)
- V Vulnerable (Biodiversity Conservation Act 2016)
- **V2** Vulnerable Ecological Community (Biodiversity Conservation Act 2016)

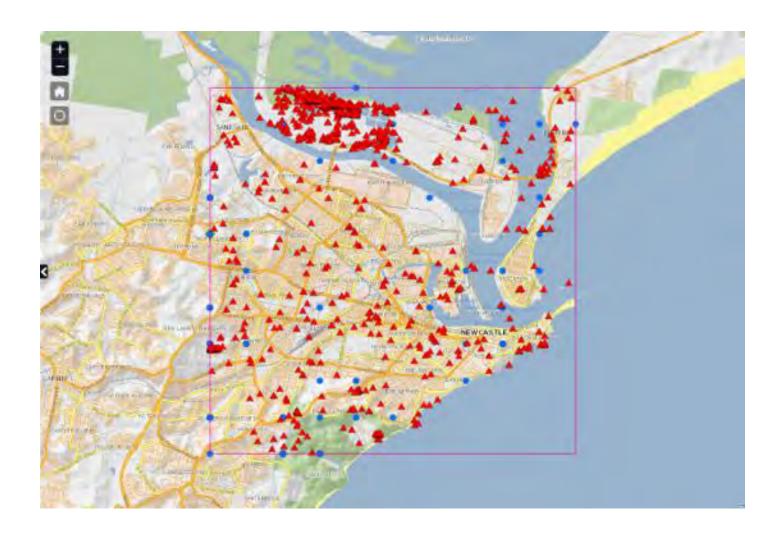
### **Commonwealth Status**

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



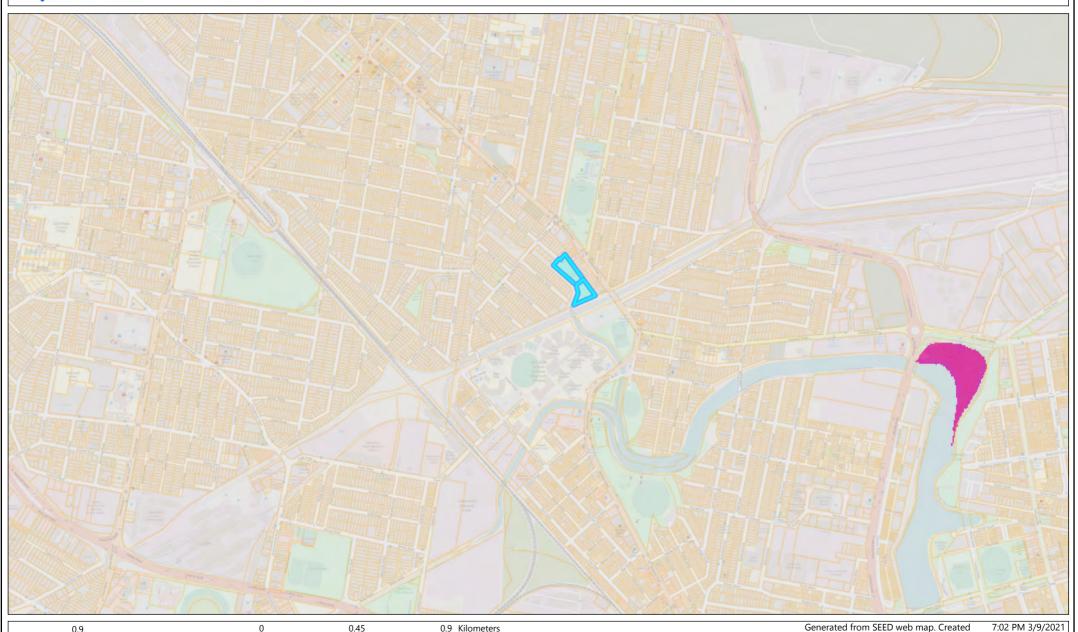






# Sharing and Enabling Environmental Data Throsby Creek Litchfield Park

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	Keith_Class		Saltmarshes
	rtom_oraco		South Coast Sands Dry Sclerophyll Forests
	Coast and Tableland Riverine Forests		Southern Escarpment Wet Sclerophyll
	Coastal Dune Dry Sclerophyll Forests	_	Forests
	Coastal Floodplain Wetlands		Subtropical Rainforests
	Coastal Freshwater Lagoons		Sydney Coastal Dry Sclerophyll Forests
	Coastal Headland Heaths		Sydney Coastal Heaths
	Coastal Heath Swamps		Sydney Hinterland Dry Sclerophyll Forests
	Coastal Swamp Forests		Sydney Montane Dry Sclerophyll Forests
	Coastal Valley Grassy Woodlands		Sydney Montane Heaths
	Cool Temperate Rainforests		Sydney Sand Flats Dry Sclerophyll Forests
	Dry Rainforests		Tableland Clay Grassy Woodlands
	Eastern Riverine Forests		Wallum Sand Heaths
	Hunter-Macleay Dry Sclerophyll Forests		Western Slopes Dry Sclerophyll Forests
	Inland Floodplain Woodlands		Western Slopes Grasslands
	Inland Riverine Forests		Western Slopes Grassy Woodlands
	Inland Rocky Hill Woodlands		Western Vine Thickets
	Littoral Rainforests		Lot
	Mangrove Swamps		
	Maritime Grasslands		
	Montane Bogs and Fens		
	New England Dry Sclerophyll Forests		
	New England Grassy Woodlands		
	No equivalent		
	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		
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### **APPENDIX E**

**Flood Impact Assessment** 

# **Technical Memo**

To: Shaun Murphy From: Peter Gillam

Hunter Water Aurecon

CC: Date: 13/07/2022

Subject: Flood Impact Assessment: Proposed stormwater amenity works for Throsby Creek,

Mayfield (Final)

Author Shae Jelly Reviewer Peter Gillam

### 1 Introduction

This memo outlines the methodology and outcomes of the flood impact assessment for the proposed stormwater amenity works on a section of Throsby Creek, Mayfield.

The proposed works area is within Litchfield Park, Mayfield 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 Throsby 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 on the east bank as shown in Figure 2-1 and Figure 2-2.

The works include:

- Saw cutting and removing the sections of the east concrete walls
- Placing a sandstone rock pool habitat with a diverse range of sandstone sizes
- Placing sandstone log retaining walls
- Planting between the rock walls with salt marsh communities
- Installation of two weirs to create permanent tidal pools
- Filling of the low flow channel upstream of the weirs where the permanent pool will otherwise exceed 300mm depth

Loss of channel conveyance associated with weirs and planting has been offset by increasing the cross-sectional area of the channel to minimise flood afflux.

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. Hydraulic design (Manning's formula) was undertaken during concept design development. Detailed flood modelling using a TUFLOW 2D hydraulic model was undertaken to confirm the expected flood impacts of the detailed design.

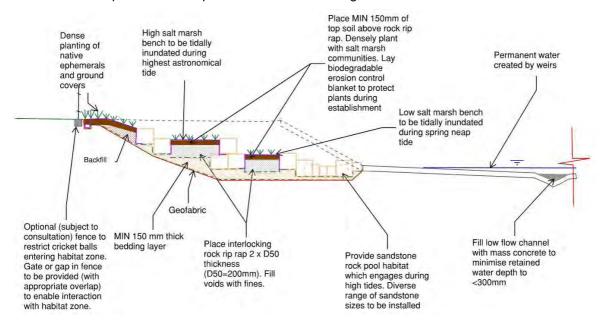


Figure 2-1 Concept design section of creek naturalisation works at outside bend and northern bank of Throsby Creek, Litchfield Park, Mayfield



Figure 2-2 Concept design plan of creek naturalisation works at Throsby Creek, Litchfield Park, Mayfield

# 3 Existing flood modelling data sets held by Council

Flood modelling has previously been undertaken by BMT WBM on behalf of The City of Newcastle (NCC) for the Throsby, Cottage and CBD Flood Study (August 2008).

The NCC Throsby Creek TUFLOW model represents concrete lined channels and bridges as 1D elements nested within the overbank floodplain area which was modelled as 2D grid using a 10m grid size. A WBNM hydrological model was used by BMT WBM to produce inflow hydrographs to the TUFLOW model. The studies used the Australian Rainfall and Runoff 1987 approach (AR&R87). The NCC Throsby Creek model is calibrated to the 1988 and 1990 historical flood events.

The NCC TUFLOW model and results were made available to use as a basis for this assessment. A review of the NCC Throsby Creek TUFLOW model determined that the 10m grid would be too coarse to appropriately model the resolution of the proposed creek naturalisation works. However, the NCC Throsby Creek model was considered a suitable basis for the schematisation of a new model (herein referred to as the HW TUFLOW model) and to extract design hydrographs to reflect the flood levels modelled in these past studies.

# 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 event flow 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 Throsby Creek TUFLOW results using WaterRide at each of the inflow locations of the HW Throsby Creek TUFLOW model.

At the site, the critical duration of 2 hours was adopted by NCC for the 10% and 1% AEP and the PMF event. Only these critical durations were modelled in the HW Throsby Creek model.

The bank-full flow was also considered, which was generated by first running the 10% event and extracting the time at which bank-full flow occurs in the HW Throsby Creek model. The 10% AEP hydrograph up to this time was then applied to the model for the bank-full flow simulation.

# 4.2 Hydraulic model parameters

A summary of the hydraulic model and parameters is provided in Table 4-1. The HW Throsby Creek TUFLOW model developed for the site was reduced to the area of interest and is shown in Figure 4-4. The model extent starts approximately 275m upstream of the proposed works at the confluence of Throsby Creek and the Waratah branch and extends past the railway culverts at the downstream end.

Table 4-1 Hydraulic model parameters

Parameter	Hunter Water Throsby Creek TUFLOW Model
Completion date	April 2022
Events/durations assessed	Bank-full flow 10yr 120min 100yr 120min PMF 120min
Hydrologic modelling	Hydrographs extracted directly from NCC Throsby Creek TUFLOW model (based on hydrology from WBNM model of ARR1987 hydrology)

Parameter	Hunter Water Throsby Creek TUFLOW Model
Hydraulic model software	TUFLOW quadtree model with version 2020-10-AB-iSP-w64
Grid size	2m base cell size over the floodplain with a 0.5m nested mesh refinement over the extent of site works
DEM	<ul> <li>Refer Figure 4-1 for data coverage.</li> <li>1m LiDAR – NSW Government LiDAR data set September 2014</li> <li>Survey data collected by Aurecon in 2021</li> <li>Design terrain modelling of completed site works</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 site survey. A design TIN has also been created for the 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.

Several terrain modifications were made to better represent the hydraulic conveyance in the base model. The channel terrain was reinforced under the Silsoe Street bridge and the railway culverts using the cross sections from the NCC Throsby Creek model 1D network. These areas were reinforced as the Silsoe Street bridge and railway were both modelled as flow constrictions (refer section 4.2.3).

The internal walls of the rail culverts were surveyed for inclusion into the 2D model to better represent the losses that would occur at this structure. This is further discussed in section 4.2.3.

Representation of both the floodplain and channel in the 2D domain is a significant difference from the existing modelling carried out by BMT WBM. This modelling approach yields 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 from the NCC Throsby Creek model were used as a basis but were further refined and adjusted where appropriate. 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 <i>n</i>			
	NCC Model	HW Model Base Model Setup		
Concrete channel	0.018 (1D)	0.018		
Sandstone blocks	-	0.02		
Spaces trees	-	0.04		
Vegetated banks	-	0.045		
Fence / Fenced lot	- Most lots modelled as Urban block, see below	0.1		
Default floodplain	0.03 (grass)	0.03		
Roads / railway	0.02	0.02		
Urban block	0.3	0.3		

# Together...

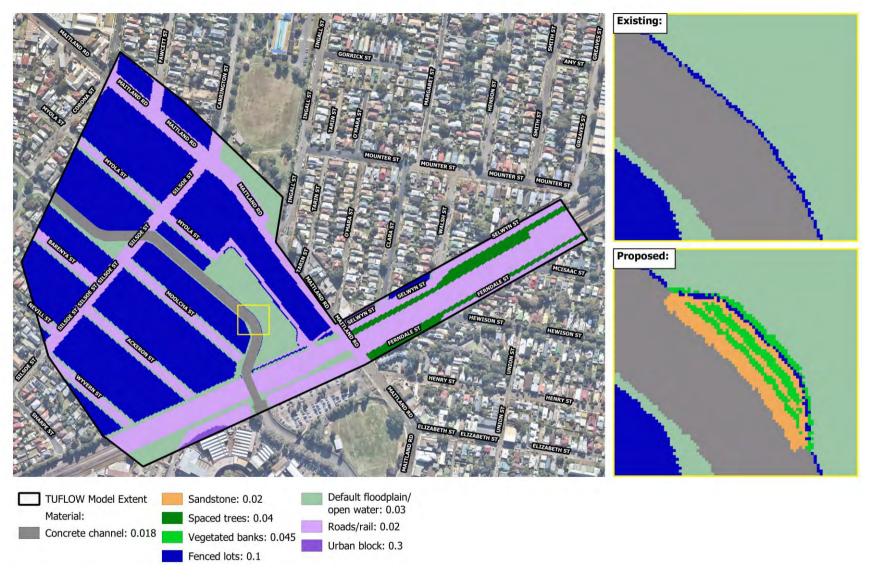


Figure 4-2 Manning's n coefficients for existing and proposed scenarios

### 4.2.3 Structures

There are several bridge structures in the NCC Throsby Creek model including the rail crossing downstream of the works, the pedestrian bridge adjoining Moolcha Street, and the Silsoe Street road bridge. 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 NCC TUFLOW model are 1D elements. A form loss coefficient of 0.1 was applied beneath the deck of the Silsoe Street and pedestrian bridges as per the NCC Throsby model, and 1.56 for the deck in line with the other Hunter Water works site models.

As discussed in section 4.2.1, the base terrain under the Silsoe Street bridge and for the base of the rail culverts was included into the 2D model using detailed survey and downstream inverts taken from the 1D network of the NCC model. A comparison between the NCC model and site survey at the rail culvert structure is shown in Figure 4-3. The site survey shows the presence of the internal walls at the rail culverts, and this is a key difference between the NCC and HW Throsby Creek model set ups. The model was originally run without these internal walls, which resulted in a reasonably close match to the NCC Throsby model results; typically within 110mm for the same 1% AEP flow and similar Manning's n values. However, it was decided that modelling the culvert walls in 2D rather than applying a 0.1 form loss coefficient would better represent the loss that would occur at this structure.

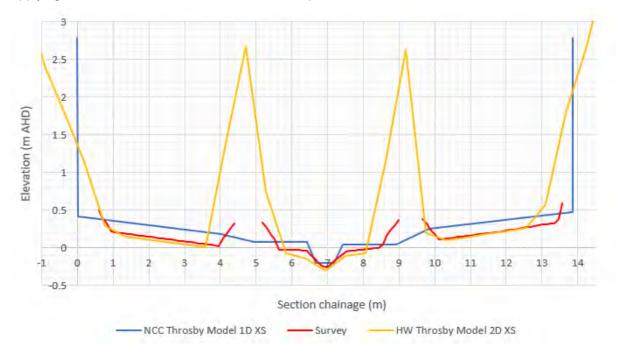


Figure 4-3 Rail culvert geometry as surveyed and represented in the NCC TUFLOW model

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

Structure	NCC Throsby Creek TUFLOW	HW Throsby Creek TUFLOW
Silsoe Street	1D	2D
bridge	Bridge soffit: 2.15 m AHD	Bridge soffit: 2.15 m AHD
	Bridge deck: 2.84 m AHD	Bridge deck: 2.84 m AHD
	Deck width: 21.3 m AHD	Deck width: 21.3 m

Structure	NCC Throsby Creek TUFLOW	HW Throsby Creek TUFLOW
Pedestrian	1D	2D
bridge	Bridge soffit: 2.3 m AHD	Bridge soffit: 2.3 m AHD
	Bridge deck: 2.68 m AHD	Bridge deck: 2.68 m AHD
	Deck width: 1.8 m	Deck width: 1.8 m
Rail culvert	1D	2D
	Bridge soffit: 2.78	Bridge soffit: 2.69 m AHD
	Bridge deck: 4.05	Bridge deck: 3.69 m AHD
	Deck width: 24.8 m	Deck width: 24.8 m
	Two support walls under deck not	Note: Deck level taken from LiDAR
	included in bridge geometry	Two support walls under deck included in bridge geometry

### 4.2.4 Initial water level

The default initial water level in the NCC Throsby Creek model is 0.6 m AHD for the PMF and 0.501 m AHD for all other events. These same values were applied to the HW Throsby Creek model.

A low tailwater scenario was adopted for simulating hydraulics around the proposed works as discussed below in section 4.2.5. The initial water level was set to match the low tailwater level (-0.709 m AHD) in this scenario which would result in higher velocities that might occur in the channel.

## 4.2.5 Boundary conditions

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

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

This section of Throsby Creek is tidally influenced and as such, required an appropriate tailwater level be applied. The NCC Throsby Creek model applied a dynamic tailwater level for each event at the downstream end of the model. The period of the dynamic tailwater applied to each duration typically resulted in a worst-case flood level result. Stage-time (HT) curves were extracted from the NCC model at the location of the HW Throsby Creek downstream boundary and applied as a dynamic tailwater to the HW model.

A low tailwater scenario was run for the proposed works scenario where the tailwater was set to - 0.71 m AHD, which is the lowest level in the dynamic tailwater that is applied at the downstream end of the NCC Throsby model. This was set to determine peak velocity results in an event where the tailwater does not inundate any part of the proposed works and the resulting flood velocities are not dampened by the tailwater. A tailwater of -0.71 m AHD is a conservative estimate when assessing worst-case velocities, as the tailwater level may only reach this level in rare events.



Figure 4-4 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 impacts 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 2-2, 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 impact maps of the modelled works show that there is potential for some minor localised changes in the 1% AEP and PMF flood levels at the transitions of the structural works and immediately upstream of the weirs. There are no adverse impacts to private properties and only a minor impact (<20mm) adjacent the pedestrian bridge on Moolcha Street in the 1% AEP event. There are no adverse impacts in the PMF event.

During the 10% AEP event, flood afflux mapping shows localised impacts within the channel for the extent of the proposed structural works. This impact extends up to the lot boundaries from the corner of 31 Moolcha Street to 35 Moolcha Street. A 12mm impact encroaches into the 33 Moolcha Street boundary over a very small area (0.5 m² in extent), and the impact reaches a 25mm increase in flood depth adjacent the lot boundaries.

It should be noted that the 1% AEP flood level (existing and proposed) sits below the finished floor levels of these properties between 31 to 35 Moolcha Street. A comparison has been made between flood levels and floor levels provided by NCC. As such, any possible impact within the property boundaries that may result from flows between the 10% and 1% AEP events will not result in worsening of flooding causing above floor flooding on any lots in the vicinity of the works.

### 5.2 Design velocity

Flood velocities have been reviewed for the proposed design case to ensure the proposed riprap is sized correctly and will not be subject to scour or uplift. For this purpose, the model was run with a very low tailwater level to ensure the worst-case velocities were observed at the creek naturalisation works. The design peak velocity maps are presented in Figures A5 to A8.

The 1% AEP velocity results show that flow velocities over the rock works are typically below 1.5 m/s and do not exceed 1 m/s over the extent of planting. Only the PMF indicates velocities may exceed 1.8 m/s within the extent of works, but even this is only at the transition and remains below 1.5 m/s within the planting extent.

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

# 5.3 Sensitivity Testing of Velocity

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 (under the low tailwater condition) is shown in Figure 5-1. It can be seen in the proposed scenario that velocities are not expected to exceed 1.8 m/s and are typically below 1.5 m/s for the majority of the works extent.

The sensitivity test shows that the maximum velocities during low roughness, or plant establishment, could reach 2.1 m/s but only at the upstream transition area. Velocities over the remainder of the works extent would be similar to the base case conditions. The expected velocity over the benches within the works extent has been considered in the erosion control and establishment of the proposed planting.

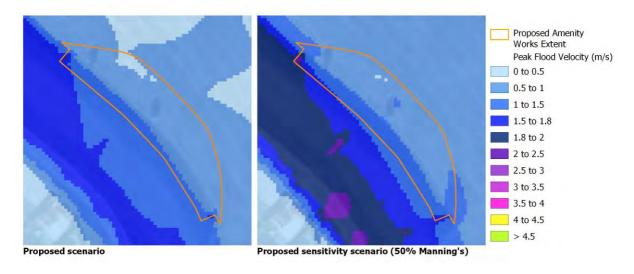


Figure 5-1 1% AEP (low tailwater) sensitivity test velocity comparison

# 5.4 Sensitivity Testing of Tailwater

As discussed in section 4.2.5, a low tailwater scenario was run for the 1% AEP to determine the worst-case velocity results that may be expected at the proposed amenity works. The effect that the low tailwater boundary conditions has on the water level along the length of the model is shown in Figure 5-2. The low tailwater scenario results in a reduced water level profile of approximately 90mm adjacent the works and is typically less than 100mm difference upstream of the rail culverts. This indicates that the water level results have relatively low sensitivity to the tailwater conditions, and the downstream control of the rail culverts has a greater influence over the results. Therefore there is a low risk of incorrectly modelling the tailwater level downstream of the rail culverts.

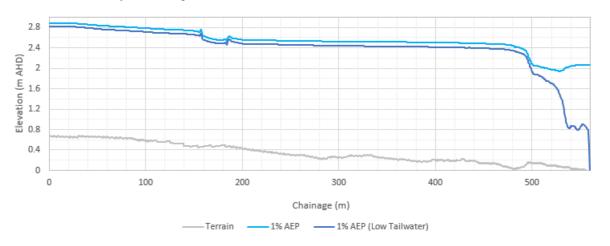


Figure 5-2 Water level profiles for the 1% AEP base case and low tailwater level scenarios

### 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 W Throsby Creek TUFLOW model health

Simulation	Final Cumulative Mass Error (CME) %
Bank full Existing	0.01
10% AEP 540min Existing	-0.01
1% AEP 540min Existing	-0.00
PMF 120min Existing	-0.01
Bank full Proposed	0.01
10% AEP 540min Proposed	-0.01
1% AEP 540min Proposed	-0.00
PMF 120min Proposed	-0.01

## 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. These plot comparisons for the 10% AEP event and 1% AEP event are shown in Figure 6-1 and Figure 6-2 respectively. Please note that all hydrographs are shown but may not be individually visible where overlayed.

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 flood impacts (in both an increase and decrease in levels) over the site works, the flow behaviour and floodplain storage remains effectively unchanged.

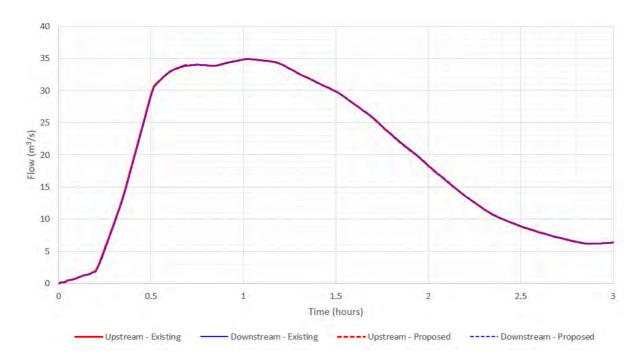


Figure 6-1 10% AEP flow plot comparisons upstream and downstream of the proposed works

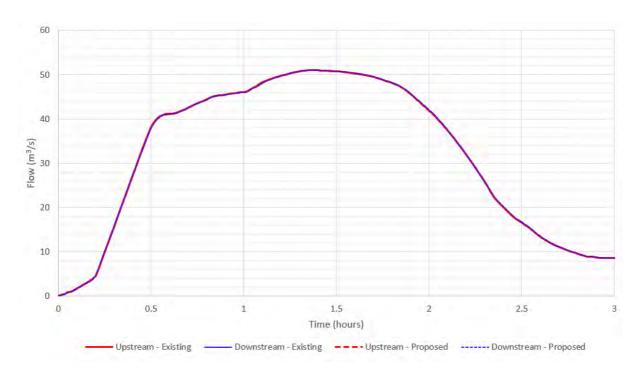


Figure 6-2 1% AEP flow plot comparisons upstream and downstream of the proposed works

# 6.3 Comparison to Council Flood Mapping

A comparison of the flood extent predictions between the NCC and HW Throsby Creek models for 10% AEP, 1% AEP and PMF events (critical durations) is compared below in Figure 6-3, Figure 6-4 and Figure 6-5 respectively. The HW Throsby Creek modelling includes the support walls under the rail bridge, whereas the NCC Throsby Creek model does not include these walls. This modelling shows a difference between the 1% AEP flood level models of up to approximately 340mm between

the Silsoe Street bridge and the railway bridge. This discrepancy in modelled levels is due to the difference in hydraulic losses induced by the rail bridge support walls and their effect on upstream flood levels.

Where the HW Throsby Creek model is run without the support walls under the rail bridge in a consistent way to the NCC Throsby Creek model, the HW Throsby Creek model produced slightly higher levels than the NCC Throsby Creek model but typically within 110mm for the same 1% AEP flow and similar Manning's n values. This shows that except for the railway bridge walls, the HW Throsby Creek model generally predicts similar flood behaviour.

Given that the support walls are likely to have the effect of inducing hydraulic losses at the rail bridge, it has been decided to include the walls in hydraulic testing, as outlined above.

### 6.4 Validation of Flood Model

The HW Throsby Creek baseline hydraulic model is fit for the purpose of modelling flood impacts associated with the proposed works as it:

- yields a stable solution
- preserves the volume and shape of critical flood hydrographs
- predicts 1% AEP flood extents and levels that generally match Council's adopted model and therefore the HW Throsby Creek TUFLOW model predicts similar hydraulic behaviour.



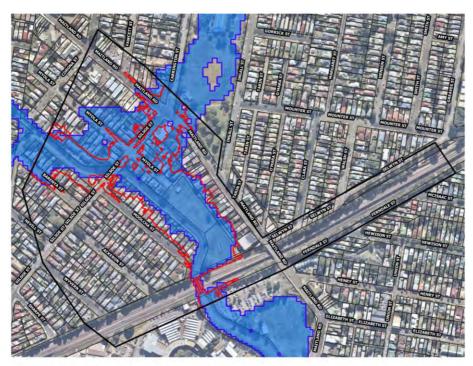
■ TUFLOW Model Extent

Peak Flood Extents

NCC Throsby Creek model

HW Throsby Creek model

Figure 6-3 Comparison of model peak flood level extents for the 10% AEP extents



- ☐ TUFLOW Model Extent
- Peak Flood Extents
- NCC Throsby Creek model
- HW Throsby Creek model

Figure 6-4 Comparison of model peak flood level extents for the 1% AEP extents



- TUFLOW Model Extent
- Peak Flood Extents
- NCC Throsby Creek model
- HW Throsby Creek model

Figure 6-5 Comparison of model peak flood level extents for the PMF extents

### 7 Conclusions

The proposed works are located within a small footprint of the Throsby 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 TUFLOW model. Flows were extracted using WaterRide.

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

### **Model Validation**

Base case model results of the existing floodplain were compared with the 1% AEP NCC model results before and after adjustment of the rail bridge structure geometry and losses.

When the rail culvert was modelled with a form loss coefficient of 0.1 and no internal walls, the flood levels compared reasonably well for the 1% AEP event results; with the HW 1% AEP flood levels within 110mm of the NCC model results.

When the modelling includes the surveyed support walls under the rail bridge, the 1% AEP event results are typically within 340mm of the NCC model results. This is considered an acceptable difference in flood levels given the change in losses at the downstream control. 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 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 and weirs for a range of flow events. 1% AEP flood levels are likely to increase by up to 27mm over the extent of works. No increase in 1% AEP flooding affects existing buildings, infrastructure, roads or private property. There are no adverse impacts in the PMF event.

10% AEP flood levels are likely to increase within the channel for the extent of the proposed structural works and extend up to the rear of the lot boundaries from the corner of 31 Moolcha Street to 35 Moolcha Street. A 12mm impact encroaches into the 33 Moolcha Street property boundary over a 0.5 m<sup>2</sup> extent, and the impact reaches 25mm along the lot boundaries.

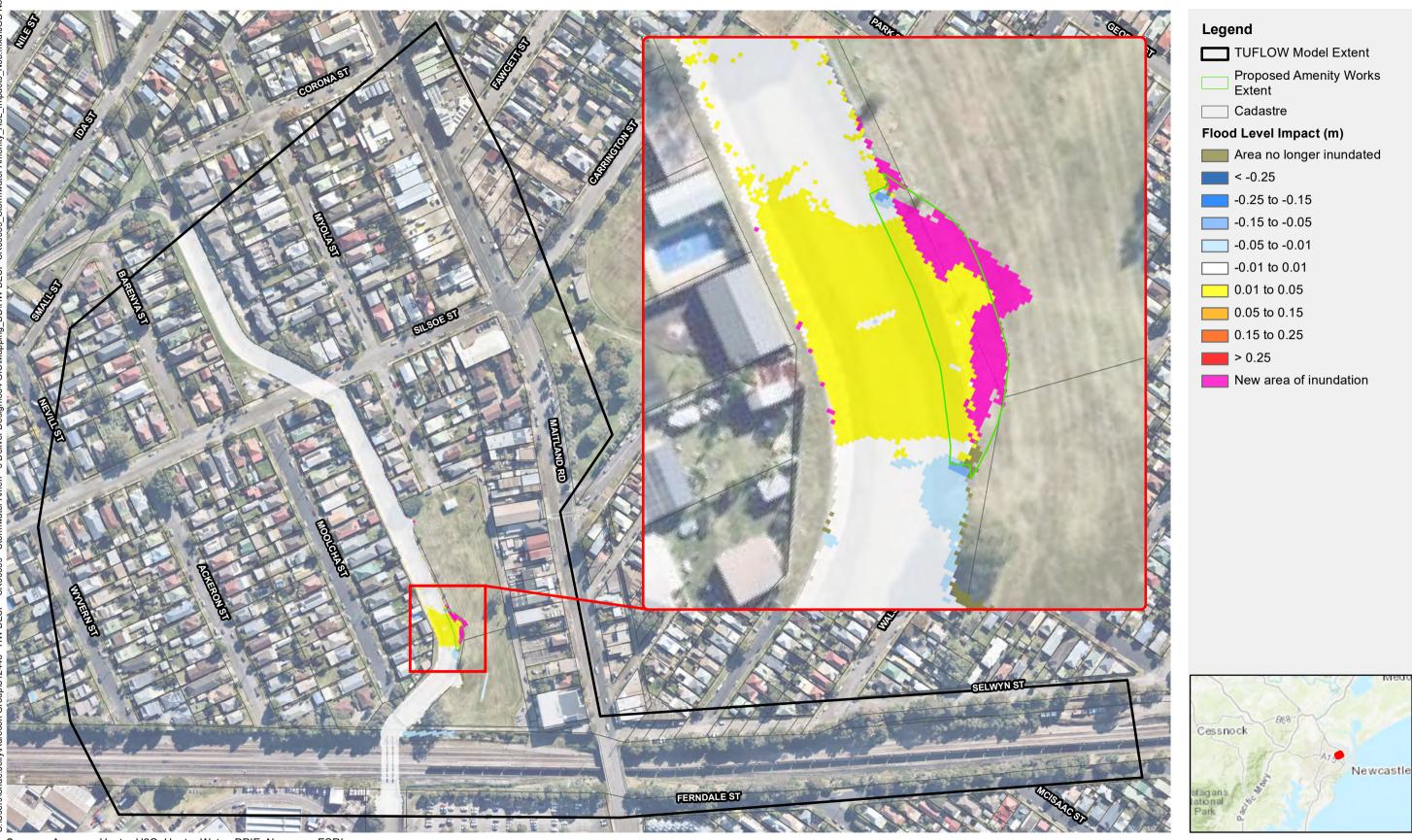
### **Velocity and Scour Protection**

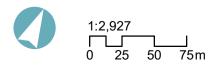
Flood velocities have been reviewed for the proposed design case to ensure the proposed riprap is sized correctly and will not be subject to scour or uplift.

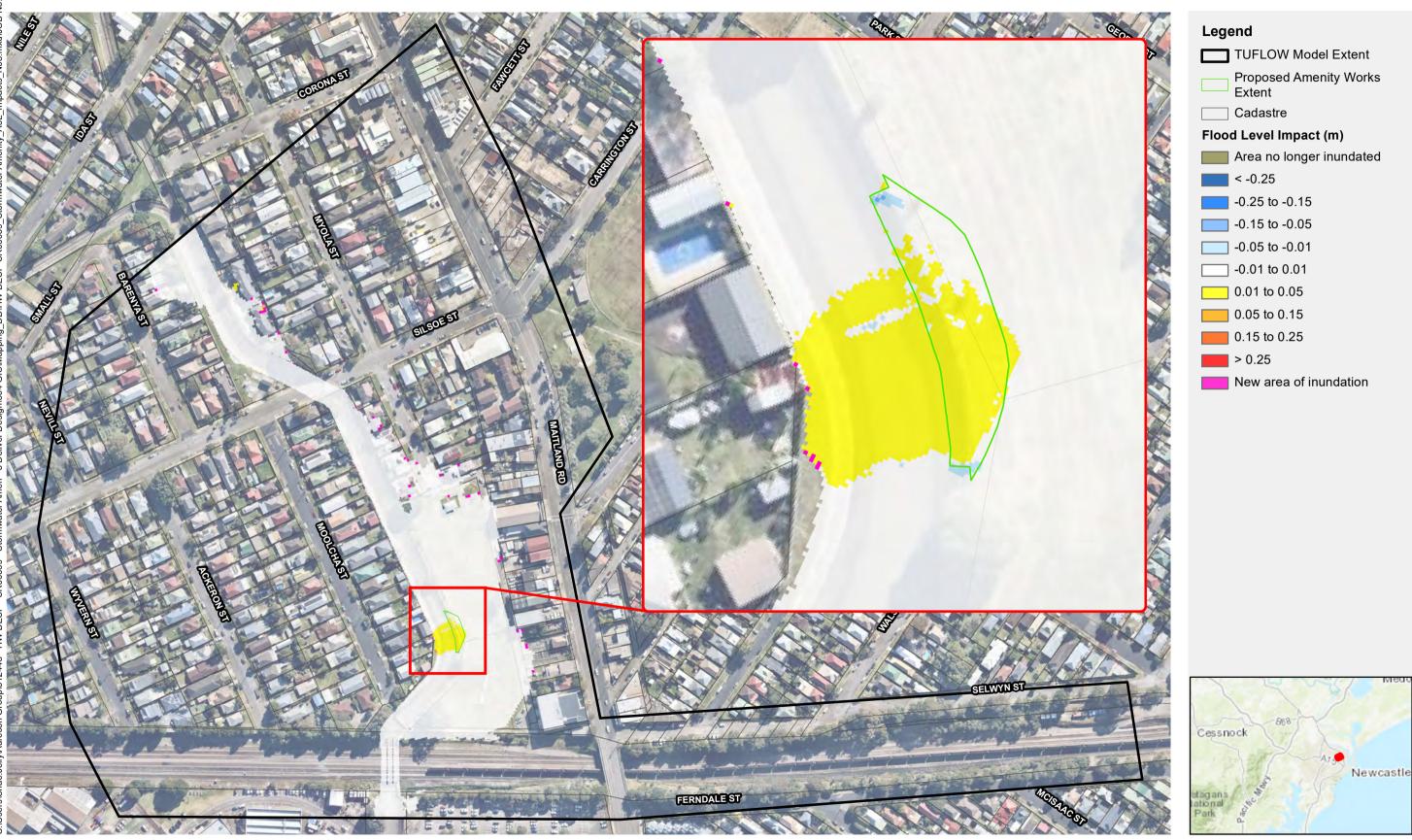
The 1% AEP flood velocities are typically below 1.5 m/s and do not exceed 1 m/s over the extent of planted areas once plants have fully established.

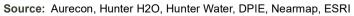
During plant establishment, 1% AEP flow velocities are not expected to exceed 1.8 m/s and are typically below 1.5 m/s for the majority of the works extent.

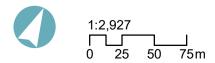
### Flood mapping



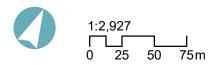


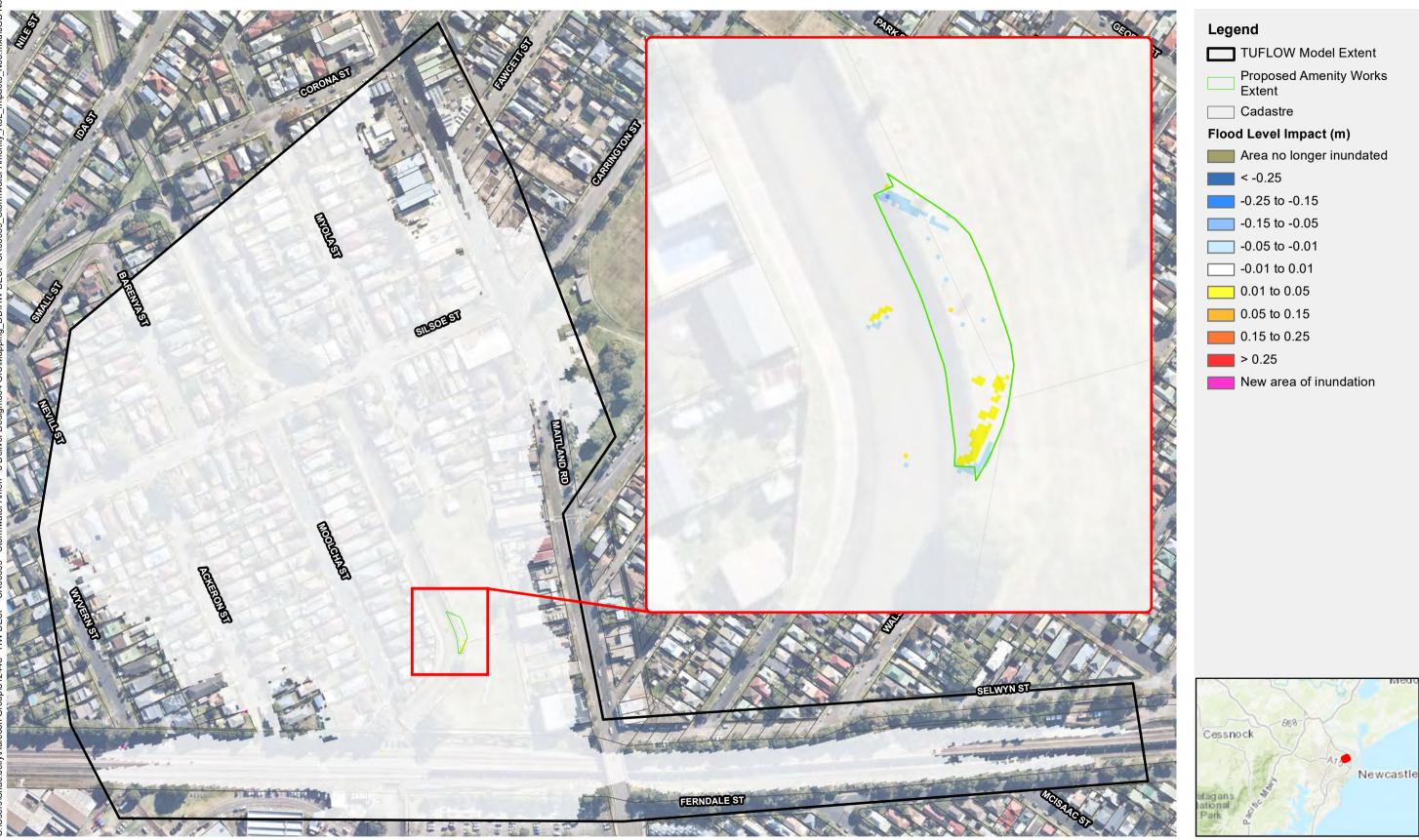


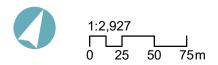






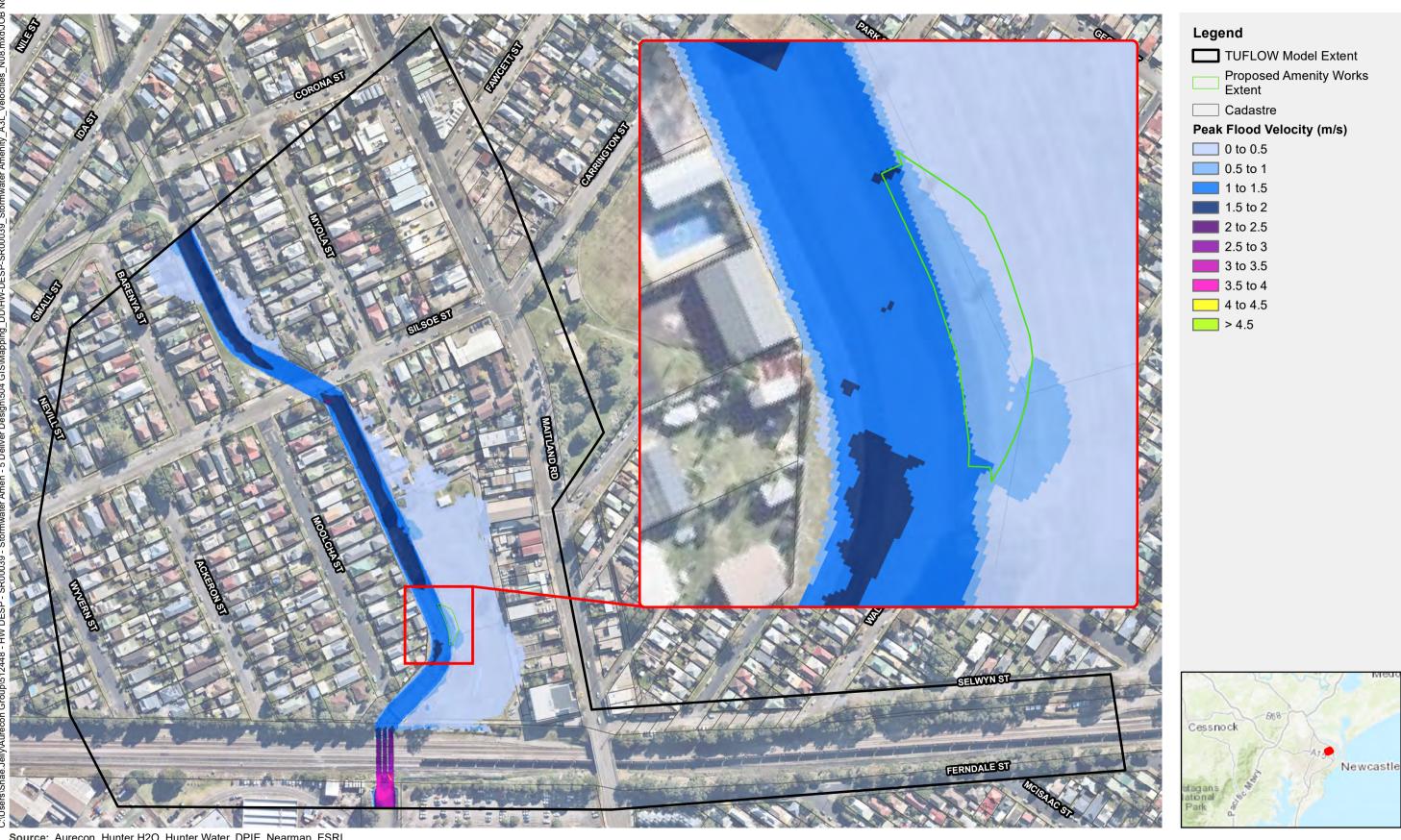


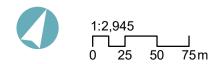


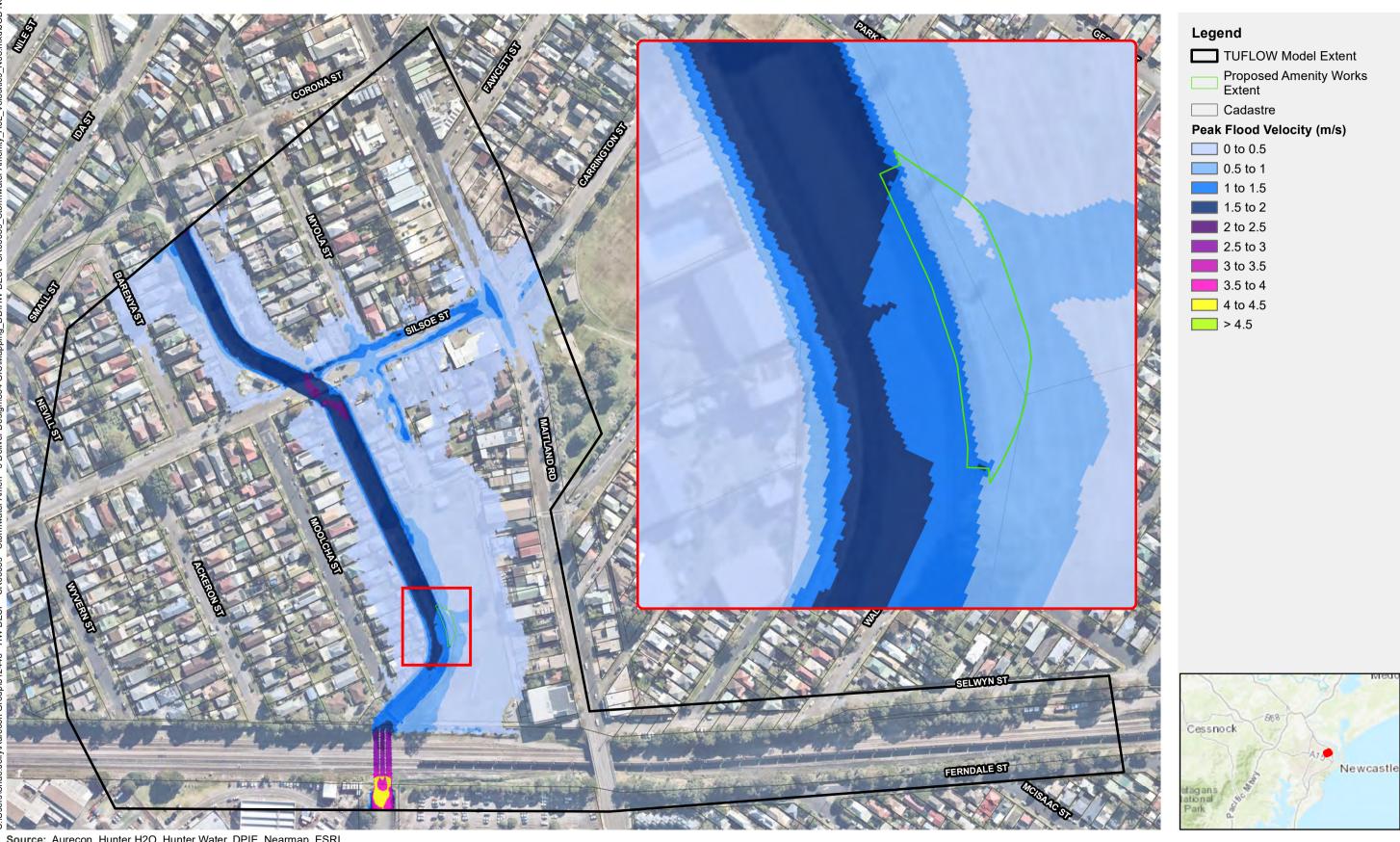


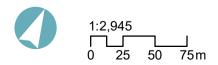


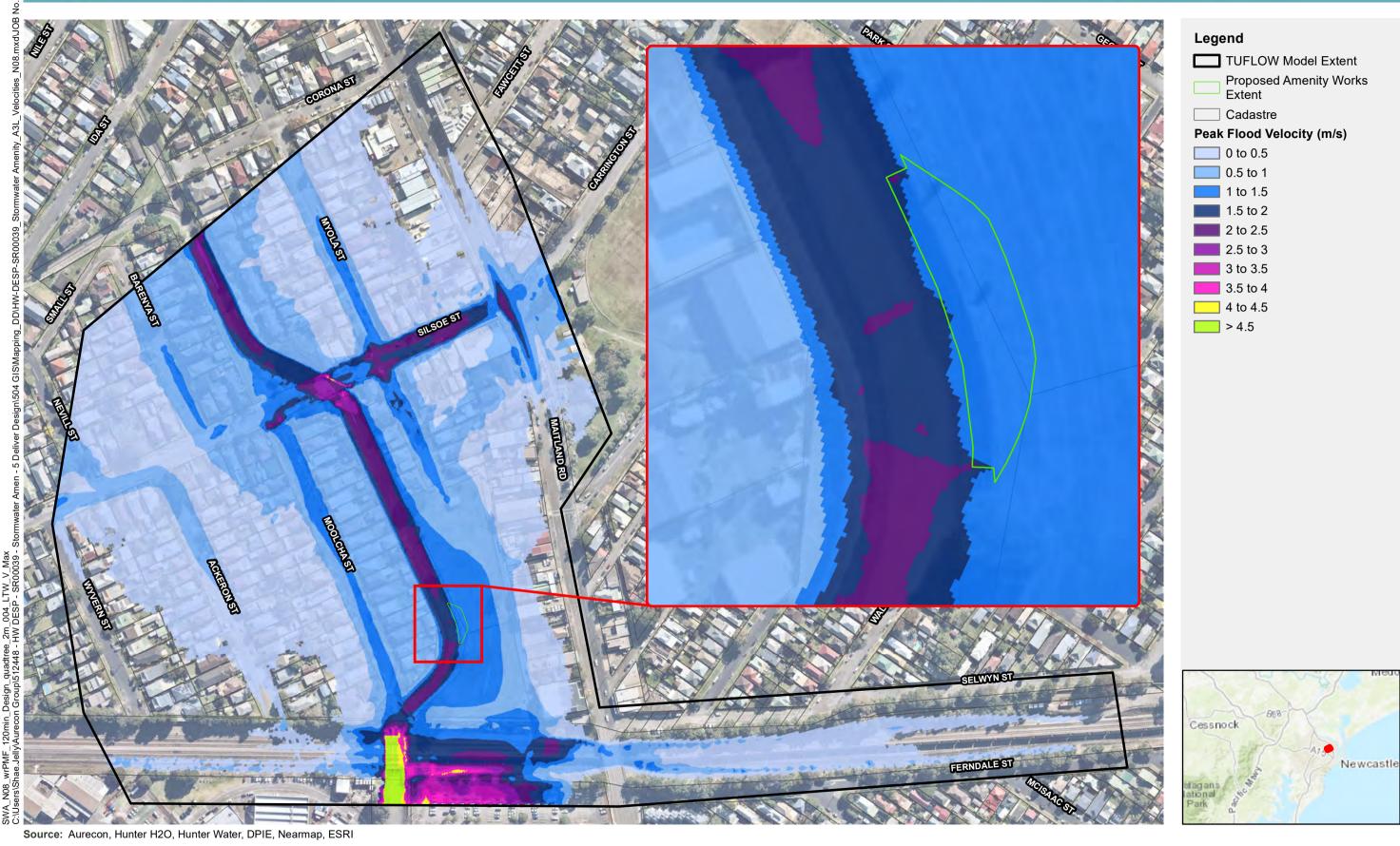
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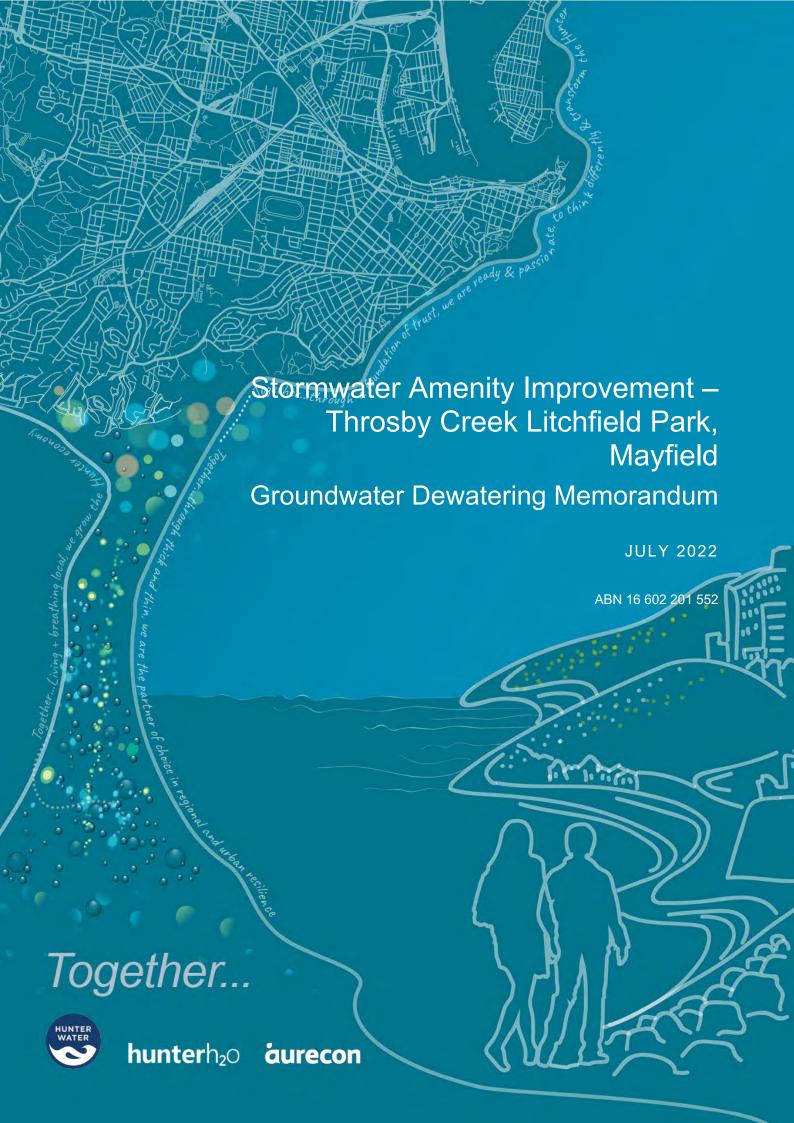




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## **APPENDIX F**

**Groundwater Dewatering Memorandum** 



### **Report Details**

Report Stormwater Amenity Improvement –Throsby Creek Litchfield Park, Mayfield:

Title Groundwater Dewatering Memorandum

Project No. 512448
Status Draft

**File** https://aurecongroup.sharepoint.com/sites/512448/5 Deliver Design/501 **Location** Engineering/Reports/Groundwater/Mayfield/512448 Mayfield\_Stormwater

Amen Dewatering Memo RevB.docx

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### **Document History and Status**

Revision	Report Status	Prepared by	Reviewed by	Approved by	Issue Date
Draft	Draft for client comment	Manon Gebauer	Harry Gregg	William Legg	03/05/2022
Final	Final version	Manon Gebauer	Harry Gregg	William Legg	22/06/2022
Final rev1	Final version, revision 1	Manon Gebauer	Harry Gregg	William Legg	12/07/2022

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#### Contents

1	lı	ntro	ducti	on	3
	1.1		Obje	ectives and Scope of Works	3
2	C	Ove	view	of Design and Construction Activities	4
	2.1		Exca	avation and Dewatering Methodologies	7
3	A	Asse	essm	ent Methodology	8
	3.1		Des	ktop Assessment	8
	3.2		Geo	technical Investigations	8
	3.3		Ana	lytical modelling methodology	11
		3.3	.1	Radius of Influence	11
		3.3	.2	Groundwater Recharge	11
		3.3	.3	Dewatering Rates	11
4	C	3rou	ındw	ater Conditions	13
	4.1		Surf	ace Geology	13
	4.2		Litho	ology	14
	4.3		Grou	undwater Levels	14
	4.4		Hyd	raulic Conductivity	15
5	F	Resi	ults		16
6	C	Cond	clusio	ons and Recommendations	18
7	F	Refe	renc	es	19
Ω	^	\ee1	ımnti	ione and Limitations	20

Figures		
Figure 2-1	Throsby Creek Litchfield Park: Mayfield Site Overview	5
Figure 2-2	Throsby Creek Litchfield Park: Mayfield Typical Cross-Section	6
Figure 2-3 2022)	Conceptual diagram – Sump pump dewatering methodology (Image source: Gharpe 7	dia,
Figure 3-1	Throsby Creek Litchfield Park: Mayfield Geotechnical Investigation Locations	. 10
Figure 4-1	Surface geology mapping at the site (Department of Regional NSW, 2018)	. 13
Tables		
Table 2-1	Concept design details summary	4
Table 3-1	Summary of the borehole locations.	8
Table 3-2	Standpipe piezometer details.	9
Table 4-1	Lithological observations - Summary	. 14
Table 4-2	Groundwater level measurement at the site	. 14
Table 4-3	Adopted hydraulic conductivity values	. 15
Table 5-1	Throsby Creek Litchfield Park: Mayfield – Dewatering Estimates	. 16
Table 5-2	Groundwater recharge rates	. 16
Table 5-3	Total dewatering volumes	. 17

## **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 **Throsby Creek Litchfield Park, Mayfield (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 **Throsby Creek Litchfield Park**, **Mayfield** (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** and **Figure 2-2** and are summarised in **Table 2-1** below.

Table 2-1 Concept design details summary

Site Location	Total excavation length (m)	Maximum excavation depth (mBGL*)
Throsby Creek, Mayfield	36	2.0
	(North-eastern bank)	

<sup>\*</sup>mBGL = metres below ground level.

## Together.

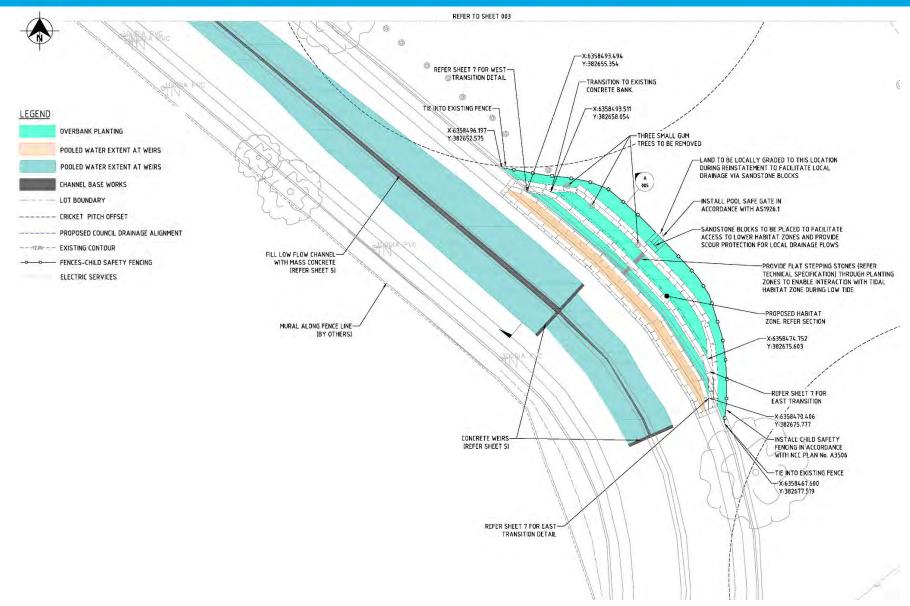


Figure 2-1 Throsby Creek Litchfield Park: Mayfield Site Overview

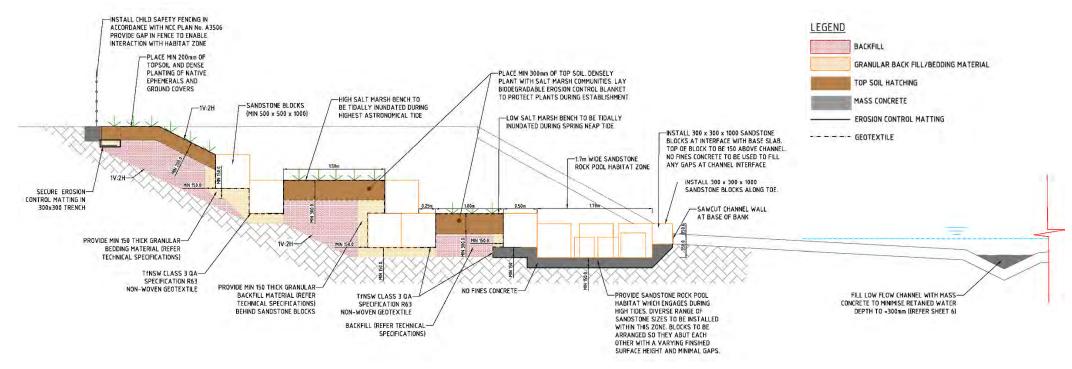


Figure 2-2 Throsby Creek Litchfield Park: Mayfield Typical Cross-Section

## 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, bedding layer and sandstone blocks to the 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 tidal inflows 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.

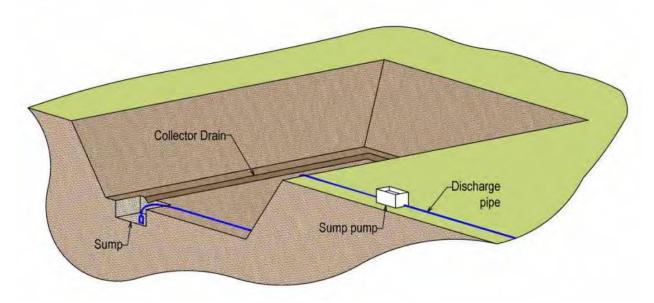


Figure 2-3 Conceptual diagram – Sump pump dewatering methodology (Image source: Gharpedia, 2022)

## 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 Throsby Creek Mayfield (N08): 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 boreholes 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 indicated on **Figure 3-1** and the borehole logs and explanatory notes are presented in **Appendix B**.

Location	Borehole ID/ Test Pit ID	Easting (mE)	Northing (mN)	Top RL (mAHD)	Drilled Depth/Excavated Depth (mBGL)	Piezometer Installed
Mayfield	N08-BH01	382613	6358531	1.92	5.45	-
	N08-BH02	382658	6358492	1.67	5.45	Yes
	N08-BH03	382678	6358469	1.68	2.45	-

#### 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 N08-BH02. 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)
N08-BH02	5.45	0.0 – 1.0	1.0 – 1.5	1.8 – 4.8	1.5 – 5.45

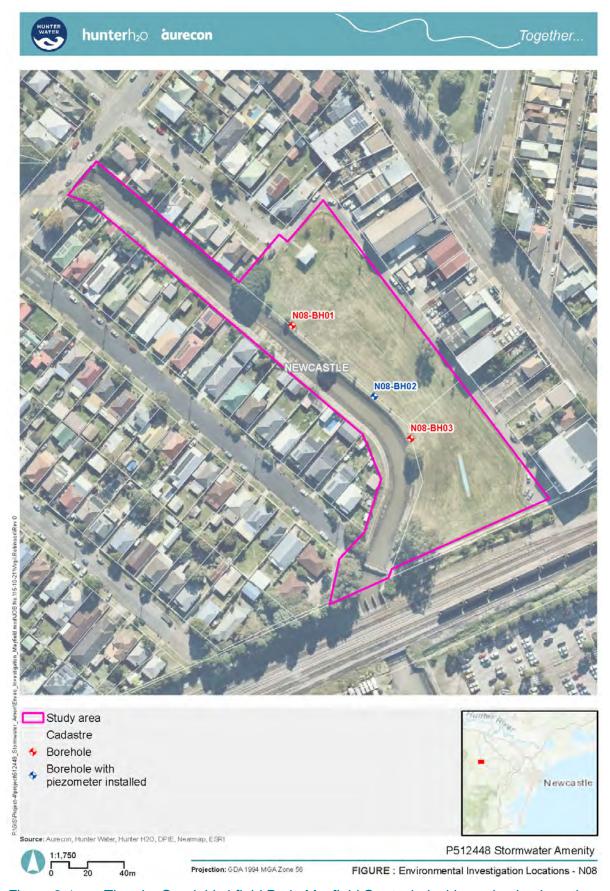


Figure 3-1 Throsby Creek Litchfield Park: Mayfield Geotechnical Investigation Locations

### 3.3 Analytical modelling methodology

Dewatering rate/volume calculations were carried out for the site as identified in Section 2. 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 project will be four weeks.

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 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:

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

Where:

Ro = 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.

## 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).

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

#### 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)

R₀ = 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 flood plain Deposits (QH\_af) comprising of silt, very fine to medium-grained lithic to quartz-rich sand, clay. The site is also overlain by Estuarine channel deposits (subaqueous) (QH\_ecw) compromising of fine- to medium-grained lithic-carbonate-quartz sand (marine-deposited), silt, clay, shell, gravel. The approximate site location is identified in relation to the NSW state surface geology in **Figure 4-1**.

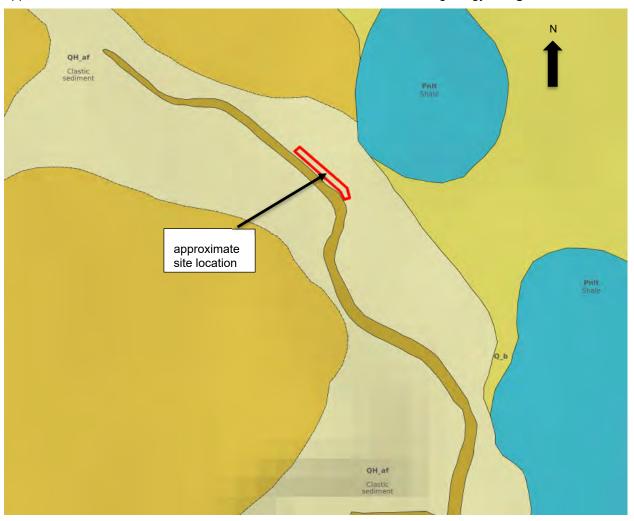


Figure 4-1 Surface geology mapping at the site (Department of Regional NSW, 2018)

#### 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	Bore/Test Pit ID			
Description	N08-BH01	N08-BH02	N08-BH03	
Fill	0.00 – 1.40	0.00 - 0.60	0.00 – 1.30	
Alluvium	1.40 – 4.40	0.60 - 4.00	1.30 – 2.45	
Residual soil	4.40 – 5.45	4.00 – 5.30	-	
Weathered bedrock material	-	5.30 – 5.45	-	

The fill material was typically logged as the following

- **Sandy clay** Characterised as low plasticity with medium grained sand. The colour of this material was dark brown and had a moisture condition of greater than the plastic limit.
- **Silty clay** Characterised as medium plasticity. The colour of this material was dark brown and had a moisture condition of greater than the plastic limit.
- Silty sand Characterised as fine to medium sand. The colour of this material was dark grey and had a moisture condition of dense.

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

- Clayey Sand The material was characterised as fine to medium sand. The colour of this
  material was dark grey and had a moisture condition of moist.
- **Sand** The material was characterised as fine to medium grained sand. The material was saturated with a grey colour.

The residual soil material is typically logged sandy clay. The material was characterised as soft consistency, medium to high plasticity with fine to medium grained sand. The colour of this material was dark grey with a moisture condition of greater than the plastic limit.

There was a thin layer of extremely weathered material typically logged as mudstone. The material was characterised as hard with carbonaceous inclusions. The colour of this material was dark grey with a moisture condition of greater than the plastic limit.

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 23 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)
N08-BH02	21/09/2021	1.3	0.37

## 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	Material	Adopted USDA		draulic conduction and Rawls, 2	
Description	Description	soil texture class	Minimum (m/s)	Geometric mean (m/s)	Maximum (m/s)
Alluvium	Clayey sand / sand	Loamy sand	9.88 x 10 <sup>-6</sup>	1.83 x 10 <sup>-5</sup>	3.39 x 10 <sup>-5</sup>

## 5 Results

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

The required drawdown, based on the maximum depth of excavation (2.0 mBGL) and the measured groundwater level (1.3 mBGL) is approximately 0.7 m. To introduce a level of conservatism, and account for the potential variability in groundwater level at the site (due to climatic conditions, likely tidal influence etc), 0.5 m has been added to this value and 1.2 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 project features is approximately 36 m. For the purposes of dewatering calculations, it is assumed that the duration of earthworks for the project will be four weeks.

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

Table 5-1 Throsby Creek Litchfield Park: Mayfield – Dewatering Estimates

Parameter	Values		
	Minimum	Expected	Maximum
Required drawdown (m)	1.2	1.2	1.2
Applied hydraulic conductivity (m/s)	9.88 x 10 <sup>-6</sup>	1.83 x 10 <sup>-5</sup>	3.39 x 10 <sup>-5</sup>
Radius of Influence (m)	7.54	10.26	13.97
Total length of trench (m)	36	36	36
Discharge rate (m³/day)	3.17	7.98	20.11
Dewatering duration (days)	28	28	28
Total discharge (m3)	88.70	223.48	563.08

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> )	605.6	Average radius of influence buffer around total length of excavations.
Average annual rainfall (m/year)	1.118	Annual average rainfall between 1862 to 2022 (Newcastle Nobbys Signal Station, No. 61055 (BoM, 2022))
Average annual rainfall volume (m³)	677.1	Calculated based on above values
Groundwater recharge rate (%)	18%	Adopted as typical value based on recharge studies from unconfined coastal alluvium aquifers in NSW (CSIRO, 2010)
Groundwater recharge rate (m³/day)	0.3	Calculated based on above values

Parameter	Value	Comment
Total groundwater recharge volume (m³)	30.7	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 (m³)						
	Minimum	Expected	Maximum				
Total including estimated groundwater recharge	98.0	232.8	572.4				

Therefore, the estimated total volume of dewatering, including groundwater recharge during dewatering, is expected to be 232.8 m³, or 0.23 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. 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(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 0.23 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*, would be:

- Discharge to a receiving surface water body such as creek, river, stream etc. 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

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## 8 Assumptions and Limitations

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

- The required drawdown, based on the maximum depth of excavation (2.0 mBGL) and the measured groundwater level (1.3 mBGL) is approximately 0.7 m. To introduce a level of conservatism, and account for the potential variability in groundwater level at the site (due to climatic conditions, likely tidal influence etc), 0.5 m has been added to this value and 1.2 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 four weeks.
- Groundwater recharge volumes have been estimated based on average annual rainfall amounts between 1862 to 2022 (Newcastle Nobbys Signal Station, No. 61055 (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)



Empirical equation based on drawdown and permeability

Essential input
Optional input
Calculated

	_	-		
Drawdown in well	s	expected 1.2 m	min max 1.2 1.2 m	
Hydraulic conductivity	K	1.83E-05 m/s	9.88E-06 3.39E-05 m/s	The following assumptions apply to this equation
		1.5803 m/d	0.85345 2.9261 m/d	- the aquifer is unconfined
				- the aquifer has infinite areal extent
Factor	С	2000	3000 for radial flow	- the aquifer is homogeneous, isotropic and of uniform thickness
			1500-2000 for line flow to	- flat initial water table
			trenches or wellpoints	- the aquifer is pumped at a constant discharge rate
Radius of influence	$R_0$	10.26 m	7.54 13.97 m	<ul> <li>- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer</li> <li>- the flow to the well is in a steady state</li> </ul>
				the new te the well is in a dieday state
Data sources (to complete an audit trail)				
Drawdown in well	S	Depth of exca	vation (2.0m) - groundwater	depth (1.3 m) + 0.5 n
Hydraulic conductivity	K	Assumed hyd	raulic conductivity range (Sa	axton and Rawls, 2006
Factor	С	Linear trench		

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

$$Q = \left[ \left( 0.73 + 0.27 \frac{(H - h_{v})}{H} \right) \frac{Kx}{R_{0}} (H^{2} - h_{v}^{2}) \right]$$

Essential input Optional input Calculated

Head		expected	min	max	<del>-     -     -     -     -     -     -       -       -  </del>	
Height of water table at radius of influence	Н	1.2 m	1.2	1.2 m		2
Height of water table at well	$h_w$	<mark>0</mark> m	0	<mark>0</mark> m		
Conductivity					Line source	
Hydraulic conductivity of aquifer	K	1.580 m/d	0.853	2.926 m/d	จาดบางบอาดบางบางบางบางบางบางบางบางบางบางบางบางบางบ	0601
Radius					R <sub>o</sub>	
Length of trench	X	36 m	36	36 m	(Figure adap	tec
Distance to line source, equal to radius of influence	$R_0$	10.26 m	7.54		The following assumptions apply	to
			``mmananananana	**************************************	- the slot is infinite in length	
Is R <sub>0</sub> /H greater than or equal to 3 ?		Yes	Yes	Yes	- R <sub>0</sub> /H greater than or equal to 3	
					- the aquifer is unconfined	
Total discharge from wellpoints	Q	7.98 m <sup>3</sup> /d	l 3.17	20.11 m <sup>3</sup> /d	- the aquifer is homogeneous, iso	tro
					and of uniform thickness	
					- the Dupuit Forcheimer assumpti	
					- the aquifer has reached steady	
					- the initial water table is horizonta	ii.
Data sources (to complete an audit trail)					<u> </u>	

▼		<b>→</b>
Line source		Line
onconcondencionacionacionicionicion	ocorocorocarocorocorocorocoro	uniconconconco

ted from Mansur & Kaufman, 1962)

to this equation

- tropic
- on is valid
- tate conditions

(Mansur & Kaufman, 1962)

Data sources (to complete an audit trail)		
Height of water table at radius of influence	Н	Depth of excavation (2.0m) - groundwater depth (1.3 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 trench section
Radius of influence	$R_0$	Calculated from Sichardt method

## Appendix B

# **Borehole Logs**

## Engineering Log - Borehole

SHEET 1 OF 1

	Cli Pro	•	t		Sto		Water vater Amenity d					Lo	roject No. ogged By hecked By	512448 MC NS	
	Со	mp	d D leteo	d D	ng rillin	g	21.9.21 21.9.21	Northing Easting	6358531.00 382613.00 DESCRIPTION	Slope Bearing	90		Equipme Ground	Level	DT1200 1.924 AHD G & OTHER INFORMATION
Method					Graphic Log	Classification		Descri (soil type: pla	otion of Soil asticity/grainsize, ther components)		Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
			1	_1		CL	FILL: Sandy CLA	AY: low plasticity, c	lark brown, medium grai	ned sand			SPT 2, 3, 3 N=6		FILL  SPT Recovery: 0.45 m
		(	0-1	2		СН	Silty CLAY: high	n plasticity, grey, trace fine to medium grained sand		F	SPT 0, 1, 2 N=3		ALLUVIUM  SPT Recovery: 0.45 m		
<-DrawingFile>> 03/11/2021 15:08 10.00.01.07 Developed by Datgel AD/T		-		3		CL -CI	3.00m to 4.40m:	becomes Sandy (	CLAY, low to medium pl	asticity	>PL	S	SPT 3, 2, 1 N=3		2.7m - seepage observed SPT Recovery: 0.45 m
ngFile>> 03/11/2021 15:0		-	2	_4		CI- CH	4.40m to 5.45m: medium grained	Sandy CLAY: med	dium to high plasticity, da	rk grey, fine to			SPT 0, 1, 2 N=3		SPT Recovery: 0.45 m  RESIDUAL SOIL
MENITY.GPJ < <drawin< td=""><td></td><td>-</td><td>3</td><td>5</td><td></td><td></td><td>Davida NOO D</td><td>UO4 Torrio de de la constante de la constante</td><td>5.45</td><td></td><td><pl< td=""><td>F to St</td><td>SPT 1, 3, 5 N=8</td><td></td><td>SPT Recovery: 0.45 m</td></pl<></td></drawin<>		-	3	5			Davida NOO D	UO4 Torrio de de la constante	5.45		<pl< td=""><td>F to St</td><td>SPT 1, 3, 5 N=8</td><td></td><td>SPT Recovery: 0.45 m</td></pl<>	F to St	SPT 1, 3, 5 N=8		SPT Recovery: 0.45 m
AURECON SYD LIB 05.GLB LOG CW NON-CORED BOREHOLE LOG STORMWATER AMENITY.GPJ	P		44	7			Borenole NU8-BI	H01 Terminated at	Đ.4≎ M						Borehole terminated at target depth



# Engineering Log - Borehole

SHEET 1 OF 1

1	Clien Proje Loca	ect		Sto		Water vater Amenity d					Lo	roject No. ogged By hecked By	512448 MC NS	
(	Start Com	plete	ed D		g	21.9.21 21.9.21	Northing Easting	6358492.00 382658.00 DESCRIPTION	Slope Bearing	90		Equipme Ground	Level 1	0T1200 .671 AHD
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification		Descrip	otion of Soil asticity/grainsize, her components)		Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
		1	- - - - - - - - 1		CL- CI	FILL: Silty CLAY:	low to medium pla	asticity, dark brown		D >PL				FILL
	<b>-</b>	0_	2		SC	Clayey SAND: fir	e to medium grain	ed, dark grey				SPT 2, 2, 1 N=3		SPT Recovery: 0.45 m  ALLUVIUM  1.3m - seepage observed
AD/T		-1_	- 3			0.1.010				М	VL	SPT 2, 0, 0 N=0		SPT material recovered very soft; SPT Recovery: 0.45 m
		-2_	- 4		CL	Sandy CLAY: lov	r piasticity, grey, fil	ne to medium grained sand			S	SPT 1, 2, 1 N=3		SPT Recovery: 0.45 m
		-3_	5			4.70m: As above	, sand becomes m	edium grained		>PL	F to St	SPT 3, 3, 4 N=7		RESIDUAL SOIL SPT Recovery: 0.45 m
ADIT	_	-4_ 4_	6			handled	grey, with carbonad	ceous inclusions, easily bro	ken when	<pl< td=""><td>VSt to H H</td><td>SPT 4, 10, 19 N=29</td><td></td><td>SPT Recovery: 0.45 m  EXTREMELY WEATHERED MATERIA  Borehole terminated at target depth</td></pl<>	VSt to H H	SPT 4, 10, 19 N=29		SPT Recovery: 0.45 m  EXTREMELY WEATHERED MATERIA  Borehole terminated at target depth
		-5_	- - - - - - - 7											
	Rem	-6_ -6_ - arks	- 8											



# Engineering Log - Borehole

SHEET 1 OF 1

F	Clien Proje Loca	ect		Sto		Water vater Amenity d				Lo	ogged By	512448 MC NS	
		ed D			g	_	6358469.00 382678.00	Slope Bearing	90		Equipment Ground Le		0T1200 .68 AHD
	RIL	LING	;			MATERIAL [	DESCRIPTION				TESTING, SA	AMPLING	& OTHER INFORMATION
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification	(soil type: plas colour and othe	er components)		Moisture Condition	Consistency	Tests	Samples	Additional Comments (material origin, pocket penetrometer values, investigation observations)
			-			FILL: Silty CLAY: low to medium plas	ticity, dark brown						FILL
AD/T		1	- - - - - - 1			SAND: fine to medium grained, grey			>PL		SPT 2, 2, 3 N=5	-	SPT Recovery: 0.45 m
	<b>-</b>	0_	- - -			Orang. Interior medium grained, grey							1.6m - seepage observed
			- _2 -	- [. · ]					W	VL	SPT 2, 1, 0 N=1		SPT Recovery: 0.45 m
		]	-	:		Borehole N08-BH03 Terminated at 2.	AE				N=1		Borehole terminated at target depth
F		-3 -4 -4 -5 -6 -6 -6 -6	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3										
F	Rema	arks:	- 8									1	



#### **APPENDIX G**

**Arboricultural Impact Assessment and Tree Protection Plan** 



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# Arboricultural Impact Appraisal and Method Statement

27 Myola Street Mayfield, NSW

Prepared for Hunter Water

4 July 2022

by Andrew Scales
Dip. Horticulture / Dip. Arboriculture AQF5

PO Box 5085, Elanora Heights NSW 2101 E: info@naturallytrees.com.au M: 0417 250 420

#### 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.

Six low category trees will be lost because of this proposal. However, they are small newly planted trees, and the retention of the significant boundary tree cover will ensure there is no impact on the wider setting. The proposed changes may adversely affect a further one high category tree and two low 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 little impact on the contribution of trees to local amenity or character.

# **Table of Contents**

		Page
1	INTRODUCTION	4
2	THE LAYOUT DESIGN	5
3	ARBORICULTURAL IMPACT APPRAISAL	7
4	ARBORICULTURAL METHOD STATEMENT	9
5	HOW TO USE THIS REPORT	11
6	OTHER CONSIDERATIONS	12
7	BIBLIOGRAPHY	12
8	DISCLAIMER	13
	Appendices	
1	Qualifications and experience	14
2	Tree schedule and explanatory notes	15
3	Tree AZ categories	17
4	Tree protection fencing and signs – Illustrative specification	18
5	Root zone and trunk protection – Illustrative specification	19
6	General guidance for working in TPZ	20
7	Schedule of works and responsibilities	24
8	Tree management plan	25



#### 1. INTRODUCTION

- 1.1 **Instruction:** I am instructed by Aurecon Group to inspect the tree population at 27 Myola Street, Mayfield 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. 85220-16265-001 to 85220-16265-009 (Revision 01), by Hunter Water dated 8 June 2022.
- 1.5 **Scope of this report:** This report is only concerned with nine 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:** 27 Myola Street is located in the suburb of Mayfield (refer figure 1). The site is on the southern side of the road and surrounded by residential and commercial development. The site consists of Litchfield Park which has a variety of ornamental and 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	Importa	int trees	Unimportant trees		
		AA	Α	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		12	10, 11		
Trees to be removed	Civil and construction and/or level variations within TPZ			6, 7, 8, 9, 13	14	

#### 3.2 **Detailed impact appraisal**

- 3.2.1 Category A tree that could potentially be affected through TPZ disturbance: One category A tree (Tree 12) could potentially be affected through disturbance to their TPZs as follows:
  - Tree 12: This is an important tree on the boundary with an existing roadway near it. The proposed works remain largely outside the TPZ of Tree 12 and therefore direct impacts are not expected. 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 retained: Trees 10 and 11 could be successfully retained without any adverse effects if appropriate protective measures are properly specified and controlled through a detailed arboricultural method statement.
- 3.2.3 Low category trees to be removed: The proposed development will necessitate the removal of six trees of low retention value. These include Trees 6, 7, 8, 9, 13 and 14. None of these trees are considered significant or worthy of special measures to ensure their preservation. It should be noted that these trees are newly planted species that can easily be replaced with new planting.

Page 7 of 25

- 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: Six low category trees will be lost because of this proposal. However, they are small newly planted trees, and the retention of the significant boundary tree cover will ensure there is no impact on the wider setting. The proposed changes may adversely affect a further one high category tree and two low 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 little 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 <u>must</u> 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 <u>must</u> be checked against the original submission documents. The precise location of all protective measures <u>must</u> 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 any retained tree where access is required across a TPZ.
- 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 10, 11 and 12 as illustrated on plan TMP01 and summarised below:
  - Removal of existing surfacing/structures and replacement with new surfacing/structures: Trees 10, 11 and 12 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:

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#### 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



# **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

Page 14 of 25



#### 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
6	Eucalyptus sp.	3	2	40	2.0	70%	Υ	Nil	Grass	Nil	L	<b>Z</b> 1
7	Eucalyptus sp.	2	1	30	2.0	70%	Υ	Nil	Grass	Nil	L	<b>Z</b> 1
8	Eucalyptus sp.	2	1	30	2.0	70%	Υ	Nil	Grass	Nil	L	<b>Z</b> 1
9	Eucalyptus sp.	3	2	40	2.0	70%	Υ	Nil	Grass	Nil	L	<b>Z</b> 1
10	Eucalyptus sp.	2	2	30	2.0	70%	Υ	Nil	Grass	Nil	L	<b>Z</b> 1
11	Eucalyptus robusta	4	3	70	2.0	70%	Υ	Nil	Grass	Nil	L	<b>Z</b> 1
12	Melaleuca quinquenervia	14	12	700	8.4	80%	М	Nil	Grass	Nil	Н	<b>A</b> 1
13	Melia azedarach	4	2	60	2.0	60%	S	Root plate heaving	Grass	Nil	L	<b>Z5</b>
14	Elaeocarpus reticulatus	4	2	60	2.0	40%	S	Dieback	Grass	Nil	L	ZZ4



#### **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 <u>main</u> 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.



#### **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								
	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>Z</b> 5	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
21	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

- 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
- Poor condition or location with a low potential for recovery or improvement, i.e. dominated by adjacent trees or buildings, poor architectural framework, etc
- **Z11** Removal would benefit better adjacent trees, i.e. relieve physical interference, suppression, etc
- **Z12** 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.

# Category A: Important trees suitable for retention for more than 10 years and worthy of being a material constraint

A1	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					
А3	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/)

Page 17 of 25

#### 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.

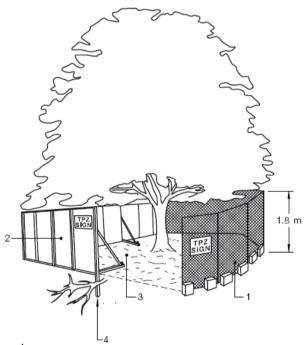
Inside the protective fencing, the following rules must be strictly observed:

- 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

- 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.
- 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.

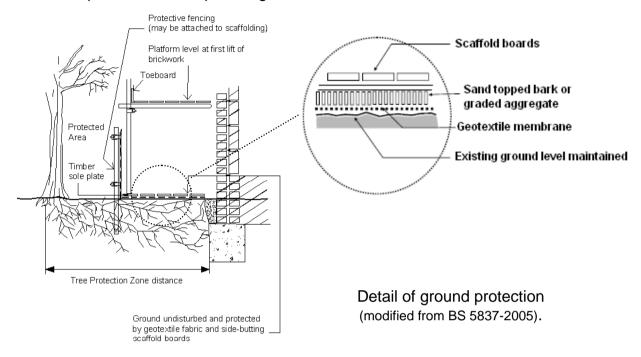
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Page 18 of 25

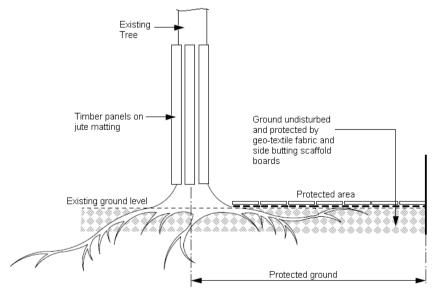


#### Root zone and trunk protection - Illustrative specification

**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.



**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.



Page 19 of 25

#### 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.

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Page 20 of 25

#### 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.



Page 21 of 25

#### 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 quidance 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

Page 22 of 25



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.



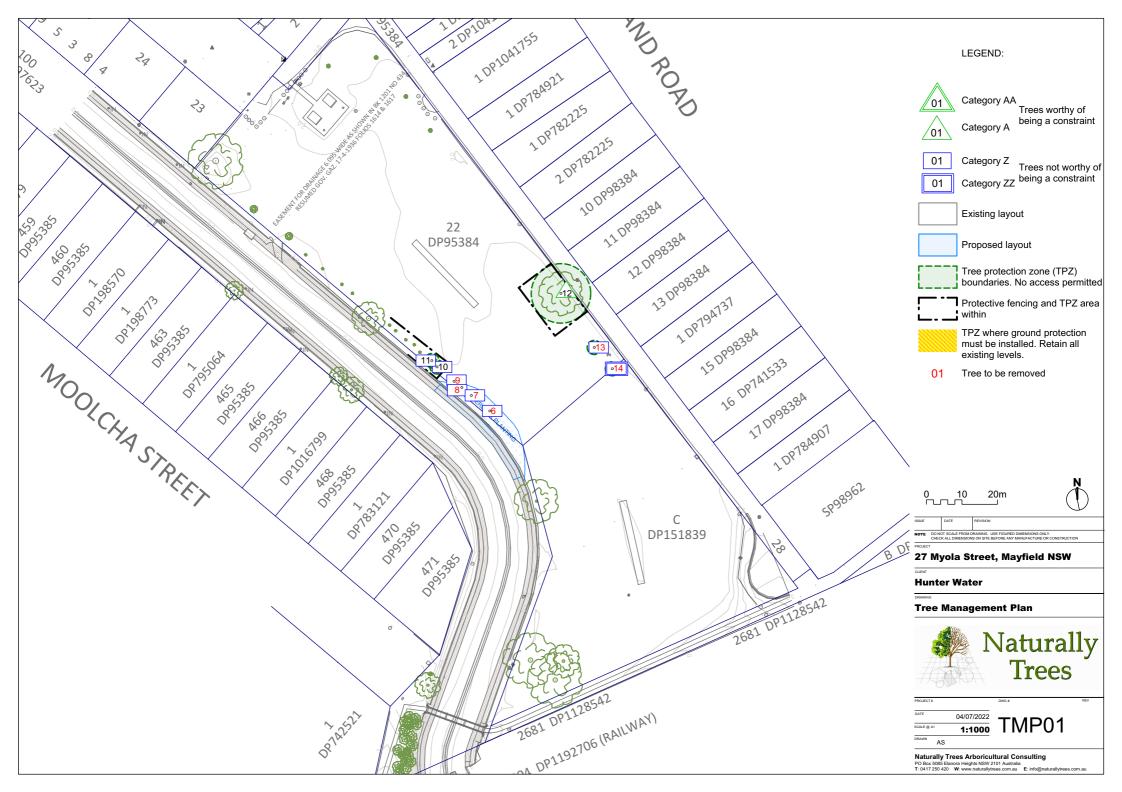
# Schedule of works and responsibilities

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



#### Tree management plan

-refer attached Tree Management Plan, Dwg No. TMP01, by Naturally Trees dated 4 July 2022



#### **APPENDIX H**

**Noise and Vibration Impact Assessment** 



# STORMWATER AMENITY IMPROVEMENT: MAYFIELD – THORSBY CREEK

# **Construction Noise and Vibration Impact Assessment**

18 July 2022

Aurecon

TM711-01F04 (r3) Mayfield REF Construction NVIA.docx





#### **Document details**

Detail	Reference
Doc reference:	TM711-01F04 (r3) Mayfield 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	R.Phillips	R.Phillips	A.Leslie
18.07.2022	Final	-	4	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 Mayfield, Thorsby Creek. The Proposal involves amenity works along the Throsby Creek stormwater channel within Litchfield Park, Mayfield.

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, the nearest residences are generally predicted to be more than 20 dB(A) above the NML, which is considered highly intrusive. These residences are located along Moolcha Street to the south of the works and Myola Street to the north-west.

Impacts would be greatest during periods where high noise plant and equipment, such as an excavator with hydraulic hammer, are being used. During these periods, up to three residences on Moolcha Street and Myola Street 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 beyond approximately 30 metres from the works 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. These nearest structures are approximately 15 to 20 metres from the works where the excavator with hydraulic hammer attachment

would be in use, and approximately 10 metres from any works within the channel. Based on this, 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.

#### **Contents**

Exe	cutive	summary	III
	Con	struction noise	iii
	Construction vibration		
1	Intro	oduction	8
	1.1	Proposal scope	8
	1.2	Proposal construction activities	8
	1.3	Report objectives	11
	1.4	Relevant policies and guidelines and assessment objectives	11
	1.5	Acoustic concepts, terminology & quality	11
2	Exis	12	
	2.1	Noise and vibration-sensitive receivers	12
	2.2	Noise monitoring	15
	2.3	Existing background noise levels	15
3	Noise and vibration criteria		
	3.1	Construction noise criteria	17
		3.1.1 Noise metrics	17
		3.1.2 Noise management levels (NMLs)	17
		3.1.3 Summary of construction noise management levels	19
	3.2	Construction-related road traffic noise	19
	3.3	Construction vibration criteria	20
		3.3.1 Disturbance to buildings occupants	21
		3.3.2 Damage to buildings or structures	22
		3.3.2.1 British Standard	23
		3.3.2.2 German Standard	24
		3.3.3 Heritage structures and items	25
		3.3.4 General vibration (building damage) screening criterion	26
		3.3.5 Damage to vibration sensitive equipment	26
		3.3.6 Damage to buried services	27
4	Con	29	
	4.1	Construction hours	29
		4.1.1 Standard construction hours	29
		4.1.2 Works outside standard construction hours	29
		4.1.3 Summary of construction hours	29
	4.2	Construction noise and vibration activities and assumptions	30
		4.2.1 Construction activities and noise sources	30
	4.3	Construction airborne noise assessment	31

	4.3.1	Noise prediction methodology	31
	4.3.2	Construction noise results	33
		4.3.2.1 Representative receivers	33
		4.3.2.2 Summary of results	34
	4.3.3	Discussion of results	37
		4.3.3.1 Residential receivers	37
		4.3.3.2 Non-residential receivers	37
4.4	Cons	truction-related road traffic	38
4.5	Cons	truction vibration assessment	38
	4.5.1	Cosmetic damage	39
		4.5.1.1 Reinforced and unreinforced structures	39
		4.5.1.2 Heritage structures	40
	4.5.2	Human response	40
4.6	Cons	truction mitigation and management measures	40
	4.6.1	Noise and vibration control measures	40
	4.6.2	Noise monitoring and management measures	43
5 Cond	clusio	n	44
5.1	5.1 Construction noise assessment		44
5.2	5.2 Construction traffic noise assessment		44
5.3	Cons	truction vibration assessment	45
Reference	S		46
APPENDIX	Ά	Technical terms and concepts	47
A.1	Glos	sary of terminology	47
A.2	Acou	stic concepts	48
	A.2.1	Sound and noise	48
	A.2.2	Individual's perception of sound	49
	A.2.3	Environmental noise assessment indicators	50
	A.2.4	Cumulative sound exposure	51
APPENDIX	ίВ	Locality Map and Land Use Survey	53
APPENDIX	C	Noise monitoring methodology	54
C.1	Nois	e monitoring equipment	54
C.2	Mete	eorology during monitoring	54
C.3	Nois	e vs time graphs	54
C.4	Nois	e monitoring location	55
	C.4.1	M1 - 25 Moolcha Street, Mayfield	55
APPENDIX		Unattended noise monitoring results	56
APPENDIX E Predicted construction noise impacts		•	57
APPENDIX	( F	Construction vibration minimum working distances	58

# List of tables

Table 1-1: Construction activities and associated works	8
Table 1-2: Construction noise and vibration policies, guidelines and standards	11
Table 2-1: Nearest and representative noise sensitive receivers	13
Table 2-2: Unattended noise monitoring location	16
Table 2-3: Measured existing ambient and background noise levels, dB(A)	16
Table 3-1: Noise management levels at residential receivers	18
Table 3-2: Noise management levels at other noise sensitive land uses, dB(A)	18
Table 3-3: Construction noise management levels at residential receivers, dB(A)	19
Table 3-4: Construction-related road traffic noise assessment criteria	20
Table 3-5: Vibration management levels for disturbance to building occupants	21
Table 3-6: BS 7385 structural damage criteria	24
Table 3-7: DIN 4150-3:2016 structural damage criteria	25
Table 3-8: Acceptable vibration limits for vibration measured on building structure housing sense equipment	sitive 27
Table 3-9: DIN 4150-3: 2016 Guideline values for vibration velocity to be used when evaluating a short-term vibration on buried pipework	the effects of 27
Table 4-1: Noise modelling assumptions for construction - activities and equipment	30
Table 4-2: Key to the predicted construction noise results tables	33
Table 4-3: Predicted construction noise levels at representative residential receivers – Standard hours	construction 33
Table 4-4: Predicted construction noise levels at representative other sensitive receivers	34
Table 4-5: Number of residential receivers over the noise management levels	35
Table 4-6: Number of other sensitive receivers (including commercial and industrial) over the no management levels	oise 36
Table 4-7: Minimum working distances (m) for cosmetic damage (continuous vibration)	39
Table 4-8: Minimum working distances (m) for human annoyance (continuous vibration)	39
Table 4-9: Noise mitigation and management measures	40

# 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 works at Mayfield, Thorsby Creek (the Proposal).

The Proposal would involve approximately 155 metres of amenity works along the Throsby Creek stormwater channel within Litchfield Park, Mayfield.

The amenity works include the replacement of around 35 metres of concrete bank from the eastern bank of the channel with a constructed habitat zone consisting of sandstone terraces and native plantings.

# 1.2 Proposal construction activities

The key 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> <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> <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	pre-construction asset inspections.
Materials delivery	delivery of fill materials to laydown areas
Structural works – Stage 1 (removing concrete channel)	<ul> <li>channel structural works would be completed in sections, starting at the downstream end.</li> <li>This phasing of structural works will ensure protection of the Proposal site during stormwater flow events in the channel</li> </ul>
	<ul> <li>excavator to remove recently planted trees, turf and topsoil within Proposal site and move to stockpile</li> </ul>
	following an arborist assessment, excavator to remove trees within works extent
	sawcut channel wall and undertake works along eastern bank within the Proposal site
	<ul> <li>excavate to base of works and temporarily stockpile spoil for disposal</li> </ul>
	<ul> <li>batter slopes to be shaped at a 1V:2H to facilitate placement of fill and rock revetment (rip- rap)</li> </ul>
	demolition of existing drainage outlet headwall
Dewatering	dewatering using portable pumps as required and appropriate disposal
Waste disposal	disposal of construction waste including spoil to a licensed waste facility

Construction activity	Description
Structural works – Stage 2 (asset protection/restoration, transition wall works and channel base extension)	<ul> <li>constructing transition retaining walls (sandstone logs) grouted to existing bank wall</li> <li>sandstone logs to be grouted to the concrete at the interface with the concrete channel base</li> <li>construct cast in-situ concrete weirs in channel including scabbling of concrete and tie-in to existing channel base i.e. install starter bars using hammer or core drill</li> </ul>
Structural works – Stage 3 (bank protection works	<ul> <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> </ul>
Site restoration	<ul> <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.

The Proposal site overview is shown in Figure 1-1 below.

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 objectives

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
Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009)	Airborne noise and ground-borne noise impacts (including construction traffic within the construction support site boundary)
Assessing Vibration: a technical guideline (Department of Environment and Climate Change, 2006)	Vibration amenity
British Standard BS 7385: Part 2-1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration (BSI, 1993)	Vibration impacts to structures impacts
German Standard DIN 4150-3 (2016) Structural vibration – Effects of vibration on structures (Deutsches Institut für Normung, 2016)	Vibration impacts to structures impacts
NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011)	Construction road traffic noise impacts (on public roads)
Noise Policy for Industry (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)
  - o Community centres
  - o Special noise and/or vibration-sensitive receivers (eg. laboratories, recording studios)
- Commercial premises (including offices and retail outlets) [OSR]
- Industrial premises [OSR].

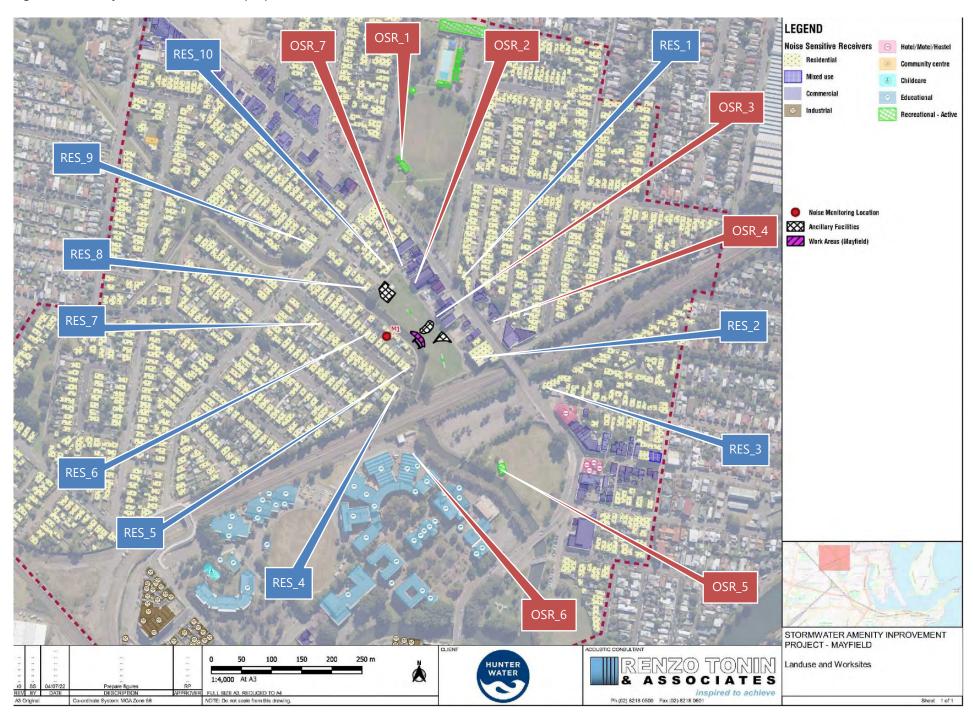
All assessed noise and vibration-sensitive receiver types for the Proposal are shown in APPENDIX B. A number of the nearest representative noise sensitive receivers surrounding the Proposal have been identified for the purposes of reporting noise levels at nearby noise sensitive receivers. These selected 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	19 Maitland Road, Mayfield East	130
RES_2	Residential	Residence	10 Maitland Road, Mayfield	80
RES_3	Residential	Residence	2a Henry Street, Tighes Hill	200
RES_4	Residential	Residence	32 Moolcha Street, Mayfield	65
RES_5	Residential	Residence	35 Moolcha Street, Mayfield	25
RES_6	Residential	Residence	21 Moolcha Street, Mayfield	30
RES_7	Residential	Residence	8 Moolcha Street, Mayfield	70
RES_8	Residential	Residence	25 Myola Street, Mayfield	10
RES_9	Residential	Residence	17b Myola Street, Mayfield	90
RES_10	Residential	Residence	38 Myola Street, Mayfield	50
OSR_1	Active recreation	Dangar Park	21a Maitland Road, Mayfield	200
OSR_2	Commercial	Highway Group	44 Maitland Road, Mayfield	70
OSR_3	Commercial	Thompson's Auto Electrics	30 Maitland Road, Mayfield	60
OSR_4	Commercial	Dunlop	7-11 Maitland Road, Mayfield East	120
OSR_5	Active recreation	Tighes Hill Oval	266 Maitland Road, Tighes Hill	230
OSR_6	Educational facility	TAFE NSW - Newcastle	266 Maitland Road, Tighes Hill	170
OSR_7	Active recreation	Litchfield Park	27 Myola street, Mayfield	20

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Figure 2-1: Nearby sensitive receivers to proposal



# 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* (NPfI) (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 NPfI 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 2-2 below and shown on the map in APPENDIX B. The existing measured background and ambient noise levels are presented in Table 2-3.

A summary of the unattended noise monitoring results along with a graphical recorded output from the long-term noise monitoring are included in APPENDIX C. The graphs in APPENDIX C 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	25 Moolcha St, Mayfield	Ambient noise environment had contribution from noise natural environment (bird noise etc.) in addition to distant traffic noise.  Noise from rail line audible during train passbys.	
		Background noise levels had contribution from distant traffic noise from Maitland Road and from surrounding roads	

Table 2-3: Measured existing ambient and background noise levels, dB(A)

Noise Location logger #		Rating background noise levels (RBL), L <sub>A90</sub>			Ambient noise levels, L <sub>Aeq</sub>		
logger #		Day	Evening	Night	Day	Evening	Night
M1	25 Moolcha St, Mayfield	37	43	40	53	49	44

# 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 LAmax 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	How to apply		
Recommended standard hours:	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise.		
Monday to Friday 7:00 am to 6:00 pm		• Where the predicted or measured LAeq (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.		
Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays		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.		
public Holidays	Highly noise affected	The highly noise affected level represents the point above which there may be strong community reaction to noise.		
	75 dB(A)	<ul> <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:</li> </ul>		
		<ol> <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> </ol>		
		<ol><li>if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</li></ol>		
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours.		
		<ul> <li>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</li> </ul>		
		<ul> <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> </ul>		
		• For guidance on negotiating agreements see <i>ICNG</i> section 7.2.2.		

<sup>\*</sup> 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 (15 min)</sub>
Childcare centre <sup>2</sup>	When in use	Outdoor noise level	50 <sup>2</sup>
Classrooms at schools and other	When in use	Indoor noise level	45
educational institutions		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 <sub>Aeq (15 min)</sub>
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 <sub>Aeq(15min)</sub>
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 LAeq(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 <sub>Aeq 15 hour</sub>	55 L <sub>Aeq 9 hour</sub>
Local roads	55 Laeq 1 hour	50 LAeq 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=Δx/Δt) 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=Δv/Δt) is the rate of change of velocity with respect to change in time. The SI
  unit for acceleration is metres per second squared (m/s²). 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 VDVs 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 <sup>1.75</sup>	Adverse comment possible eVDV m/s <sup>1.75</sup>	Adverse comment probable eVDV m/s <sup>1.75</sup>
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

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

<sup>2.</sup> 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

C	T	Damage level		Peak component particle velocity, mm/s				
Group	Type of structure	Damage level	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 triaxial 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

		Vibration ve	elocity, mm/s			
Group	Type of structure	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 <u>and</u> 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 microelectronic 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	Vibration Limit <sup>1</sup> mm/s,		Description of Use 3
Requirements	RMS <sup>4</sup>	Peak <sup>5</sup>	Description of Use <sup>3</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):

- 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
- 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	Franna/ mobile crane		1	99
Site establishment & environmental controls	Trucks		4 per hour	106
environmental controls	Hand tools including hammer or core drills		1	107
	Assumed combined activity noise level			108
S2	Franna crane	20 tonne	1	99
Ancillary facilities	Trucks		4 per hour	106
Including waste disposal	Wheel loader		1	110
	Generator		1	94
	Assumed combined activity noise level			110
S3	Franna crane	20 tonne	1	99
Investigations	Tracked excavator w bucket	19 tonne	1	103
	Hand tools including hammer or core drills		1	107
	Assumed combined activity noise level			108
S4	Tracked excavator w bucket	19 tonne	1	107
Structural works – Stage 1 (removing concrete	Concrete saw		1	119
channel)	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
	Assumed combined activity noise level			119
S5 Dewatering	Pump		1	90

Scenario	Plant / Equipment	Operating weight kg	Assumed no. units	Sound Power Level (Lw re: 1pW), dB(A) L <sub>Aeq</sub>
S6	Tracked excavator w bucket	19 tonne	1	107
Structural works – Stage 2 (asset	Franna/ mobile crane	20 tonne	1	99
protection/restoration,	Hand tools including hammer or core drills		1	107
transition wall works and channel base extension)	Concrete truck		1	108
charmer base extension;	Concrete pump	1	103	
	Assumed combined activity noise level			112
S7	Tracked excavator w bucket	19 tonne	1	107
Structural works – Stage 3 (bank protection works)	Small vibratory roller	4T	1	105
(bank protection works)	Franna/ mobile crane		1	99
	Assumed combined activity noise level			108
S8	Hand tools		1	107
Site restoration	Tracked excavator w bucket	19 tonne	1	107
	Franna/ mobile crane	20 tonne	1	99
	Trucks		4 per hour	106
	Assumed combined activity noise level			110

#### Notes

### 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 in 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

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.

Assumed activity noise level in brackets () includes all noise sources for that activity, including high noise impact sources in brackets.
 Assumed activity noise level outside brackets assumes high noise impact sources in brackets is not operating.

 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.

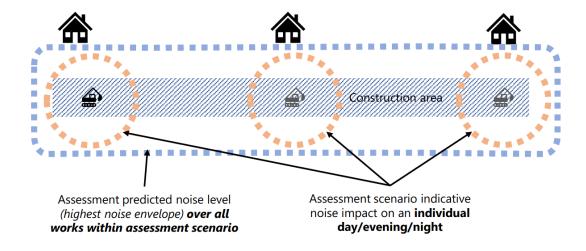
Construction noise levels are assessed at the most noise affected facade and floor level of a receiver building. Construction noise levels experienced at other points on the building may be lower.

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	essment Time of day Key							
L <sub>Aeq(15min)</sub>	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

eiver		Predicted noise level for each scenario, LAeq, 15min, dB(A)							
Representative receiver (Figure 2-1)	NML (day)	S1	S2	S3*	S4*	<b>S</b> 5	S6*	S7*	S8*
RES_01	47	50	50	50	60	<30	53	50	51
RES_02	47	63	65	65	70	40	65	65	65
RES_03	47	50	38	50	61	<30	54	50	52
RES_04	47	56	58	58	65	36	58	58	58
RES_05	47	69	63	69	77	51	73	66	71
RES_06	47	60	62	62	71	37	64	62	62
RES_07	47	52	54	54	60	<30	54	54	54

receiver	Predicted noise level for each scenario, LAeq, 15min, dB(A)								
Representative reco (Figure 2-1)	NML (day)	S1	S2	S3*	S4*	S5	S6*	S7*	S8*
RES_08	47	70	72	72	72	38	72	72	72
RES_09	47	53	55	55	57	<30	55	55	55
RES_10	47	69	71	71	71	37	71	71	71

Notes

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

ceiver		Predict	Predicted noise level for each scenario, LAeq, 15min, dB(A)							
Representative receiver (Figure 2-1)	NML (day)	S1	S2	S3*	S4*	S5	S6*	S7*	<b>S</b> 8	
OSR_01	65	41	41	41	52	<30	45	41	43	
OSR_02	70	65	67	67	70	40	67	67	67	
OSR_03	70	71	73	73	76	45	73	73	73	
OSR_04	70	58	60	60	67	37	60	60	60	
OSR_05	65	49	51	51	60	<30	53	51	51	
OSR_06	55	52	53	53	63	34	56	53	54	
OSR_01	65	68	68	68	79	46	72	68	70	

Notes:

# 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.

<sup>\*</sup> Includes construction noise from ancillary facilities

<sup>\*</sup> Includes construction noise from ancillary facilities

Table 4-5: Number of residential receivers over the noise management levels

		Day (standard hours) L <sub>Aeq, 15minute</sub>							
Construction scenario		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	-	80	21	4				
S2	Ancillary facilities	-	96	25	2				
S3	Investigations	-	98	25	4				
S4	Structural works – Stage 1	3	430	75	11				
S5	Dewatering	-	3	-	-				
S6	Structural works – Stage 2	-	125	27	7				
S7	Structural works – Stage 3	-	99	26	2				
S8	Establishment of mural fence	-	112	25	5				
<b>S9</b>	Site restoration	-	80	21	4				

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Table 4-6: Number of other sensitive receivers (including commercial and industrial) over the noise management levels

Construction scenario Assessment reference		1 - 10 dB(A) above NML	11 - 20 dB(A) above NML	> 20 dB(A) above NML
S1	Site establishment & environmental controls	4	-	-
S2	Ancillary facilities	4	-	-
S3	Investigations	4	-	-
S4	Structural works – Stage 1	27	2	-
S5	Dewatering	-	-	-
S6	Structural works – Stage 2	7	-	-
S7	Structural works – Stage 3	4	-	-
S8	Site restoration	4	-	-

Notes

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<sup>1.</sup> 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 Moolcha Street to the south of the works, Myola Street to the north-west and Maitland Road to the north-east.

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 three residences on Moolcha Street 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.

The north-western ancillary facility is located close to residential receivers on Myola Street. Noise impacts to these residences 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 and restricted to standard construction hours. 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 29 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.

The most impacted commercial receivers on Maitland Road to the north of the works. The predicted noise levels are based on the worst case facade, which would typically be the rear facade of the commercial buildings.

Noise levels at the adjacent sports fields are predicted to be approximately 10 dB(A) to 15 dB(A) above the NMLs during periods of high noise activity, and are generally predicted to be up to 5 dB(A) above the NML during typical works.

Noise levels are predicted to exceed the NMLs at several buildings at the Tafe NSW Newcastle campus during periods where high noise generating plant and equipment is in use. However, in general, construction noise is predicted to comply with the NMLs.

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. During 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 Myola Street as shown on the map on Figure 1-1

Myola Street is a local road with low existing traffic volumes. As the site cannot be accessed via a more direct route from a major road such as Maitland Road, there is not alternative to the proposed local road access point

It is estimated that up to four heavy vehicle movements (i.e. two movement each way) along each of the proposed eastern and western access routes would comply with the local road daytime criteria of 55 dB(A) L<sub>Aeq,1hr</sub>. Based on the on the proposed traffic volumes, exceedances of the local road noise goals are not generally expected, however there may be minor exceedances where there are more than four movements per hour along Myola Street during peak periods.

Recommendations have been provided in Section 4.6 to minimise impacts from construction related road traffic noise.

#### 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)

	Minimum working distance (m)			
Plant item	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)

	Minimum working distances (m)					
Plant item	Cuitáine I anns an	Residences		0	W. L.L.	
	Critical areas 0.28 mm/s	Day 0.56mm/s	Night 0.40 mm/s		Workshops 2.2 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 identified minimum working distance for an excavator with excavator with hydraulic hammer attachment for both reinforced and unreinforced structures is five metres. The only stage with vibration intensive works proposed is Stage 1 Structural works. The nearest structures to the Stage 1 Structural works, are on the northern boundaries of the residential dwellings on Moolcha Street. These nearest structures are approximately 15 to 20 metres from the works where the excavator with hydraulic hammer attachment would be in use, and approximately 10 metres from any works within the channel.

Given the above, there are no reinforced or unreinforced structures within the minimum working distance identified Table 4-7 above. 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 excavator with hydraulic hammer attachment. The nearest residences are or the northern side of Moolcha Street are approximately 40 metres from works.

Given the above, 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
At-source miti	gation measures		
Equipment selection	Airborne noise Vibration	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable.	Variable. Minimise noise impact and reduce risk
		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.	of annoyance.

Action required	Applies to	Details	Estimated noise benefit		
Rental plant and equipment	· · · · · · · · · · · · · · · · · · ·		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.	Up to 20 dB reduction + reduce vibration		
		- 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.			
Non-tonal and ambient sensitive reversing	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.	5-10 dB reduction		
alarms		Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.			
Minimise disturbance	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers.	Variable. Reduce noise/ vibration impact + risk		
arising from delivery of		Select site access points and roads as far as possible away from sensitive receivers.	of annoyance.		
goods		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.			
Silencers on mobile plant	Airborne noise	Where possible reduce noise from mobile plant through additional fittings including:	0-20 dB reduction Reduce annoyance +		
		- Residential grade mufflers	sleep disturbance.		
		- Air Parking brake engagement is silenced.			
		Ensure plant including the silencer is well maintained.			
Prefabrication of materials	Airborne noise	Where practicable, pre-fabricate and/or prepare materials off-site to reduce noise with special audible characteristics	5-20 dB reduction Reduce noise/ vibration		
off-site		occurring on site. Materials can then be delivered to site for installation.	impact + risk of annoyance		
Engine compression	pression	Limit the use of engine compression brakes in residential areas.	5-20 dB reduction		
brakes		Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'Inservice test procedure' and standard.			
Path mitigation measures					
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			
223		,	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 on Myola Street and Moolcha Street.	Receiver <b>with</b> line of site of the ancillary facility works area: 5-10 dB reduction		

Action required	Applies to	Details	Estimated noise benefit
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.
Management m	neasures		
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.	Keeps stakeholders informed of the likely impact. Community may
		In addition to Periodic Notification, the following strategies may be adopted to notify the community of upcoming works:  • Project Specific Website  • Project Infoline	identify solution to assist in managing impacts.
		<ul> <li>Email Distribution List</li> <li>Web-based Surveys</li> <li>Social Media</li> <li>Community and Stakeholder Meetings.</li> <li>Additionally, it is recommended that as several buildings at the Tafe NSW Newcastle campus may be noise affected, consultation be undertaken in order to assist with minimising scheduling high noise generating construction activities during sensitive periods for these receiver buildings (ie. exam periods) where feasible and reasonable.</li> </ul>	
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:  • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number.  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
Site inductions	Airborne noise Vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include:  • All relevant project specific and standard noise and vibration mitigation measures  • Permissible hours of work  • Any limitations on noise generating activities with special audible characteristics  • Location of nearest sensitive receivers  • Construction employee parking areas  • Designated loading/unloading areas and procedures  • Site opening/closing times (including deliveries)  • Environmental incident procedures.	Keeps construction workforce informed of actions required to minimise noise and vibration impact.

Action required	Applies to	Details	Estimated noise benefit
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.
Heavy vehicle routes	Airborne noise	Construction heavy vehicles and delivery vehicles should be scheduled during standard construction hours where feasible and reasonable. In addition, heavy vehicles should access the site from Myola Street via Silsoe Street and Maitland Road. Silsoe Street to the south of Myola Street and Myola Street to the west of Silsoe Street should be avoided.	Minimises noise impacts
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 with investigating
and addressing 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 Works: Mayfield, Thorsby 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 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 Moolcha Street to the south of the works, Myola Street to the north-west and Maitland Road to the north-east.

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 three residences on Moolcha Street 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. Given the site constraints, all traffic is required to access the site via Myola Street, which is a local road. As part of the Proposal, up to three heavy vehicles per hour are expected to be generated. Based on the on the proposed traffic volumes, exceedances of the local road noise goals are not generally expected, however there may be minor exceedances where there are more than four movements per hour along Myola Street during peak periods.

Management measures have been provided in Section 4.6 to minimise construction related road traffic noise.

#### 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

 ASHRAE Applications Handbook (SI) (2003), Chapter 47 Sound and Vibration Control, pp47.39-47.40

- 2. British Standard (2008), BS 6472-2008: Evaluation of human exposure to vibration in buildings (1-80Hz)
- 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)
- 5. NSW Department of Environment and Climate Change (2009), *Interim Construction Noise Guideline* (ICNG)
- 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)
- 8. NSW Environment Protection Authority (2016), Noise Policy for Industry (NPfl)
- 9. Standards Australia (2016), Acoustics Recommended design sound levels and reverberation times for building interiors, AS/NZS 2107:2016
- 10. Standards Australia (2016), *Guide to Noise Control on Construction, Demolition and Maintenance Sites*, AS 2436:2010 (R2016)
- 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 sour common sounds in		ured in. The following are examples of the decibel readings of me environment:				
	threshold of	0 dB	The faintest sound we can hear				
	hearing	10 dB	Human breathing				
	almost silent	20 dB					
		30 dB	Quiet bedroom or in a quiet national park location				
	generally quiet	40 dB	Library				
	generally quiet	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				
	loud	90 dB	The sound of a truck passing on the street				
	very loud	100 dB	Indoor rock band concert				
	very loud	110 dB	Operating a chainsaw or jackhammer				
	extremely loud	120 dB	Jet plane take-off at 100m away				
	threshold of	130 dB					
	pain	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  $L_v$ , 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<sub>Aeq</sub> - 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 LAeq. The LAeq indicator accounts for the total energy content from all sources of sound under consideration. The fact that the L<sub>Aeq</sub> is a cumulative measure means that louder activities have greater influence of the LAeq level than do quieter ones, and activities that last longer in time have greater LAeq than do shorter ones. An increase in the number of events also increases the LAeq. 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 LAmax). 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 LAmax 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<sub>Amax</sub>, L<sub>Aeq</sub> and L<sub>A90</sub> 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.

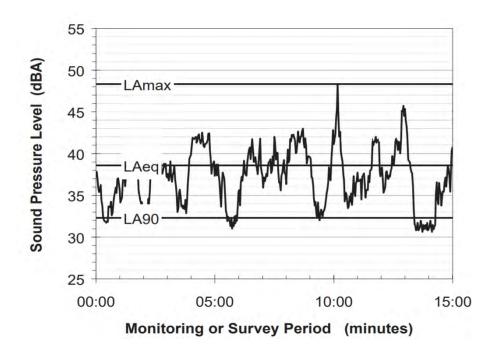
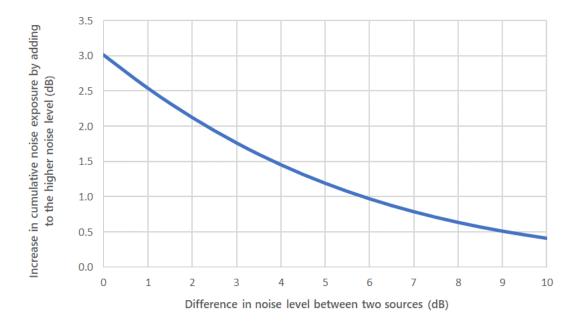


Figure A-1: Environmental noise assessment indicators

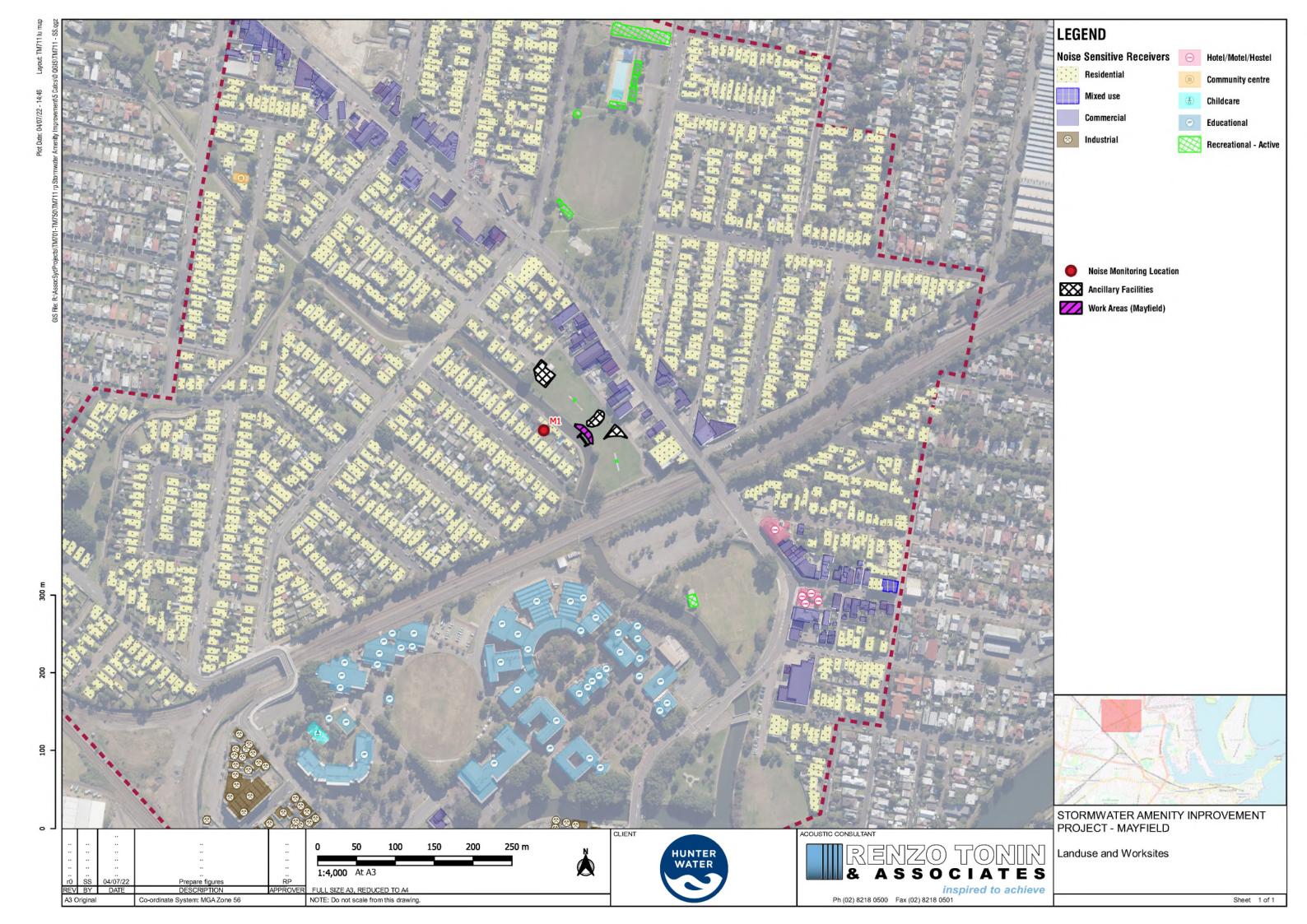
#### A.2.4 Cumulative sound exposure

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



### 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	Туре	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

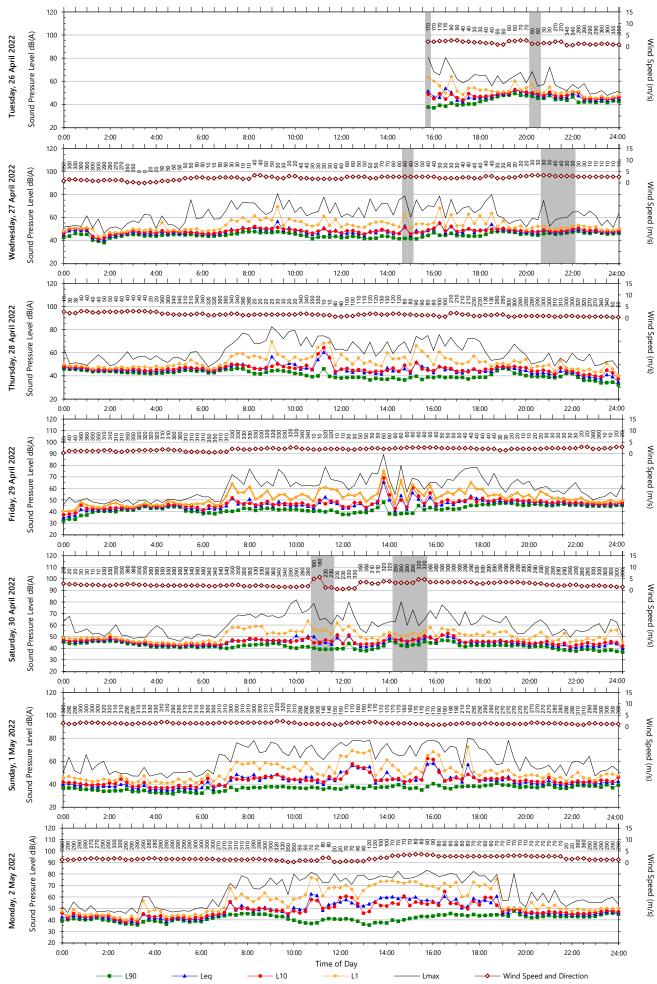
Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the  $L_{10}$ ,  $L_{90}$ , and  $L_{eq}$  levels. The statistical descriptors  $L_{10}$  and  $L_{90}$  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.

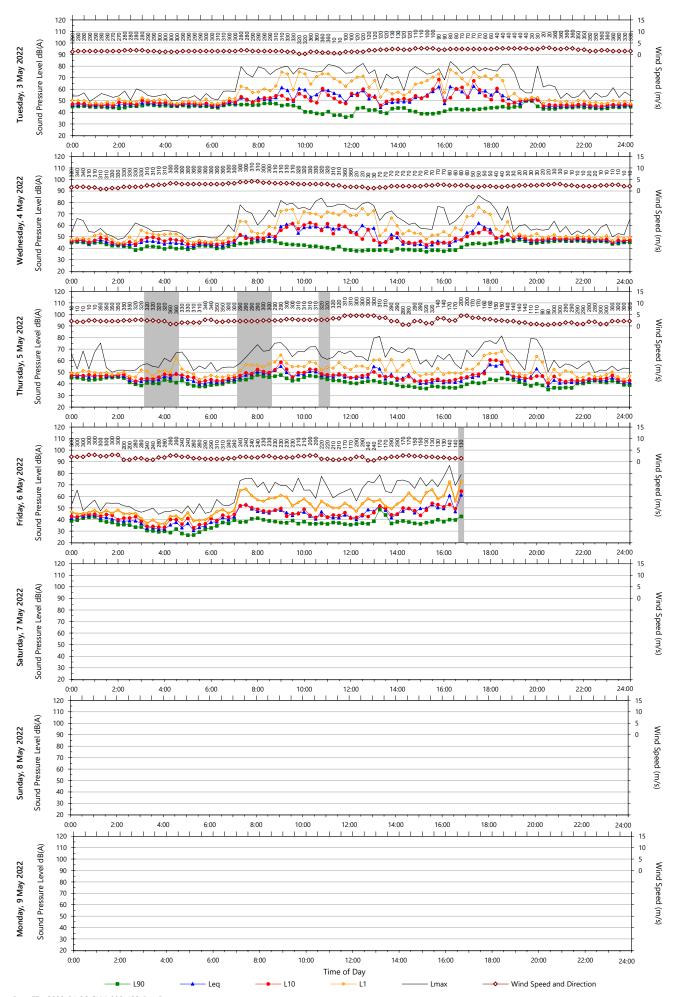
## C.4 Noise monitoring location

### C.4.1 M1 - 25 Moolcha Street, Mayfield

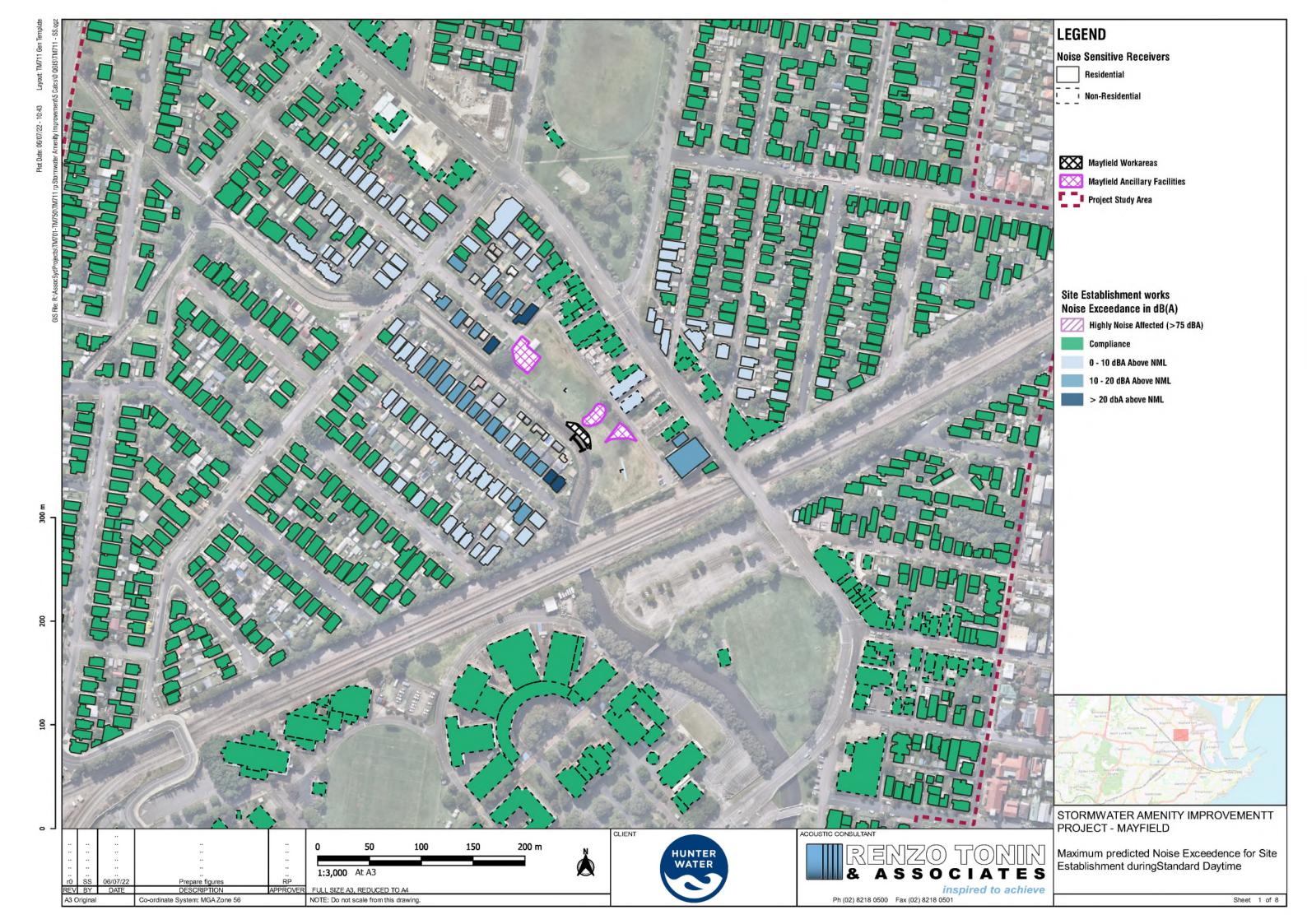


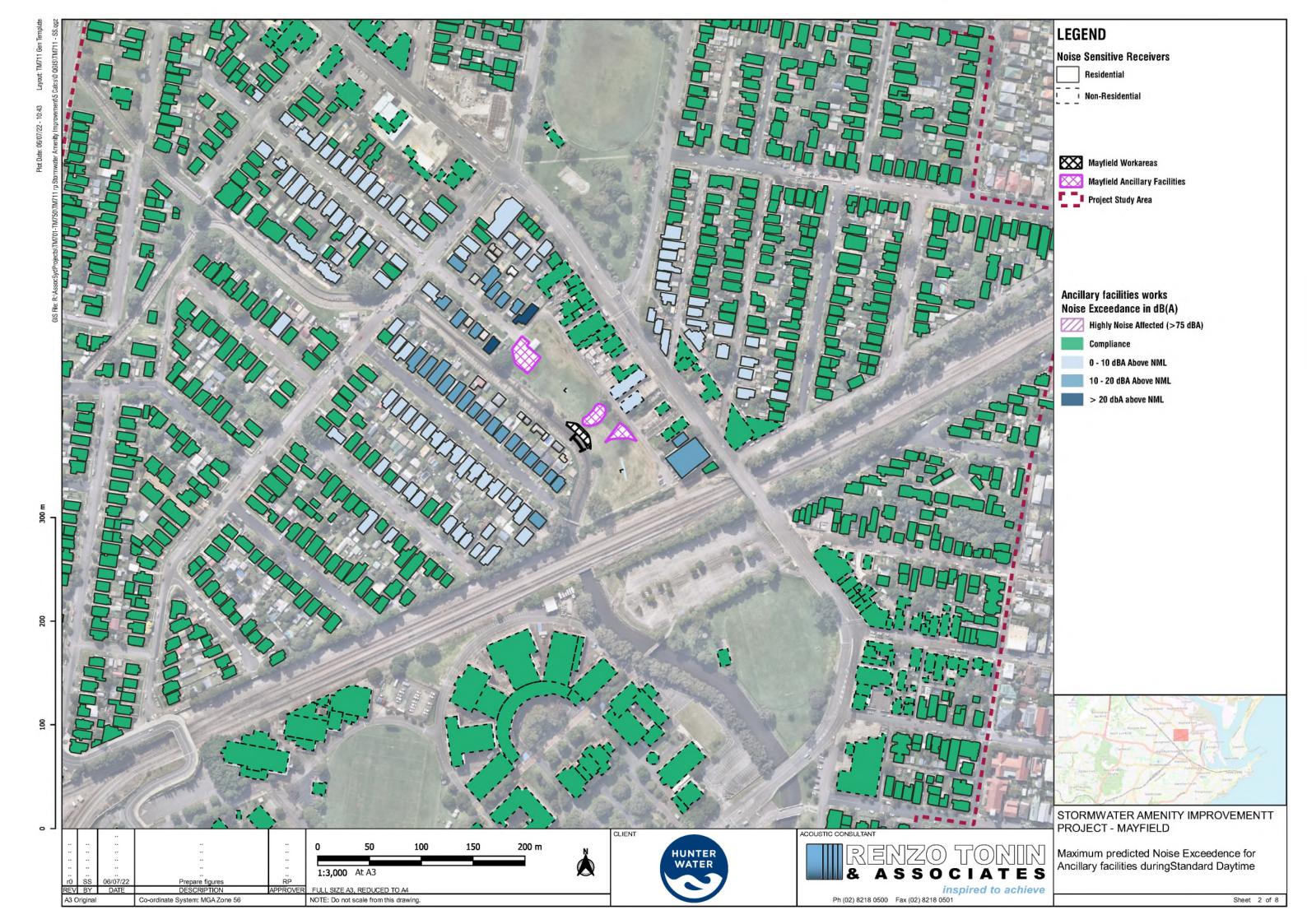
# APPENDIX D Unattended noise monitoring results

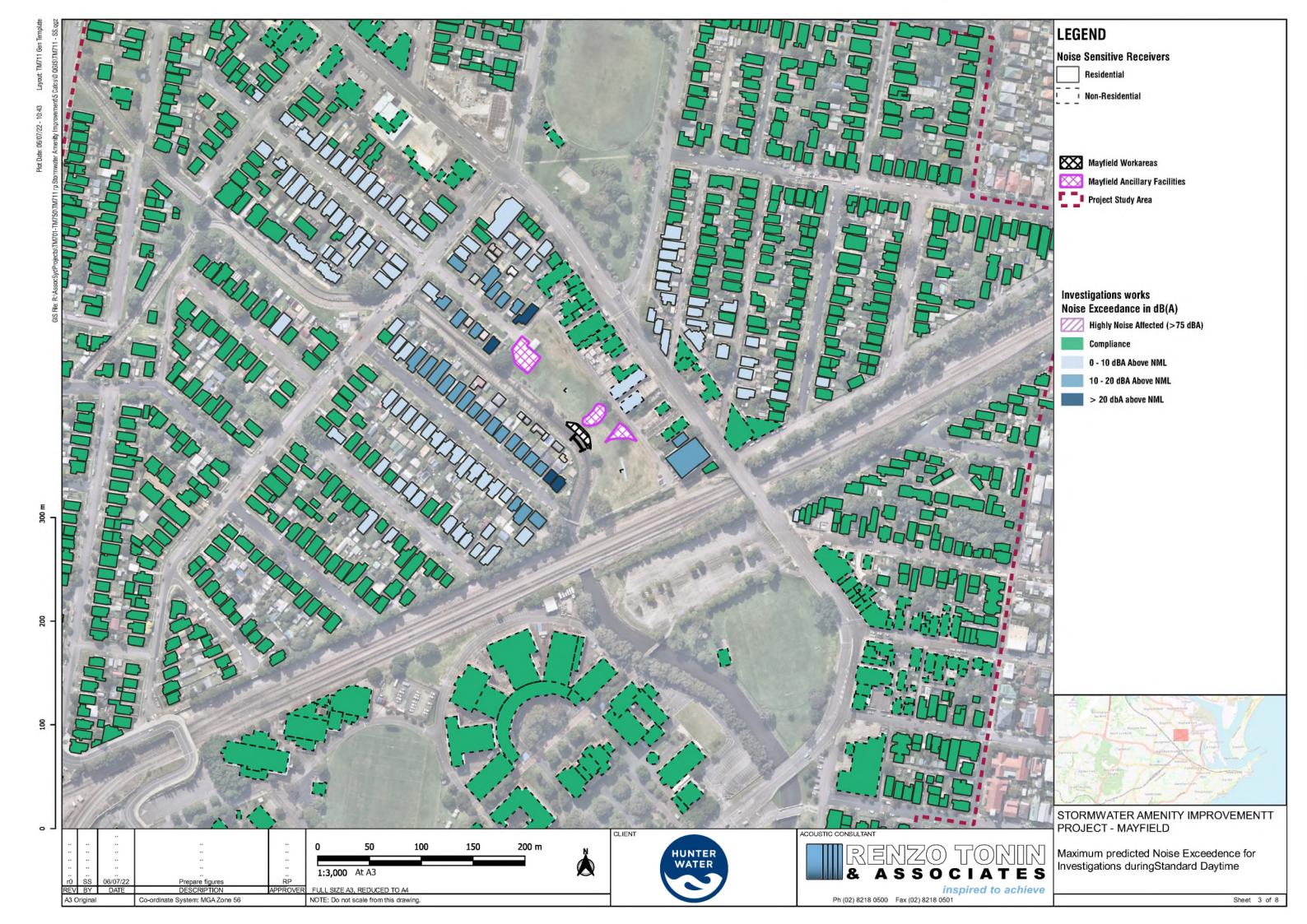


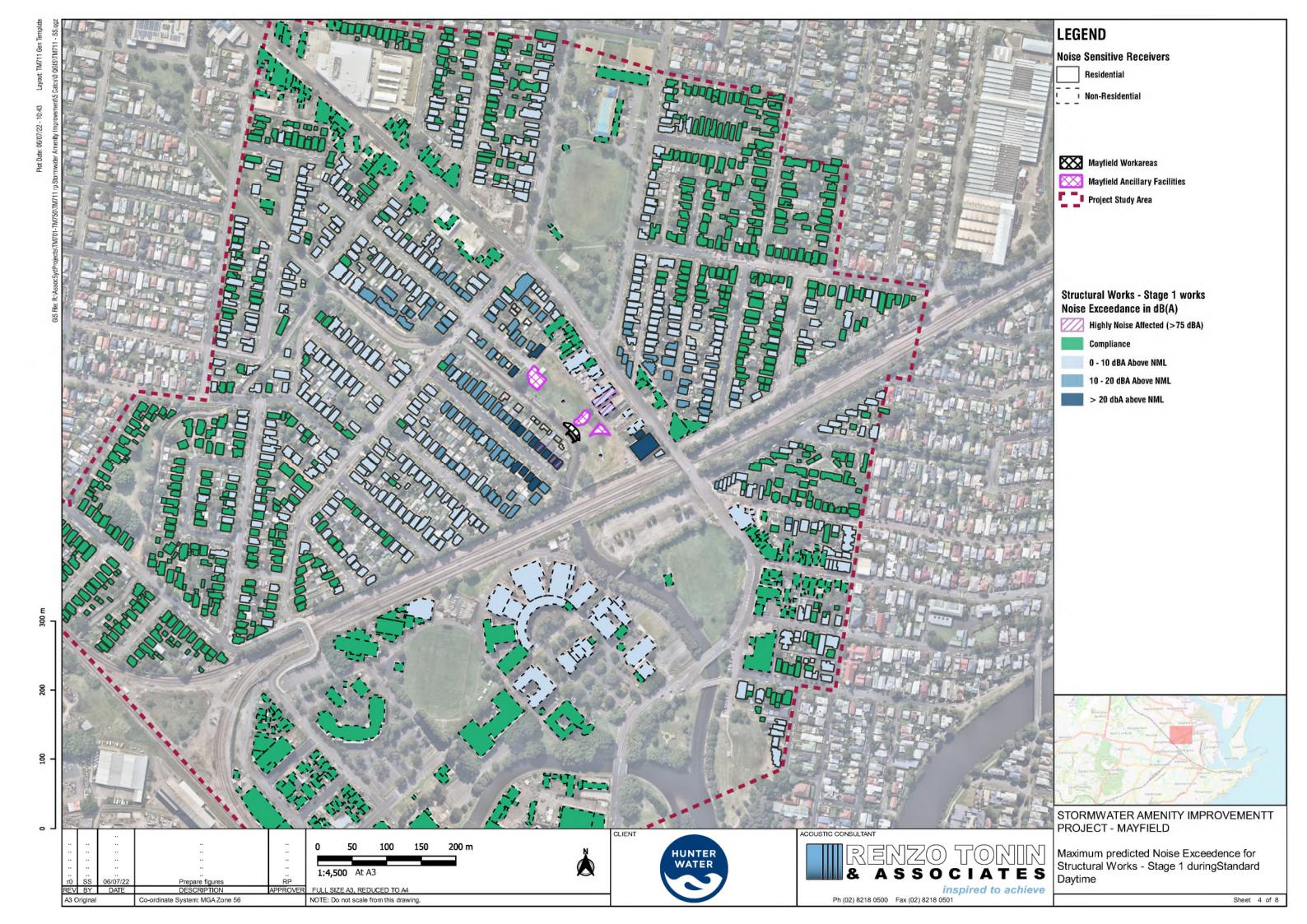


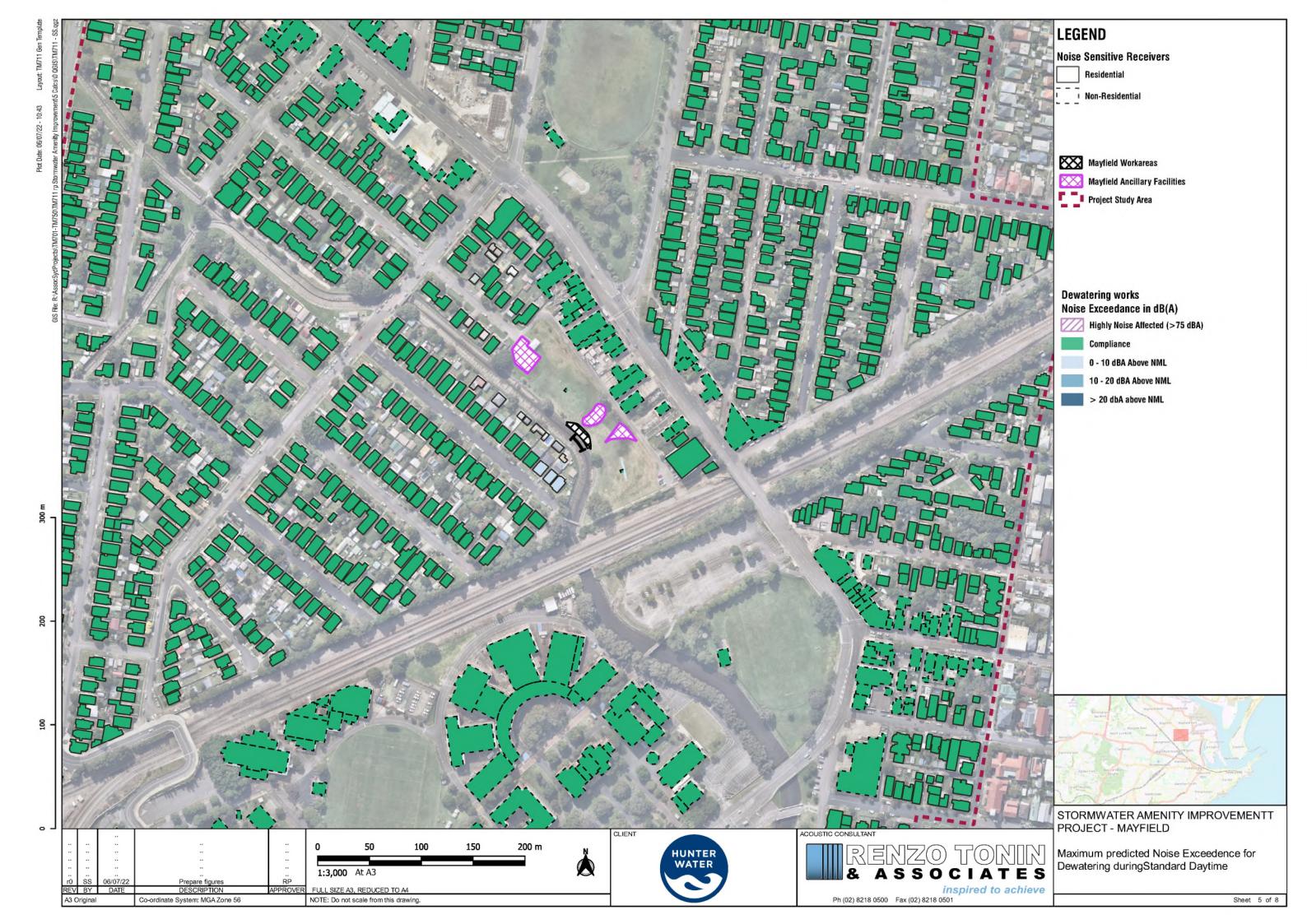
# **APPENDIX E** Predicted construction noise impacts

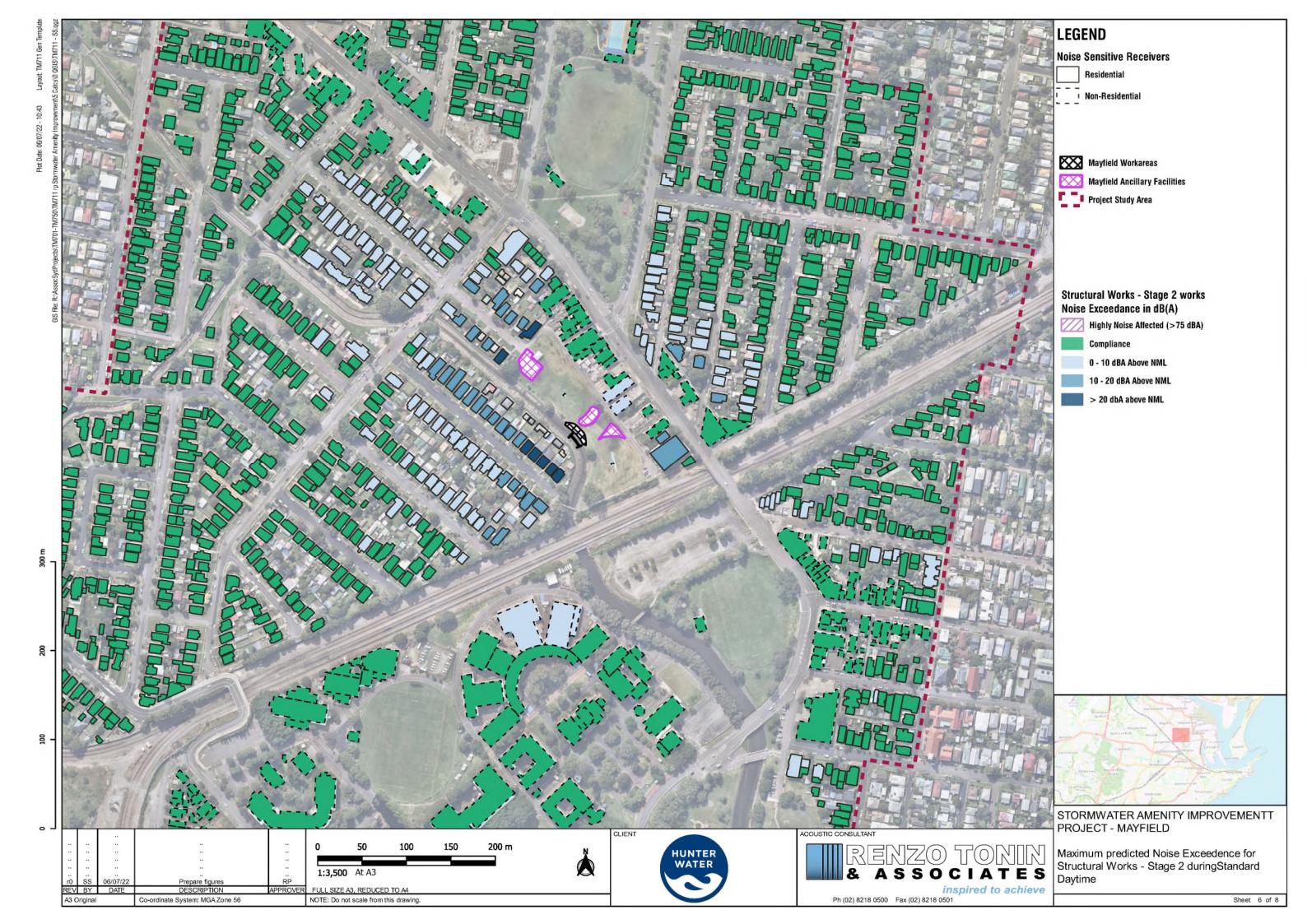


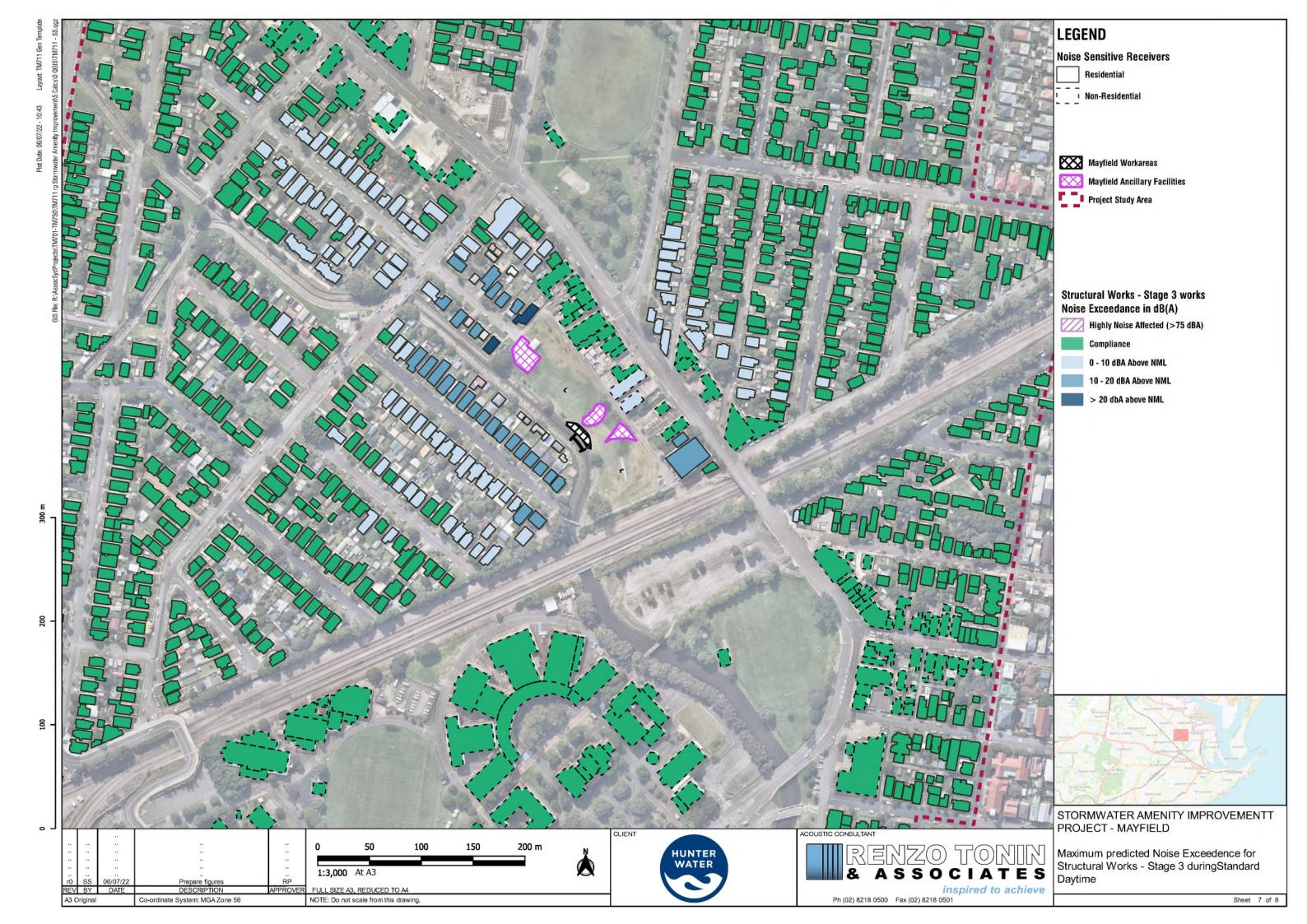


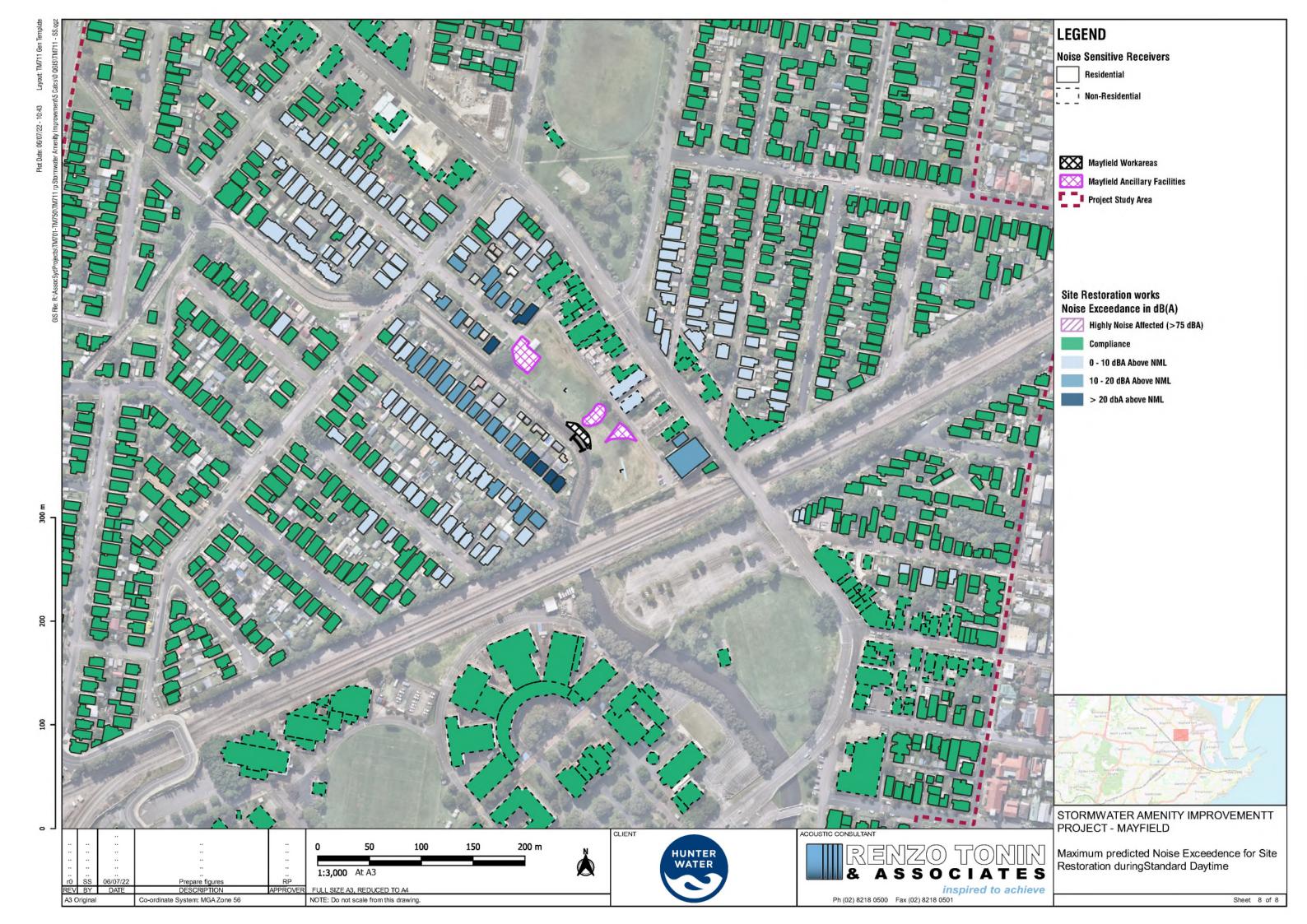












# APPENDIX F Construction vibration minimum working distances

