total earth care

Waterway Impact Statement

William Charlton Village

181 Allambie Road, Allambie Heights 2100

Total Earth Care Pty Ltd

February 20

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181 Allambie Road, Allambie Heights 2100
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Executive Summary

The proposed development plan, DP752038, of a retirement village at Lot 2615, 181 Allambie Road, Allambie Heights occurs on “Waterways and Riparian Lands” as mapped in the Warringah Development Control Plan 2011. The majority of the subject site is mapped as Waterways and Riparian Lands (Warringah DCP 2011) which is based on the riparian buffer around Curl Curl Creek (Warringah Creek Management Study (WCMS) 2004). Section E8 of the Warringah DCP 2011 states that for any proposals on land identified as waterway or riparian land, a Waterways Impact Statement (WIS) must be submitted by the proponent. This report has been prepared with reference to Warringah Council’s Waterways Impact Statement Guidelines.

Potential impacts of the proposal are restricted to issues of stormwater runoff, erosion and sedimentation during the construction phase, and removal of native vegetation. Impacts on the existing channel form, erosion rate, or bank stability of the artificial drainage lines are not expected as they have been excavated into sandstone bedrock.

These drains are assessed as having low ecological value due to their “urban modified” river styles and that their geomorphic attributes have been altered so much that they function as drains not creeks.

Mitigation measures have been proposed which will maintain and enhance riparian landscapes, stabilise erosion and downstream sedimentation, reduce stormwater runoff, and preserve the natural components that contribute to ecological value of the site. These include Water Sensitive Urban Design (WSUD) measures such as vegetated swales, On-site Stormwater Detention (OSD) systems such as detention and retention basins, and site rehabilitation through bush regeneration and riparian revegetation, amongst others.

This Waterway Impact Statement provides a waterways analysis, assessment of impacts, assessment of compliance with the Warringah DCP 2011, and provision of mitigation measures in regards to the proposal and surrounding environment.

The proposed development will, on balance, have positive impacts on the waterway and will result in better onsite detention, reduced flow rates, better aquatic habitat, healthier bushland and a reduced weed seed source to the catchment below.

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1 Introduction

1.1 Background

Total Earth Care (TEC) has been commissioned by Allambie Heights Village to prepare a Waterway Impact Statement (WIS) for the development proposal at 181 Allambie Road, Allambie Heights 2100. Allambie Heights Village is located within the Northern Beaches Council Local Government Area (LGA). See Appendix A for the proposed architectural and landscape plans.

The majority of the subject site is mapped as Waterways and Riparian Lands (Warringah DCP 2011) (Figure 1) which is based on the riparian buffer around Curl Curl Creek (Warringah Creek Management Study (WCMS) 2004). Section E8 of the Warringah DCP 2011 states that for any proposals on land identified as waterway or riparian land, a Waterways Impact Statement (WIS) must be submitted by the proponent. This report has been prepared with reference to Warringah Council's Waterways Impact Statement Guidelines.

Figure 1. Waterways and Riparian Lands (Warringah DCP 2011)

1.2 Objectives

The objective of the WIS is to conduct an adequate environmental assessment of development works so as to protect, maintain and enhance waterways and riparian lands. This includes undertaking

1. Waterway Analysis;
2. Assessment of Impacts;
3. Assessment of Compliance with the Warringah Development Control Plan; and
4. Provision of Mitigation Measures.

1.3 Relevant Legislation and Guidelines

The legislation and guidelines relevant to this WIS include the:

- *Biodiversity Conservation (BC) Act 2016* (NSW);
- *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* (Cth);
- Protection of Waterways and Riparian Land Policy PL 740 (Warringah Council) ;
- Warringah Creek Management Study (WCMS) (Warringah Council 2004);
- Warringah Development Control Plan (DCP) 2011;
- Warringah Local Environmental Plan (LEP) 2011;
- *Water Management Act 2000* (NSW), and;
- Waterway Impact Statement Guidelines (Warringah Council)

1.4 Staff Qualifications

This report has been prepared by Andrew McGahey who is suitably qualified with over 25 years' experience. His qualifications are as follows:

- Associate Diploma of Horticulture
- Certificate II in Bushland Regeneration
- Planning for Bush Fire Protection
- White Card (WHS General Construction Induction)
- Senior First Aid Certificate

1.5 Subject Site and Study Area

The subject site is defined as 181 Allambie Road, Allambie Heights (Lot 2615 DP752038) and includes the area directly affected by the proposal. The study area includes additional areas which are likely to be affected by the proposal, either directly or indirectly. See Map 1 for subject site, study area, and property boundaries.

Title: Subject Site & Study Area

Map No: 1

Site: William Charlton Village

Client: Allambie Heights Village

Date: February 2020

Project No: C11661

Legend

- Study Area
- Subject Site
- Lot

0 15 30 60 Meters

N

Data Source:
Total Earth Care
Nearmap

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2 Waterway Analysis

2.1 Site Description

2.1.1 Physical Characteristics

Three (3) drainage lines have been artificially built within the study area.

Drain 1 is a catch drain which runs around the northern and western perimeter of the proposed development area and intercepts most stormwater before it enters the development site. This drain has been excavated out of solid rock and is closed over (a culvert), where it drains beneath a sealed access road. This drain delivers its water over a small rock shelf and into the Manly Warringah War Memorial Park (MWWMP). This drain will protect the proposed development site from rains during and after construction. It will be affected by the proposal when a perimeter road is built on the northern boundary and when vegetation close to it is modified to install fire Asset Protection Zones (APZs).

Drain 2 is fed by an informal swale/gutter located on the high side of the central access road. The intercepted water is surface flow within the development site. This water is fed through a small culvert under the road which it then releases into a broad grassy swale which is also receiving water from the lower half of the development site. This grassy swale discharges into an artificial drainage basin/sediment trap within MWWMP. This drain will be completely rebuilt during the installation of the new roads and buildings.

Drain 3 runs along the western boundary of the site. This drain is essentially an erosion channel which has formed via head cut erosion. The channel is fed by water that has shed from the Sydney Water pipeline access road. The access road has caused the concentration and channelling of erosive volumes of water onto the proponents land. The western drain is also fed by the gutter/swale on the high side of the access road. Disturbance will occur within proximity of the drain when the access road is widened to install a twelve (12) metres wide turning circle for Rural Fire Service (RFS) vehicles.

All three (3) of these artificial drainage lines are not mapped by the Office of Water as streams recognised by the Strahler System (i.e. they do not appear as blue lines on a 1:25,000 topographic map as held by the Land Information Centre). Drain 1 is approximately one-hundred and forty-five (145) metres long to the north of the existing road and approximately sixty (60) metres long to the south of the road. Drain 2 is approximately fifty (50) metres long and Drain 3 is approximately eighty (80) metres long. All three (3) drains flow in a north-east to south-west direction.

Drain 1 is mapped as forming part of the upper headwaters of Curl Curl Creek within the Manly Creek sub-catchment (WCMS 2004). Council has agreed with the proponent that the upper most extent of the drain above the road culvert is to remain defined as a drain whilst the lower reach below the access road will be defined as a creek.

All three (3) drains are defined as ephemeral drains or “urban modified”, meaning their channels have been modified to the extent that they no longer function as rivers (WCMS 2004). The creeks function as open drainage lines to transport the flow of stormwater (see Figures 1 and 2).

The vegetation along Drains 1 and 2 is not distinctly riparian in contrast with the surrounding bushland.

See Map 2 for the locations of the drainage lines within the site and see Figure 2, Figure 3 and Figure 4 for photos taken on the 19th February 2020.

Figure 2. Drain 1

Figure 3. Drain 3

Figure 4. Drain 2

2.1.2 Connectivity

The artificial drainage lines are situated within the upper Manly Creek sub-catchment and are approximately 1km upstream from Manly Dam. Although there is no direct connectivity between the drainage lines on site with the permanent tributaries that flow into Manly Reservoir, there is continuous connectivity of bushland from the site to Manly Dam Reserve (i.e. MWWMP).

According to the WCMS 2004, “Manly Dam Reserve covers approximately 375ha of which 78% is bushland (Nelson Consulting Pty Ltd, 1998). This provides a high level of connectivity of natural vegetation in the floodplain and riparian zone of Curl Curl Creek and reasonable habitat for dispersal of native terrestrial fauna species. Geomorphic diversity is also very high, providing a wide range of habitats and supporting excellent native species richness. Curl Curl Creek and its tributaries also provide high landscape and passive recreation value to the area”.

The diversity on site is lower than other reaches of the creek due to it being man made and substantially cleared of native vegetation.

2.1.3 Threatened Aquatic Flora and Fauna

Previous studies by Total Earth Care did not identify any threatened aquatic flora or fauna within the site. However, there are known records and sightings of threatened species within the locality, which may utilise the ephemeral drainage lines including the Red-Crowed Toadlet (*Pseudophryne australis*).

2.1.4 Existing Erosion and Sediment Conditions

Drain 1 is cut directly into sandstone bedrock and is not prone to erosion. There are no signs of bank erosion or head cut.

Drain 2 is to the east of Drain 1 and commences on the southern side of the existing road. The start is marked by a culvert. No siltation is evident.

Drain 3 has at least one (1) actively eroding head cut and steep vulnerable banks that are likely to collapse. No siltation is evident. This drainage line ponds into shallow soils and onto a broad sandstone bench. There is no clearly defined channel beyond the site boundary.

The majority of the site is vegetated or turfed. A thick layer of leaf litter in the existing bushland prevents soil erosion except where disturbance has occurred.

The existing artificial detention basin within MWWMP collects sediment from Drain 2 and the adjacent property. The use of sandstone boulders in the landscaping around the detention basin prevents further erosion in this area. The sediment basin has not been maintained and it requires the silt load to be removed so that it can function as intended.

2.1.5 Channel Form, Erosion Rate and Bank Stability

The defined channels of the creeks have an unnatural shape and location which reflect the property boundaries rather than the natural topography of the site.

Table 1. Channel Form, Erosion Rate and Bank Stability for the Three (3) Drainage Lines

Drain	Channel Form	Erosion Rate	Bank Stability
1	Solid sandstone channel in bedrock	No erosion	Banks are stable
2	Broad turfed swale	No erosion	Banks are stable
3	Actively eroding head	Erosion evident and active	Banks are unstable in parts

There are no issues of erosion or bank stability due to the channels being cut into sandstone bedrock.

2.1.6 Stormwater Discharge Points and Stormwater Treatment Measures

The artificial creeks function as stormwater drainage points. Drain 1 discharges into the artificial detention basin within MWWMP, which is a stormwater treatment measure approved as part of a previous DA on Council land. Drain 3 discharges into the managed bushland downslope. No significant siltation issues are evident in either drainage line.

Figure 5. Existing artificial detention basin

Figure 6. Western drainage line discharging into bushland

2.2 Ecological Value

Drain 1 forms part of the upper headwaters of Curl Curl Creek within the Manly Creek sub-catchment (WCMS 2004). Council has determined the beginning of Curl Curl Creek on site to be the culvert below the existing road (see Map 2).

Curl Curl Creek is classified as a Group A creek meaning it has very high ecological value and less than 10% connected impervious area (WCMS 2004). It has received an Overall Ecological Value of 3.6/5 meaning that the naturalness, rarity and diversity of the creek's ecosystem structures and functions are considered to be high to very high (WCMS 2004).

It should be noted that the section of Curl Curl Creek that is mapped within the study area, Drain 1, is approximately one-hundred and forty-five (145) metres long to the north of the existing road and approximately sixty (60) metres long to the south of the road. Neither Drain 2 nor Drain 3 are mapped as being part of Curl Curl Creek.

The river styles of Drains 1 and 2 are "urban modified", meaning that their channels have been modified to the extent that they no longer function as rivers. As noted above, they function as open drainage lines to transport the flow of stormwater. Due to these artificial geomorphic attributes the ecological value of drainage lines on site are greatly diminished and are considered low for the purposes of the current assessment. Even so, they may still provide limited foraging and breeding habitat for amphibians, reptiles and invertebrates.

2.2.1 Water Quality

Curl Curl Creek contains elevated concentrations of total and dissolved nitrogen which exceed the ANZECC (2000) Trigger Levels, while concentrations of suspended solids are relatively low (WCMS 2004). Stormwater runoff from residential areas within Allambie Heights and Manly Vale, open spaces along the creek line, use of fertilisers in the upper catchment, and polluted groundwater are likely causes of this (WCMS 2004). These results suggest that surrounding bushland does little to trap pollutants before they enter Curl Curl Creek (WCMS 2004).

Water quality testing for the artificial drainage lines on site will be undertaken as part of a Construction Environmental Management Plan (CEMP) to be prepared prior to construction. Samples will be taken of water entering and water exiting the drainage lines. These will be tested for: M17 Total, pHEC, TSS, Turbidity, COD, TOG, TOC, TN, TP, M17 dissolved, TRH/BTEX, PAH, OC/OP/PCB, NH4, Chlorophyl-a, and various metals. Results will be assessed in comparison to the ANZECC (2000) Trigger Levels.

2.2.2 Risks to Ecological Value

Generally, Group A creeks can sustain very little further development before their aquatic ecosystems will change substantially, especially when they are close to natural condition and minor perturbations can have a major impact (WCMS 2004). However, in the case of the artificial drainage lines on site, these are not close to natural condition as they have already been substantially modified, and are situated within existing developments or managed areas.

Group A creeks are at high risk of vegetation clearing and weed proliferation, medium risk of urban development (sedimentation, erosion, water pollution), and low risk of industrial and commercial operations (WCMS 2004).

Figure 7. Weeds such as Lantana camara, *Ageratina adenophora* and *Paspalum quadrifarium* pose a risk to the existing drainage lines

Figure 8. Example of "urban modified" river style

2.3 The Proposal

2.3.1 Nature and Extent of Proposed Activities during Construction

Proposed activities during construction include but are not limited to:

- Excavation and realignment of existing roads;
- Excavation and installation of residential and community buildings;
- Installation of stockpiles and hardstand areas;
- Phytophthora controls, e.g. shake-down bays and cleaning of all machinery entering and exiting the site; and
- Establishment of exclusion zones around drainage liness, etc.

A CEMP will be prepared prior to construction which will include full details of proposed construction activities relevant to the drainage lines and surrounding bushland. See also Map 2 for the extent of the proposed development.

2.3.2 Nature and Extent of Proposed Activities during Operation

Allambie Heights Village Ltd, an aged care organisation, has taken a lease over 3.72ha of Crown lands at 181 Allambie Rd, Allambie Heights (Allambie Heights Village). These lands are contiguous to a property that they currently own at Martin Luther Place, Allambie Heights.

A masterplan is being produced by Allambie Heights Village with the intention of building a retirement village adjacent to its aged care facility, Allambie Heights Village, at Martin Luther Place. The development will be a state-of-the-art retirement village infrastructure precinct which will augment its current capacity, and service a burgeoning need for retirement needs. The site is currently being used as a Residential Aged Care Facility.

Development of the land was substantially started by the past lessees and it is the intention of the new current lessees to continue with what they consider to be an existing use right. The western end of the property has not been fully developed and a significant portion of the site is remnant bushland.

See Map 2 for the extent and location of proposed construction and operational activities relative to the mapped riparian lands and drainage lines.

Title: Distance of Development to Drainage Lines

Map No: 2

Site: William Charlton Village

Client: Allambie Heights Village

Date: February 2020

Project No: C11661

Legend

- Lot
- Study Area
- Subject Site
- Community Building
- Habitable Building
- 10m Riparian Zone
- Creek 1st Order
- Drainage Line
- Distance to Drainage Line

0 15 30 60 Meters

N

Data Source:
Total Earth Care
Nearmap

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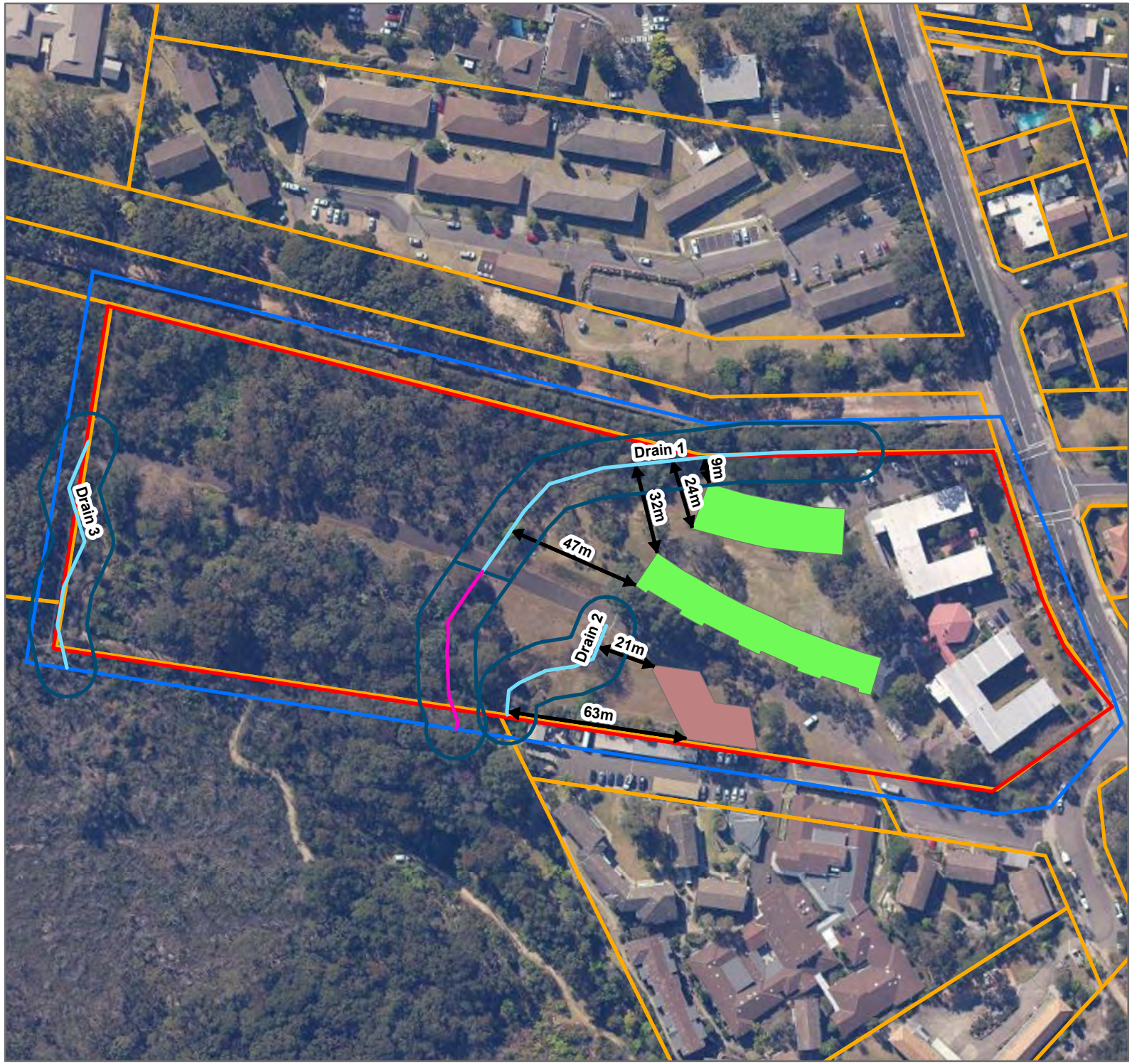

Title: Vegetation Communities

Map No: 3
Site: William Charlton Village
Client: Allambie Heights Village
Date: Feb 2020
Project No: C11661

Legend

- Subject site
- Study area
- Lot

Plant Community Type (PCT)

- PCT 1250: Sydney Peppermint - Smooth-barked Apple - Red Bloodwood
- PCT 1783: Red Bloodwood - Scribbly Gum / Old-man Banksia
- PCT 1824: Mallee - Banksia - Tea-tree - Hakea
- Urban Exotic/Native
- Weeds and Exotics

0 15 30 60 Meters

N

Data Source:
Total Earth Care
SIX Maps

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3 Assessment of Impacts

3.1 Impact upon Water Quality

The site to the west of Drain 1 consists of remnant bushland. The proposed development will occur to the east of this drainage line. The area of the proposed development is largely located on two managed vegetation types:

- *Vegetation Type 1: Managed Grassland*

  Above the existing access road vegetation is a managed grassland with well separated local non-local and exotic trees which are growing on the shallow sandy colluvial soils of the Hawkesbury Soil landscape as per Soil Landscape Series Sheet 9130 (1983).

  Managed grassland also occurs below the access road where the soil profile appears to have been altered through filling. This soil is supporting weed tree species including Coral Trees (*Erythrina × sykesii*). The fill material is assumed to be locally sourced sandy soils from the original development which has been installed over the natural soil profile. This has increased the soil depth and absorptive capacity of the natural soil.

- *Vegetation Type 2: Highly Modified / Managed Bushland along the Eastern Bank of Drain 1.*

  It is proposed that the vegetation within the drain be supplemented with instream plantings into newly created pool and riffle zones. Above the banks the drain/creek will be managed as native grassland with tree dominated overstorey to provide creek bank access to the residents while concurrently managing bushfire risks. The bushland on the eastern side of the creek below the access track has already been substantially modified and is currently heavily infested with non-native grass and tree species.

  The removal of weeds and the regeneration of a native plant community will increase the water quality by removing weed species which have a deleterious effect on ecological function.

  This landscape zone will be planted with species with deeper roots than the grass species which will improve plant evapotranspiration and reduce soil evaporation through the creation of plant windbreaks.

There may be changes to water quality during the construction phase, however mitigation measures will be implemented to prevent this occurrence. Following the development it is not anticipated that there will be any changes in water quality compared to the present as the surrounding vegetation adjacent to the new buildings will be managed as grassed areas. There will not be an increase in chemical usage or sedimentation. The net impact of the proposal on water quality due to the loss and or modification of this vegetation will be positive due to the removal of weed species.

3.1.1 Soil Water Absorption

Soil absorptive capacity of the existing sandy soils under the grass is very low and soil nutrients and biological activity in the soil is lower than healthy bushland. By establishing deep soil planter beds and by establishing a bushland community of plants along Drain 1 the soil absorption capacity will be increased and water quality improved.

3.1.2 Deep Excavations and Surface Water Catchments

Deep excavations and surface water flow will be intercepted and directed in to detention and holding tanks. Some of the water in these tanks will be pumped up slope to a header tank and released slowly through landscape water features and into the vegetated drain/creek, which will increase flow through the whole riparian landscape. The passage of this water through the creek and water features will cleanse and aerate the water.

The water quality of the artificial drainage lines and stormwater flowing offsite is predicted to be minimally impacted during the construction of the proposal and will have a net benefit in the long term.

3.1.3 Water Contamination

It is not anticipated that any water will be contaminated by the ongoing use of the site:

Water contamination will be minimised by following the procedures below:

- Minimise the risk to public health and safety by installing temporary exclusion fencing and erosion/sediment controls as per the CEMP;
- Protect Council's stormwater drainage assets during construction by implementing all the measures contained in the CEMP; and
- Minimise the quantity of stormwater runoff on Council's drainage system by directing discharge into the existing sediment basin.

3.2 Impacts on Channel Form, Erosion Rate and Bank Stability

In order to be consistent with the objectives and requirements of C4 – Stormwater of the Warringah Development Control Plan 2011, the proposal will:

- Reduce the risk to life and property from flooding lower in the catchment by installing stormwater detention tanks which adequately cater for the volume of water that might be generated in a 1:100 stormwater event;
- Manage and minimise stormwater overland flow, (sheet flooding) and groundwater related damage to properties by channelling stormwater within the existing artificial drainage lines; and
- Design, install, and maintain the stormwater drainage system in accordance with Council's Water Management Policy. Please refer to Appendix B.

The water detention measures outlined above will mitigate any potential increase in flow rate or volumes.

The proposal is not expected to alter the main channels existing form, erosion rate, or bank stability. This channel is on the western edge of the development area and feeds into the creek. It is proposed that the main channel will be broadened and deepened above the access road to create a series of pools and riffles. As with the rest of the drainage line this will be excavated into solid rock, so channel form will be substantially improved and the bank stability and erosion rates will not be effected.

The creation of pools and riffles will detain water and improve ecological function and reduce volume and flow rates to the creek downstream positively impacting on the downstream reaches of the creek.

The informal drainage line in Figure 9 below will be decommissioned and all water that is currently flowing uncontrolled into the existing detention basin will be captured and detained in underground tanks.

The existing detention basin is on council land and will be upgraded with council permission.

Figure 9. Existing culvert and beginning of informal overland drainage swale

Figure 10. Informal overland drainage swale further downstream

3.3 Impacts on Stormwater Discharge Points and Stormwater Treatment Measures

Currently the site is turfed and underlain by a thin topsoil profile over bedrock. The stormwater infiltration capacity of this is minimal and will be improved by the installation of stormwater detention and retention systems relating to the proposal. .

A hydrological engineer will design these systems which will function to decrease peak flow rates into the existing creeks. A solar power water storage tank which will cycle water to another tank at the top of the site is to be confirmed by the landscape architect. Alteration of the drain near the existing detention basin is also anticipated (see Appendix B). The stormwater treatment during construction will be managed by the CEMP which aims to clean all water prior to its release.

3.4 Ecological Impacts of the Development

The development is largely occurring in previously cleared areas and so the ecological impacts are anticipated to be reduced. Some areas of vegetation in proximity to the proposed development will be required to be managed as APZs. A Biodiversity Management Plan (BMP) has been prepared which details how the remaining bushland will be managed during and post-construction (Appendix C).

- Protect and improve the ecological condition of the surrounding bushland by requiring site rehabilitation (i.e. bush regeneration) of any areas disturbed or otherwise affected by the development, reduced weed densities will significantly benefit the bushland downstream ;
- Integrate Water Sensitive Urban Design (WSUD) measures by including vegetated swales, and pools and riffles within the existing drain. Install and maintain, sediment basins, these will also protect the downstream aquatic environment;

3.5 Landscape Impacts of the Development

The construction phase of the proposed development will require excavation works including cutting into the existing bedrock and slope. The impact of these works are detailed in the Stormwater Management Plan including alterations to flow rates, the impact of impermeable surfaces, and mitigation measures such as detention tanks (Appendix B). Any visual impacts will be addressed in the landscape architect's plan.

3.6 Flood Impact Assessment

The proposed development is not located on Flood Prone Land. The proposal has been engineered to mitigate increased flows as a result of the development and no adverse effects on floodplains downstream are predicted. For full details see the Stormwater Management Plan (Appendix B).

3.7 Bank Stability Assessment

Bank stability will not be affected by the proposed development. The banks of Drain 1 are carved into sandstone bedrock and are not prone to further erosion. Drains 2 and 3 will have their banks stabilised and bed control structures and rock armouring where required. Jute matting and planting may also be utilised.

Erosional processes outside of the drainage lines may be temporarily exacerbated during the construction phase, however these well be effectively mitigated by implementing the measures set out in the CEMP which will be written prior to construction.

3.8 Extent of Native Vegetation Proposed to be Removed

An intermittent five (5) metres wide strip of native vegetation will be removed in order to gain access to install pools and riffles in the main channel above the access road. This vegetation will be modified to remove the shrub layer and create a native grassland with a native tree canopy. See Appendix C for the BMP which details the vegetation management during and post-construction.

3.9 Any Modifications to Natural Creeklines or Overland Flow

There are no natural creeklines within the study area. The man-made creek below the access road will remain unchanged. Overland flows are expected to change as a result of excavation works and new

walls paths and roads. All water overland flows in the development area will be directed to a detention system as outlined in the Stormwater Management Plan (see Appendix B).

4 Assessment of Compliance with the Warringah Development Control Plan

This section assesses compliance with the objectives and requirements of the Warringah Development Control Plan 2011.

Table 2. Assessment of the Proposal's Compliance with Warringah DCP (2011)

Clause	Clause Title	Impact level (negligible, low, medium or high, negative or positive, or N/A)	Discussion of Compliance
C4	Stormwater	**During construction:** medium negative **During operation:** negligible	The proposal will: • Minimise the risk to public health and safety by installing temporary exclusion fencing and erosion/sediment controls as per the CEMP; • Reduce the risk to life and property from flooding by constructing a stormwater detention tank which adequately caters for the volume of water that might be generated in a 1:100 stormwater event; • Integrate Water Sensitive Urban Design measures by including vegetated swales, sediment basins, etc.; • Manage and minimise stormwater overland flow, nuisance flooding and groundwater related damage to properties by channeling stormwater within the existing artificial drainage lines; • Protect Council's stormwater drainage assets during construction by implementing all the measures contained in the CEMP; • Minimise the quantity of stormwater runoff on Council's drainage system by directing discharge into the existing sediment basin, and; • Design, install, and maintain the stormwater drainage system in accordance with Council's Water Management Policy. Together these measures will ensure that stormwater runoff will not cause downstream flooding and will have minimal environmental impact.
C5	Erosion and Sedimentation	**During construction:** medium negative **During operation:** negligible	• An Erosion and Sediment Control Plan will be prepared in accordance with Landcom's Managing Urban Stormwater: Soil and Construction Manual (2004). It will detail types of control, methods of installation, locations, maintenance regimes, responsibilities, stockpile storage, silt fencing, vehicle shake-down, floating silt boom, stabilisation access for machinery, etc. These measures will be installed and maintained until the site is fully established. • A Construction Environment Management Plan (CEMP) will be written by the construction contractor and approved by Council before commencement of works. Mitigation measures proposed during the construction phase will include, amongst others: o Construction of a temporary stormwater detention basin where silted water can be flocculated and sediment removed prior to release into bushland below; o Installation of measures to mitigate potential erosion on site and to stop the flow of silted water off site; o The requirement that any erosion and sedimentation is to be managed at the source, and; o Compliance of all erosion, sediment and pollution controls with Council's Water Management Policy.
E2	Prescribed Vegetation	Low negative	• Protect and improve the ecological condition of the surrounding bushland by requiring site rehabilitation (i.e. bush regeneration) of any areas disturbed or otherwise affected by the development; • The vast majority of the development is situated so as to minimise impact on prescribed vegetation including remnant canopy trees, understorey vegetation, and ground cover species. • The modification of a narrow bushland buffer zone for an APZ is expected between the development and existing vegetation • No trees shall be removed from this zone. Only the shrub layer will be removed to prevent connectivity between vegetation layers and reduce the fire ladder. • Several planted trees are to be removed from the turfed area on the high side of the road.

Clause	Clause Title	Impact level (negligible, low, medium or high, negative or positive, or N/A)	Discussion of Compliance
E3	Threatened species, populations, ecological communities listed under State or Commonwealth legislation, or High Conservation Habitat;	Low negative	A Biodiversity Development Assessment Report (BDAR) (i.e. a Flora and Fauna Assessment) will be prepared in accordance with the relevant guideless and will demonstrate that the objectives of the clause have been met. A Biodiversity Management Plan (BMP) has been prepared in accordance with the relevant guideless and will protect, manage, and (where appropriate) promote the recovery of threatened species, populations and ecological communities and areas of high conservation habitation within the subject property (Appendix C).
E4	Wildlife Corridors	Low negative	A Biodiversity Development Assessment Report (BDAR) (i.e. a Flora and Fauna Assessment) will be prepared in accordance with the relevant guideless and will demonstrate that the objectives of the clause have been met. A BMP has been prepared in accordance with the relevant guideless and will protect, manage and enhance wildlife corridors, and where appropriate reconstruct wildlife corridor areas on the subject property (Appendix C).
E5	Native Vegetation	Low negative	A Biodiversity Development Assessment Report (BDAR) (i.e. a Flora and Fauna Assessment) will be prepared in accordance with the relevant guideless and will demonstrate that the objectives of the clause have been met. A BMP has been prepared in accordance with the relevant guideless and will protect native vegetation on the subject property (Appendix C).
E6	Retaining unique environmental features on site	Negligible	In order to conserve the remnant bushland and trees on site, the proposed development will: • Be located largely on parts of the site where remnant bushland and trees are not present; • Minimise on-site disturbance by implementing the measures detailed in the CEMP, Erosion and Sediment Control Plan, and Soil and Water Management Plan; • Employ materials that complement the site e.g. sandstone; • Avoid the introduction of soil from outside the site; • Select provenance specific native plant species for revegetation works, and; • Select plant species that enhance resident fauna habitat as per see Council's tree replacement guide.
E8	Waterways and Riparian Lands	Low negative	• As well as the submission of this Waterway Impact Statement, the proposed development complies with Council's Protection of Waterways and Riparian Land Policy including the following sections: o 3.1(a) As the three (3) drains onsite are artificially constructed, the full range of natural ecological processes which would be present in natural watercourses and riparian land are not present. Even so, the proposal will not significantly alter these existing drainage lines and natural area restoration will be implemented to improve their ecological function and the surrounding plant communities. o 3.1(c) An informal overland drainage swale currently discharges into the existing detention basin. This will be upgraded with bank and bed control structures plus pool and riffle zones to improve water holding capacity, stability, and ecological function. It will also be vegetated to reduce the risk of erosion and siltation downslope. o 3.1(d) Cultural heritage and public access is not affected by the proposal. Drain 3 will be stabilised adjacent to the access road turning circle redevelopment. o 3.2(a) Riparian setback distances are not applicable. The artificial creeks are not mapped by the Office of Water as streams recognised by the Strahler System, i.e. they do not appear as blue lines on a 1:25,000 topographic map as held by the Land

Clause	Clause Title	Impact level (negligible, low, medium or high, negative or positive, or N/A)	Discussion of Compliance
			Information Centre. For the same reason a "controlled activity approval" pursuant to the *Water Management Act 2000* (NSW) is not required. o 3.2(b) The development is sited and designed so as not to negatively impact the stability of the existing drainage lines. o 3.2(c) These are not relevant to the current proposal. • The proposed development also complies with Council's Water Management Policy. See the Stormwater Management Plan for full details. • Infrastructure such as roads, drainage, and stormwater structures are already located inside land identified as Waterways and Riparian Land. These were approved as part of a previous DA on Council land. • Almost the entire property is located on land mapped as Waterways and Riparian Lands. The APZ necessarily intersects with some of these mapped areas due to the location of bushland on site.

5 Provision of Mitigation Measures

Outcome 1: Protecting Native Species and Communities

Table 3. Outcome 1: Protecting Native Species and Communities

Performance Criteria	Acceptable Mitigation Measures	Proposed Mitigation Measures
Maintain natural habitats	- Improvement of Endangered Ecological Communities - Improvement of riparian vegetation OR - Compensatory habitat provided for any disturbance	- Protect and improve the ecological condition of the surrounding bushland by requiring site rehabilitation (i.e. bush regeneration) of any areas disturbed or otherwise affected by the development; - Site rehabilitation will protect any remnant local native riparian vegetation at the site and restore any riparian zones, disturbed or otherwise affected by the development, to a state that is reasonably representative of the natural ecotone of the protected waters system and as required in the BMP (Appendix C); - Revegetation, in accordance with the standards required by these conditions, is to be undertaken in this 10m wide area if it is significantly degraded or is likely to give rise-to weed invasion due to lack of native vegetation cover before or after weed control. - The drainage lines will be reshaped and revegetated to improve ecological function.
Provide fauna movement routes	- Improved connection of riparian zones AND - Improved fish movement through removal of barriers OR - Install fishways on any temporary or permanent barriers	- There are no fences or walls which stop animal movement across the site. - An informal overland drainage swale currently discharges into the existing detention basin. This will be upgraded with bank and bed control structures plus pool and riffle zones to improve water holding capacity, stability, and ecological function. It will also be vegetated to reduce the risk of erosion and siltation downslope. - No fish inhabit the ephemeral artificial drainage lines, however revegetation and site rehabilitation will improve habitat function for other riparian fauna species. - Streamflow is expected to increase in frequency within the drainage lines and impacts to water quality will be mitigated by effective OSD and WSUD measures (see Appendix B). Migration routes are not expected to be affected.
Prevent unnatural erosion or sediment deposition	- No increase in peak flows AND - No increase in total sediment loads	No increase in peak flows and no increase in total sediment loads will be achieved by implementing the following: - A Soil and Water Management Plan will be prepared in accordance with Landcom's Managing Urban Stormwater: Soil and Construction Manual (2004). The measures contained therein will be installed and maintained until the site is fully established; - A Construction Environment Management Plan (CEMP) will be written by the construction contractor and approved by Council before commencement of works. Mitigation measures proposed during the construction phase will include, amongst others; - Construction of a temporary stormwater detention basin where silted water can be flocculated and sediment removed prior to release into bushland below; - Installation of measures to mitigate potential erosion on site and to stop the flow of silted water off site; and - The requirement that any erosion and sedimentation is to be managed at the source.
Maintain acceptable water quality	- Council approved sediment and erosion control plan	A Council approved Erosion and Sediment Control Plan will be prepared in accordance with Landcom's Managing Urban Stormwater: Soil and Construction

Performance Criteria	Acceptable Mitigation Measures	Proposed Mitigation Measures
		Manual (2004). It will detail types of control, methods of installation, locations, maintenance regimes, responsibilities, stockpile storage, silt fencing, vehicle shake-down, floating silt boom, stabilisation access for machinery, etc. These measures will be installed and maintained until the site is fully established.
Maintain connectivity between waterways and floodplains	- Reduction of barriers between waterways and floodplains	No barriers between waterways and floodplains are proposed as part of the development. After being treated in detention basins, water captured in the artificial drainage lines will be released into surrounding bushland and floodplains downslope.

Outcome 2: Prevent Loss of Natural Diversity through Protecting Waterway and Riparian Vegetation (including Non-native Vegetation)

Table 4. Outcome 2: Prevent Loss of Natural Diversity through Protecting Waterway and Riparian Vegetation (including Non-native Vegetation)

Performance Criteria	Acceptable Mitigation Measures	Proposed Mitigation Measures
Avoid introducing plants or animals which may displace natural species	- Construction activities must not introduce new weeds species or allow weeds to spread (Bio-diversity Management Plan)	A BMP has been prepared and includes hygiene protocols to prevent the introduction of new weeds species and the spread of existing weeds (Appendix C). The BMP also includes the removal of Weeds of National Significance (WONS) through primary weeding using bush regeneration techniques of all areas of retained vegetation on the site.
No increase in nutrient loads to riparian soils and waterways	- Use of best practice Water Sensitive Urban Design to capture net increase in nutrient loads following development	WSUD measures will be integrated into the proposal to capture net increase in nutrient loads including: vegetated swales, sediment basins, stormwater retention and detention basins, use of porous sandstone boulders in landscaping, etc.
Avoid displacing species by habitat changes	- No development within the riparian buffer OR - Provision of compensatory habitat	Besides the several planted trees to be removed on the turfed area of the site, the only impact to habitat will be the modification of the bushland buffer zone for an APZ with regard to the WIS. No trees shall be removed from this zone. Only the shrub layer will be removed to prevent connectivity between vegetation layers and reduce the fire ladder. Compensatory habitat will be provided by regenerating weed infested area of bushland on site as per the approved BMP.
Protect natural areas from contamination	- No activities within the riparian buffer - which may contaminate soils or vegetation - No storage of chemicals, fuels or oils within riparian buffers OR - Adequate bunding of stored materials	An Erosion and Sediment Control Plan will be prepared in accordance with Landcom's Managing Urban Stormwater: Soil and Construction Manual (2004). It will prescribe that no activities are to be undertaken within the riparian buffer which may contaminate soils or vegetation, that there is to be no storage of chemicals, fuels or oils within riparian buffers, and that there is adequate bunding of stored materials. It will also detail types of control, methods of installation, locations, maintenance regimes, responsibilities, stockpile storage, silt fencing, vehicle shake-down, floating silt boom, stabilisation access for machinery, etc. These measures will be installed and maintained until the site is fully established.
Prevent the loss of any rare or threatened natural features	- No loss of any species, community or habitat listed under relevant conservation legislation - No loss of natural features identified in the DCP/LEP as rare or threatened	No loss of any listed species, community, habitat, or natural feature listed is expected as a result of the proposed development. For mitigation measures see the BMP.
Protect downstream protected areas, such as National Parks	- On-site detention through On-site stormwater detention (OSD) technical specification or infiltration through best practice Water Sensitive Urban Design AND	OSD systems such as detention and retention basins are proposed as well as WSUD features such as vegetated swales and sediment basins. See Appendix B.

Performance Criteria	Acceptable Mitigation Measures	Proposed Mitigation Measures
	- On-site sediment capture through best practice Water Sensitive Urban Design	

Outcome 3: Minimise Damage to Public and Private Property by Waterway Processes through Maintaining the Relative Stability of the Bed and Banks

Table 5. Outcome 3: Minimise Damage to Public and Private Property by Waterway Processes through Maintaining the Relative Stability of the Bed and Banks

Performance Criteria	Acceptable Mitigation Measures	Proposed Mitigation Measures
Avoid increases in peak channel flows and sediment exports for events smaller than 2 year Average Recurrence Interval (ARI).	- On-site detention through On-site stormwater detention (OSD) technical specification or infiltration through best practice Water Sensitive Urban Design AND - On-site sediment capture through best practice Water Sensitive Urban Design	OSD systems such as detention and retention basins are proposed as well as WSUD features such as vegetated swales and sediment basins. See Appendix B.
Avoid local erosion at Stormwater outlets	- Energy dissipation at stormwater outlets entering waterways AND - Infiltration and on site detention with minimal use of pipes or lined drains AND - Stabilisation of actively eroding banks using best practice Natural Channel Design Principles (as per Warringah Creek Management Study 2004 – Appendix F s.3)	- Stormwater will be channeled into the existing drainage lines and vegetated swale to dissipate the volume and velocity of water entering stormwater pipes; - Infiltration and on site detention will occur through the use of retention and detention tanks; - Stabilisation of the existing informal overland swale will occur through WSUD compliant landscaping and riparian revegetation works.
Avoid export of weeds from private properties into waterways	- No disposal of garden refuse in riparian lands.	The BMP will contain a management action preventing the disposal of garden refuse in riparian lands.
Channel banks are not over steepened	- Stabilisation of actively eroding banks using best practice Natural Channel Design Principles (as per Warringah Creek Management Study 2004 – Appendix F s.3)	The existing drainage lines are not prone to erosion and the proposed development will not affect the steepness of the channel banks.
Channel banks are stable	- Stabilisation of actively eroding banks best practice Natural Channel Design Principles (as per Warringah Creek Management Study 2004 – Appendix F s.3)	The existing channel banks are fixed into sandstone bedrock and will not be affected by the proposed development.

Outcome 4: Preserve Natural Ecological Processes

Table 6. Outcome 4: Preserve Natural Ecological Processes

Performance Criteria	Acceptable Mitigation Measures	Proposed Mitigation Measures
Streamflow and water quality are natural	- No artificial barriers to capture water - No removal of water for consumptive use (except riparian use rights) - Impervious surfaces offset by stormwater management controls so there is no net change in peak loads or pollutant loads in waterways (see On-site Stormwater detention (OSD) technical specification)	- No artificial barriers to capture water are proposed except for OSD and WSUD measures; - No removal of water for consumptive use is proposed; - Alteration in hydrology as a result of increased impervious surfaces will be offset by OSD and WSUD measures; - Site design adheres to best practice WSUD principles; - On-site uses do not involve any specific risks to water quality. See Stormwater Management Plan for full details (Appendix B).

Performance Criteria	Acceptable Mitigation Measures	Proposed Mitigation Measures
	- Site design adheres to best practice Water Sensitive Urban Design principles AND - On-site uses do not involve specific risks to water quality (e.g. chemicals, organic materials, exposed soil, effluent generation)	
Aquatic and riparian vegetation are undisturbed and unmodified	- All development is outside riparian zone	All development is outside the riparian zones. Site rehabilitation works including bush regeneration will revegetate the areas around the drainage lines with riparian species. See BMP for details (Appendix C).
Aquatic and riparian fauna habitat and movement corridors are retained	- Improvement to stream bed or banks	The stream beds and banks of the existing drainage lines are confined due to being hewn from sandstone bedrock. Habitat value and movement corridors for mobile fauna will be improved by revegetation works along the drainage lines. See BMP for details (Appendix C).

Outcome 5: Create Opportunities for Public Access and Recreation in Waterway Corridors

Table 7. Outcome 5: Create Opportunities for Public Access and Recreation in Waterway Corridors

Performance Criteria	Acceptable Mitigation Measures	Proposed Mitigation Measures
Provide public access along creek corridors where appropriate	- Set back developments to allow public access within riparian buffers	The existing drainage lines do not have any public recreation value. The proposed development will not prevent access to them.

Conclusions and Recommendations

In conclusion, the three (3) artificial drainage lines on site are assessed as having low ecological value despite Drain 1 being mapped as a Group A headwater of Curl Curl Creek. This is due to the “urban modified” river style of the drains and the fact that their geomorphic attributes have been altered so much that they do not function as rivers. As such, the proposal is unlikely to negatively impact the existing channel form, erosion rate, or bank stability of the artificial drains which have been excavated into sandstone bedrock or consist of a grassy swale. Drain 3 will be locally stabilised and revegetated as a result of the proposed road works.

Potential impacts of the proposed development include:

- Increased erosion and sedimentation, especially during the construction phase;
- Increased stormwater runoff during the operational phase due to an increase in impermeable surfaces;
- Modification loss of habitat and connectivity due to the removal of vegetation;
- Decrease in water quality and increase in nutrient loads;
- Potential contamination of natural areas downstream including Manly Dam Reserve;
- Increase in peak stormwater flows; and
- Increased stormwater runoff being directed into Council’s drainage systems.

These potential impacts may be significantly reduced by the implementation of effective mitigation measures including:

- A CEMP which will require
    - Construction of a temporary stormwater detention basin where silted water can be flocculated and sediment removed prior to release into bushland below;
    - Installation of measures to mitigate potential erosion on site and to stop the flow of silted water off site;
    - The requirement that any erosion and sedimentation is to be managed at the source, and;

- o Compliance of all erosion, sediment and pollution controls with Council's Water Management Policy;

- An Erosion and Sediment Control Plan and Soil and Water Management Plan which will detail types of control, methods of installation, locations, maintenance regimes, responsibilities, stockpile storage, silt fencing, vehicle shake-down, floating silt boom, stabilisation access for machinery, etc. These measures will be installed and maintained until the site is fully established;

- A BMP has been prepared which will protect and improve the ecological condition of the surrounding bushland by requiring site rehabilitation and bush regeneration of any areas disturbed or otherwise affected by the development (Appendix C);
- Construction of OSD measures including a stormwater detention tank which adequately caters for the volume of water that might be generated in a 1:100 stormwater event;
- Integration of WSUD measures including vegetated swales, sediment basins, etc.;
- Management and minimisation of stormwater overland flow, nuisance flooding and groundwater related damage to properties by channelling stormwater within the existing artificial drainage lines;
- Minimising the quantity of stormwater runoff on Council's drainage system by directing discharge into the existing sediment basin;
- Designing, installing, and maintaining the stormwater drainage system in accordance with Council's Water Management Policy; and
- Situating the development so as to minimise impact on prescribed vegetation including remnant canopy trees, understorey vegetation, and ground cover species.

References

Department of Primary Industries (2012) *Guidelines for riparian corridors on waterfront land*. NSW Government Office of Water, DPI, Hurstville.

Total Earth Care (2020) *Biodiversity Management Plan: William Charlton Village, Allambie Heights*, Sydney.

Warringah Council (2004) *Warringah Creek Management Study*, Sydney.

Warringah Council, (2010) *Protection of Waterways and Riparian Land Policy PL 740*, Sydney

Warringah Council, *Waterway Impact Statement Guidelines*, Sydney

Wood & Grieve Engineers (2020) *Stormwater Management Plan*

Definitions

The definitions contained are derived from the documentation identified after each definition. Accordingly, the definition contained within the original documentation supersedes the definition contained within this section.

Connectivity means the interconnection of functionally related ecological elements of a landscape so that species can move amongst them (MWH Australia Pty Ltd 2004, *Warringah Creek Management Study*).

Creek means any watercourse, whether ephemeral, intermittent or perennial, whether on its natural course or altered by human interference, whether channelled or not. It also includes any drainage lines able to be identified by a linear vegetation assemblage reflective of regularly moist soil conditions or by a weed plume consistent with regularly moist soil conditions (MWH Australia Pty Ltd 2004, *Warringah Creek Management Study*).

Development means:

(a) the use of land, and
(b) the subdivision of land, and
(c) the erection of a building, and
(d) the carrying out of a work, and
(e) the demolition of a building or work, and
(f) any other act, matter or thing referred to in section 26 that is controlled by an environmental planning instrument, but does not include any development of a class or description prescribed by the regulations for the purposes of this definition *(Environmental Planning and Assessment Act, 1979).*

Riparian means occurring on the bank of a river (or other waterway, or waterbody). Usually refers to vegetation, "riparian land" (NSW Fisheries 1999, *Policy and Guidelines Aquatic Habitat Management and Fish Conservation).*

Riparian Buffer means land which is additional to the riparian zone necessary to protect the values and health of the riparian zone. The primary purpose of the buffer is to protect the integrity of the riparian zone. The combined width of the buffer and riparian zone then constitute a key protective mechanism for the ecological values of waterway systems. The minimum width of a riparian buffer is generally 10 metres, and is dependent on the catchment characteristics, slope and environmental values associated with the riparian corridor. The buffer is primarily designed to:

(a) Prevent water from affecting riparian vegetation (e.g. additional moisture, local erosion, nutrients, toxicants);
(b) Prevent weeds from invading the riparian zone; and
(c) Provide habitat for native fauna (thereby protecting it from external threats such as domestic animals) (*Warringah Council Protection of Waterway and Riparian Lands Policy PL-740*)

Riparian Land is land comprising the riparian zone, riparian buffer and wetland buffer identified by DCP Map Waterways and Riparian Land (*Warringah Council Protection of Waterway and Riparian Lands Policy PL-740*).

Riparian Zone means any land which adjoins, directly influences, or is influenced by a body of water. The width of the zone varies according to extent of riparian vegetation, flood levels, water quality, and channel form. This zone is taken to start at the highest bank of the watercourse (as defined in the *Water Management Act, 2000*). For ephemeral streams without a defined channel, the start of the riparian zone is the creek centre line. The riparian zone provides important habitat, protects the creek from water quality and hydrological impacts. It has other functions, including intrinsic value, as well as providing bed and bank stability, providing woody debris to the waterway and a buffer between development and waterways (*Warringah Council Protection of Waterway and Riparian Lands Policy PL-740*).

River includes:

(a) any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved, and
(b) any tributary, branch or other watercourse into or from which a watercourse referred to in paragraph (a) flows, and
(c) anything declared by the regulations to be a river, whether or not it also forms part of a lake or estuary, but does not include anything declared by the regulations not to be a river (*Water Management Act 2000)*.

Waterbody (artificial) or **artificial waterbody** means an artificial body of water, including any constructed waterway, canal, inlet, bay, channel, dam, pond, lake or artificial wetland, but does not include a dry detention basin or other stormwater management construction that is only intended to hold water intermittently. (*Standard Instrument—Principal Local Environmental Plan (*NSW)).

Waterbody (natural) or **natural waterbody** means a natural body of water, whether perennial or intermittent, fresh, brackish or saline, the course of which may have been artificially modified or diverted onto a new course, and includes a river, creek, stream, lake, lagoon, natural wetland, estuary, bay, inlet or tidal waters (including the sea). (*Standard Instrument—Principal Local Environmental Plan (*NSW)).

Watercourse means any river, creek, stream or chain of ponds, whether artificially modified or not, in which water usually flows, either continuously or intermittently, in a defined bed or channel, but does not include a waterbody (artificial). (*Standard Instrument—Principal Local Environmental Plan* (NSW)).

Waterway means the whole or any part of a watercourse, wetland, waterbody (artificial) or waterbody (natural). (*Standard Instrument—Principal Local Environmental Plan* (NSW)).

Wetland means:

(a) natural wetland, including marshes, mangroves, backwaters, billabongs, swamps, sedgelands, wet meadows or wet heathlands that form a shallow waterbody (up to 2 metres in depth) when inundated cyclically, intermittently or permanently with fresh, brackish or salt water, and where the inundation determines the type and productivity of the soils and the plant and animal communities, or

(b) artificial wetland, including marshes, swamps, wet meadows, sedgelands or wet heathlands that form a shallow waterbody (up to 2 metres in depth) when inundated cyclically, intermittently or permanently with water, and are constructed and vegetated with wetland plant communities (*Standard Instrument—Principal Local Environmental Plan* (NSW)).

Riparian Land is land comprising the riparian zone, riparian buffer and wetland buffer identified by DCP Map Waterways and Riparian Land (*Warringah Council Protection of Waterway and Riparian Lands Policy PL-740*).

Riparian Zone means any land which adjoins, directly influences, or is influenced by a body of water. The width of the zone varies according to extent of riparian vegetation, flood levels, water quality, and channel form. This zone is taken to start at the highest bank of the watercourse (as defined in the *Water Management Act, 2000*). For ephemeral streams without a defined channel, the start of the riparian zone is the creek centre line. The riparian zone provides important habitat, protects the creek from water quality and hydrological impacts. It has other functions, including intrinsic value, as well as providing bed and bank stability, providing woody debris to the waterway and a buffer between development and waterways (*Warringah Council Protection of Waterway and Riparian Lands Policy PL-740*).

River includes:

(a) any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved, and

(b) any tributary, branch or other watercourse into or from which a watercourse referred to in paragraph (a) flows, and

(c) anything declared by the regulations to be a river, whether or not it also forms part of a lake or estuary, but does not include anything declared by the regulations not to be a river (*Water Management Act 2000)*.

Waterbody (artificial) or **artificial waterbody** means an artificial body of water, including any constructed waterway, canal, inlet, bay, channel, dam, pond, lake or artificial wetland, but does not include a dry detention basin or other stormwater management construction that is only intended to hold water intermittently. (*Standard Instrument—Principal Local Environmental Plan* (NSW)).

Waterbody (natural) or **natural waterbody** means a natural body of water, whether perennial or intermittent, fresh, brackish or saline, the course of which may have been artificially modified or diverted onto a new course, and includes a river, creek, stream, lake, lagoon, natural wetland, estuary, bay, inlet or tidal waters (including the sea). (*Standard Instrument—Principal Local Environmental Plan (*NSW)).

Watercourse means any river, creek, stream or chain of ponds, whether artificially modified or not, in which water usually flows, either continuously or intermittently, in a defined bed or channel, but does not include a waterbody (artificial). (*Standard Instrument—Principal Local Environmental Plan* (NSW)).

Waterway means the whole or any part of a watercourse, wetland, waterbody (artificial) or waterbody (natural). (*Standard Instrument—Principal Local Environmental Plan* (NSW)).

Wetland means:

(a) natural wetland, including marshes, mangroves, backwaters, billabongs, swamps, sedgelands, wet meadows or wet heathlands that form a shallow waterbody (up to 2 metres in depth) when inundated cyclically, intermittently or permanently with fresh, brackish or salt water, and where the inundation determines the type and productivity of the soils and the plant and animal communities, or

(b) artificial wetland, including marshes, swamps, wet meadows, sedgelands or wet heathlands that form a shallow waterbody (up to 2 metres in depth) when inundated cyclically, intermittently or permanently with water, and are constructed and vegetated with wetland plant communities (*Standard Instrument—Principal Local Environmental Plan* (NSW)).

Wetland buffer means 100m buffer of land, measured from the shoreline, surrounding a wetland which directly influences and protects a wetland (*Warringah Council Protection of Waterway and Riparian Lands Policy PL-740*).

Appendix A. Proposed Architectural and Landscape Plans

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AMENDMENTS

ISSUE	DESCRIPTION	APPROVED	DATE
1	AUTHORITY APPROVAL	MR	19/12/19

DRAWING KEY:

- SITE BOUNDARY
- PROJECT BOUNDARY
- 25m / 50m OFFSET FROM APZ LINE AS ASSESSED BY BUSHFIRE CONSULTANT, DASHED RED.
- APZ LINE AS ASSESSED BY BUSHFIRE CONSULTANT DASHED BLUE
- SITE VIEWS
- EXISTING ACCESS TO SITE
- MAIN SITE ENTRY
- EXISTING RETAINED BUILDING
- EXISTING RETAINED TREE
- TREE PROTECTION ZONE, REFER ARBORIST REPORT
- PROPOSED TREE, REFER LANDSCAPE PLAN

THIS DRAWING ISSUE HAS BEEN REVIEWED FOR

AUTHORITY APPROVAL

APPROVED BY: MR
CHECKED BY: GA

CLIENT
ALLAMBIE HEIGHTS VILLAGE

DRAWING
SITE PLAN

DATE	SCALE @ A1	DRAWN
09/03/18	1 : 500	SF

PROJECT No.	DISCP.	DRAWING No.	ISSUE
2017019	A	DA-011	1

PROJECT
2017019 - ALLAMBIE HEIGHTS

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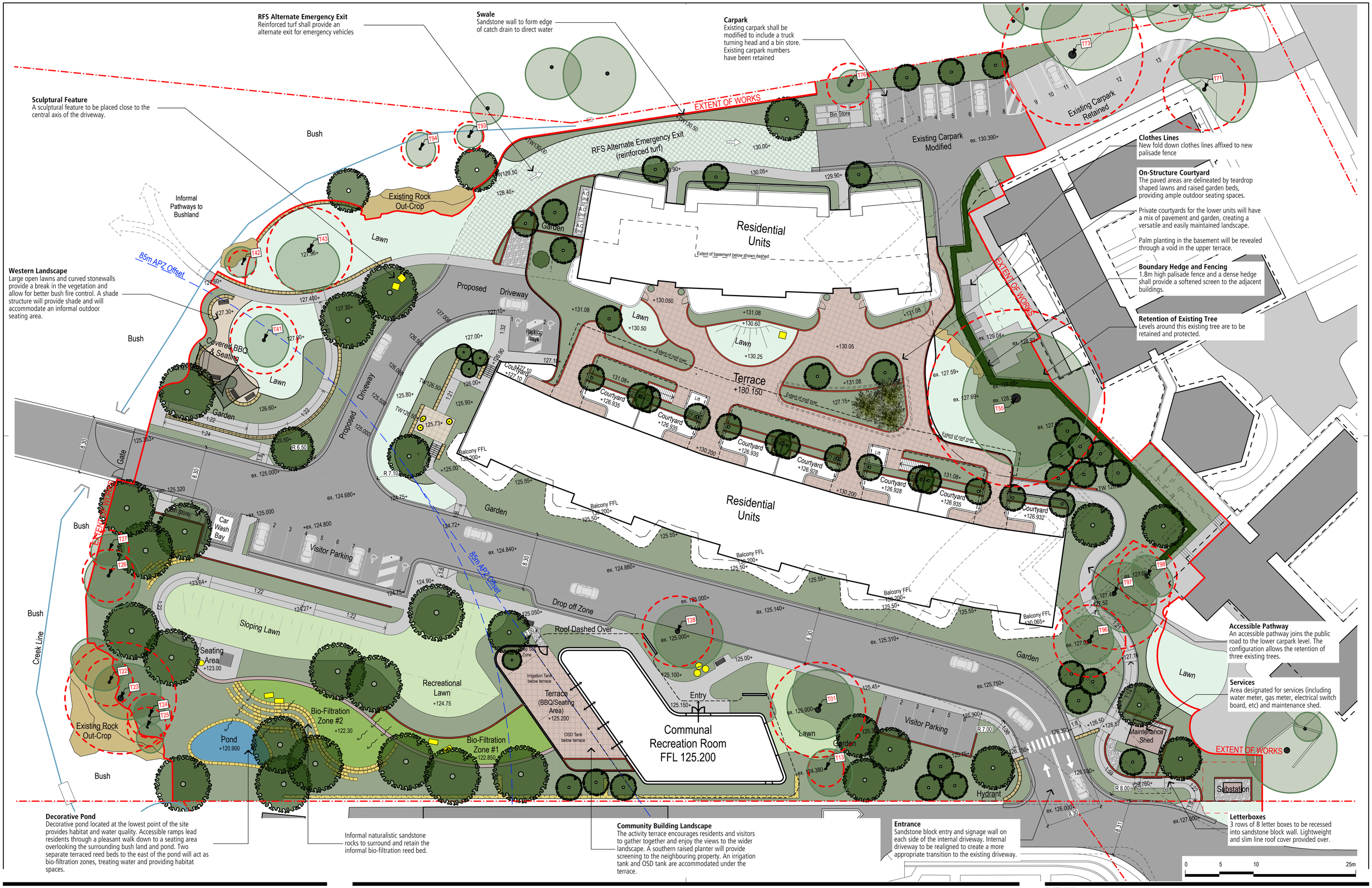
ABN 15 083 837 290
JACKSON TEECE



arterra

ARTERRA DESIGN PTY LTD ABN 40 069 552 610
SUITE 602 / 51 RAWSON STREET, EPPING, NSW 2121
P 02 9957 2466 F 02 9957 3977 W ARTERRA.COM.AU

Legend

- Boundary
- Building Outline
- Building Above
- Building Below
- Existing Creek Line
- Existing Tree Retained (Extent of canopy as verified by site measure)
- Nominal Tree Protection Zone (TPZ)
- T01 Tree ID Numbers (Retained)
- Proposed Tree
- Garden
- Bio-filtration Zone
- Turf
- Pavement - Standard Grey Concrete
- Pavement -Tile
- Pavement - Decomposed Granite
- Pavement - Gravel
- Retaining Wall - Blockwork
- Retaining Wall - Dry Stacked Stone Wall
- Retaining Wall - Gabion
- Informal Sandstone Boulders
- Clothesline
- Bench Seat
- Overland Flow Path
- Sculptural Features/ Planter

REVISION	DESCRIPTION	CHKD	DATE
P1	For Rural Fire Service Review	RWS	24/10/19

PROJECT & CLIENT

Allambie Heights Village - Project 2

Allambie Heights Village Ltd.

North

Project No : 18.11
Designed : CLB
Drawn : CLB
Scale : 1:250@A1/1:500@A3

DRAWING TITLE

Landscape Concept Plan

DRAWING NUMBER L-SD-01

REVISION P1

Plotted at : 5:27 pm 24/10/19

Appendix B. Stormwater Management Plan – Wood & Grieve Engineers 2020

WOOD & GRIEVE ENGINEERS

Allambie Heights Village – Project 2

Prepared for:

Allambie Heights Village Ltd

Date:
14 February 2020

Prepared by:

Ian Harris
Project No.38509-CI-RE_001
P:\38509\PROJECT DOCUMENTATION\CIVIL\DOCUMENTS & REPORTS\38509-CI-RE_001.DOCX

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Revision

Site Address:	181 Allambie Road, Allambie Heights, NSW
Real Property Description:	Lot 2615 DP752038
Proposed Development:	Senior Living Development
Client:	Allambie Heights Village Ltd
Local Authority	Northern Beaches Council
Authority Reference #:	N/A
Wood & Grieve Reference:	38509-CI-RE_001

Ian Harris BEng (Hons)
For and on behalf of
Wood & Grieve Engineers

REVISION	DATE	COMMENT	APPROVED BY
A	01.06.18	DA Issue	**IH**
B	18.06.18	DA Issue	**IH**
C	14.02.20	Updated DA Issue	**IH**

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1. Introduction

Wood & Grieve Engineers have been commissioned by Allambie Heights Village Ltd to prepare this Stormwater Management Plan (SMP) in support of the Development Application for the proposed development at 181 Allambie Road, Allambie Heights, NSW. The sites real address is Lot 2615 DP752038.

This SMP outlines the conceptual DA level stormwater design for the proposed development of a senior living development on the site.

This SMP demonstrates the application of Water Sensitive Urban Design (WSUD) principles and illustrates that the proposed development complies with the Mid-Coast Council Standards and Guidelines for stormwater, Australian Rainfall and Runoff, Australian Standards and best engineering practise.

The purpose of this SMP is to evaluate the quantity and quality of stormwater associated with the proposed development plan so as to demonstrate to Council that an appropriate stormwater management strategy has been adopted.

The SMP specifically addresses the following items for both the construction and operational phases of the development:

- Stormwater runoff volumes and detention (Stormwater Quantity);
- Stormwater quality treatment measures (Stormwater Quality);
- Erosion and Sedimentation Control.

The following will be achieved with the correct application of this SMP report:

- Appropriate standards to be maintained on all aspects of stormwater within the site,
- Pollution control to be maintained,
- Establishment of a unified, clear and concise stormwater management strategy.

2. Existing Site Characteristics

2.1 Property Detail

Address:	181 Allambie Road, Allambie Heights, NSW
Real Property Description:	Lot 2615 DP752038
Total Site Area:	37,176m² (3.718Ha)

The proposed development can be seen on the concept design drawings in Appendix A of this report.

The proposed development will consist of a seniors living development including residences and a pool building.

As can be seen in the site location aerial photo below, the site is located west of Allambie Road and north of Martin Luther Place.

The area of the site to be developed is currently undeveloped. There are existing seniors living buildings to the east of the development area within the extent of the site.

Figure 1: Site Location Plan (Source: Nearmaps 2018)

Existing Site Characteristics

2.2 Topography

The area in consideration is currently undeveloped and is currently vegetated over its majority. There is a current bitumen road intersecting the development area. Topographic survey confirms the site falls from the north to south from approximately RL130m AHD to RL120m AHD.

Figure 2: Site Topography (Source: CMS Surveyors 2017)

2.3 Existing Stormwater Discharge

Visual inspection of the site and the detailed site topographic survey confirm that there is currently no in ground drainage infrastructure on the area of the site being considered for development. Stormwater runoff from this area of the site runs as overland flow towards the northern edge of the bitumen road where it is collected and conveyed towards a headwall and culvert running under the road. This headwall discharges into a vegetated swale which conveys flows towards the southern boundary of the site.

There is an existing waterway running north to south through the site to the west of the proposed development area. This waterway will not be impacted by the proposed development.

There is evidence of in ground drainage for the existing buildings located on the eastern portion of the site. This stormwater network appears to drain towards Allambie Road.

3. Local Authority Requirements

Northern Beaches Council set the design requirements for any new stormwater management system associated with new development in their Water Management Policy PL850. A summary of the key requirements for the development of the Stormwater management system for this development are summarized below.

3.1 On Site Detention Requirements

Council's policy states:

(a) OSD is required for the following developments:

i. single residential dwellings where the total existing and proposed impervious areas exceed 40% of the total site area (OSD will not be required for alterations and additions or where the total site area is 450m^2 or less)

ii. new residential flat buildings/multi-residential unit dwellings

iii. commercial developments

iv. industrial developments

v. subdivisions resulting in the creation of three (3) lots or more

vi. subdivisions resulting in the creation of two (2) lots or more, OSD will be required where the post developed impervious area of the new lots exceed 40% of the site area of the new lots. This requirement also applies to newly created lots with existing dwellings to be retained

vii. Alterations and additions to existing residential flat buildings/multi-residential unit dwellings, commercial developments and industrial developments, OSD is applicable to the extent of the new works only.

(b) Development requiring OSD must comply with Council's Onsite Stormwater Detention Technical Specification.

(c) A positive covenant and Restriction As to User must be registered on the title for the OSD system to ensure regular maintenance and operation.

(d) Council will not permit the use of "Drainage Cell" type products for onsite detention storage as access for maintenance or removal of silt/debris is limited.

(e) Council will allow the volume of rainwater reuse in single residential dwellings to be credited against the calculated OSD storage volume as determined by Council's Onsite Stormwater Detention Technical Specification.

Reference to the Onsite Stormwater Detention Technical Specification states:

"The general requirement of Council's OSD Specification is to ensure that the site's stormwater runoff after any development does not exceed the runoff prior to the development"

The specification continues to state:

> The post-development runoff is to be determined based on the post-development impervious area for all storm durations for the 5 year, 20 year, and 100 year ARI storm events. The OSD system(s) must be designed to restrict these flows to the calculated pre-development discharge rates. Hence the 5 year ARI post-development runoff must not exceed the 5 year ARI pre-development discharge, the 20 year ARI post-development runoff must not exceed the 20 year ARI pre-development discharge, and the 100 year ARI post-development runoff must not exceed the 100 year ARI pre-development discharge.

3.2 Discharge

For site which cannot directly connect to council drainage infrastructure council set discharge requirements in their Stormwater Drainage From Low Level Properties Technical Specification document.

This document states that direct connection to watercourses should be avoided and On-Site Absorption should be considered. The specification gives the following advice on the design of On-site Absorption.

"The absorption pit is to be designed for an Average Recurrence Interval (ARI) storm of 50 years using DRAINS computer software based on the infiltration rate that can be maintained in the long term. An overflow mechanism in the form of a level spreader must be provided for all storms greater than the 50 year ARI storm, up to and including the 100 year ARI storm. The overflow mechanism is required to minimise overland flow disturbance to the lower property."

3.3 Water Pollutant Reduction Targets

Council's Water Management Policy states "Stormwater treatment measures are required to ensure the development does not impact on the receiving waters."

The policy outlines the following requirements for water quality treatment.

Table 4 – General Stormwater Quality Requirements

Pollutant	Performance Requirements
Total Phosphorous	65% reduction in the post development mean annual load[1]
Total Nitrogen	45% reduction in the post development mean annual load[1]
Total Suspended Solids	85% reduction in the post development mean annual load[1]
Gross Pollutants	90% reduction in the post development mean annual load[1] (for pollutants greater than 5mm in diameter)
pH	6.5 - 8.5
Hydrology	The post-development peak discharge must not exceed the pre-development peak discharge for flows up to the 2 year ARI

Note:

[1]The percentage reduction in the post development mean annual loads are relative to the loads from the proposed development without treatment applied.

4. Flood Impact Assessment

When considering a new development it is important to assess the impact of existing flooding on the proposed development and also the impact of the proposed development on existing or potential flooding both upstream and downstream of the development.

4.1 Existing Flooding

Referring to Council's online flood mapping indicates that the site is not affected by flooding.

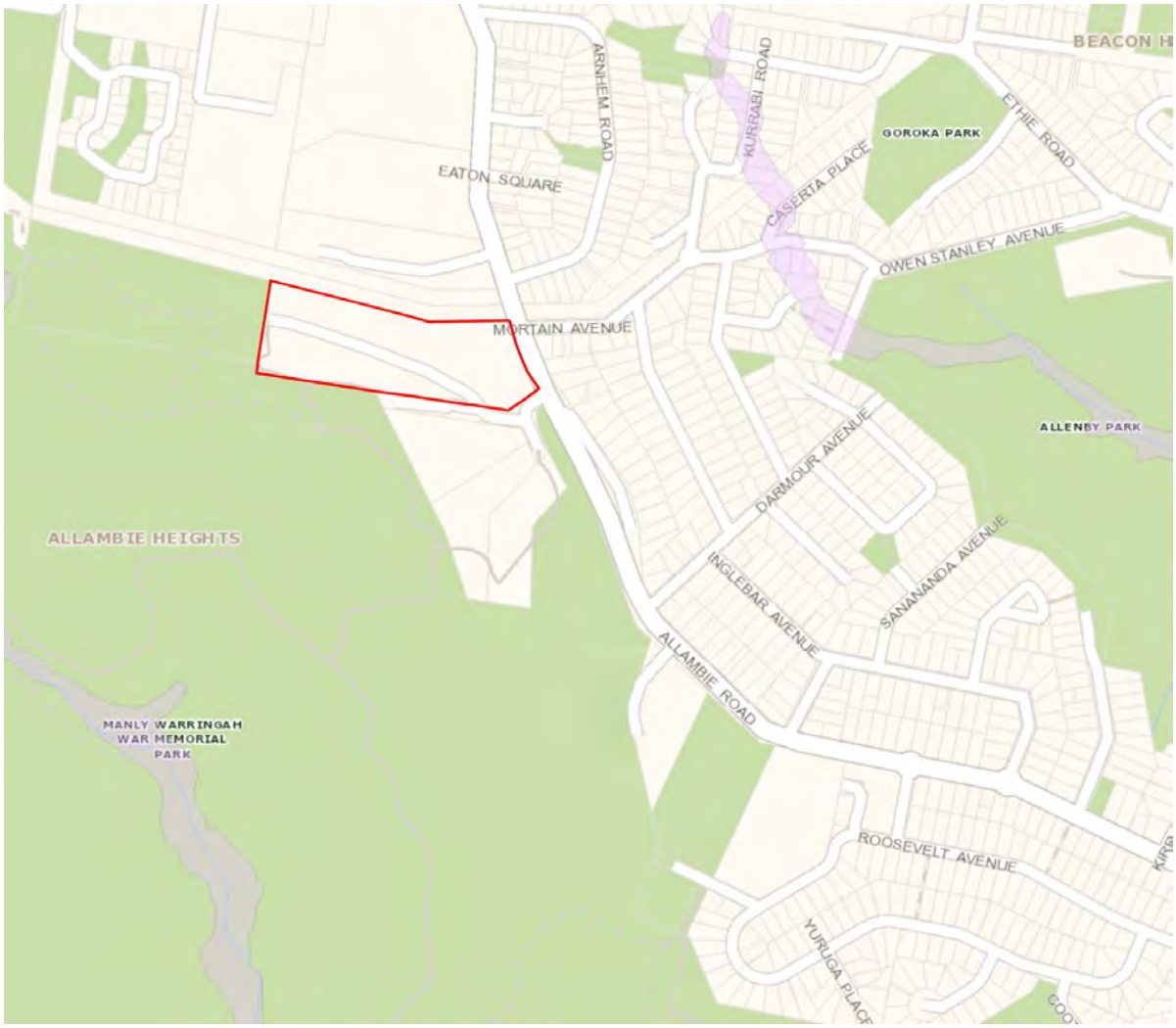

Figure 3: Low Flood Risk Planning Precinct (Source: Northern Beaches Planning Maps, 2018)

4.1.1 Flood Impacts

As the site is not affected by regional flooding no flood mitigation measures are proposed to deal with regional flooding. Measures will however be incorporated into the design to minimise the risk of local or nuisance flooding to or because of the development. These will include grading external areas to ensure positive stormwater runoff in a controlled manner and the provision of on-site detention to ensure there are no adverse downstream impacts caused by the development.

5. Stormwater Conveyance

This section of the report discusses the systems proposed to allow for stormwater to be conveyed across the site to the legal point of discharge.

5.1 Roof Drainage

All roof areas will be drained through a conventional downpipe system. The drainage system will be designed in accordance with AS3500.3:2003 to convey the 50 year design storm runoff from the roof to the proposed in ground drainage network. Flows in excess of the design flows will surcharge the roof drainage system and discharge onto the surrounding ground where it will then be conveyed overland in a controlled manner.

5.2 Infiltration Discharge

Discharge from the site will be via infiltration into the ground water. The base of the raingardens will allow runoff to discharge into the ground. Geotechnical investigations have been undertaken for the site and confirm that the existing geology on the site would allow for an infiltration rate of 0.01mm/hr, this rate has been used to calculate the area required to allow the runoff to discharge.

The infiltration system has been designed to discharge runoff occurring from a 100 year design storm, a peak discharge flow of 283L/s.

6. Stormwater Attenuation

Stormwater detention for the site will be provided to attenuate the post development discharge rates back to the pre-development rates. A DRAINS model has been produced to assess the volume of storage required for the development. This model confirms that 100m³ is required to attenuate the discharge flows.

The stormwater detention will be achieved by providing an underground tank situated below the proposed community building. The location and arrangement of the tank is indicated in the concept drawing in Appendix A of this report.

Discharge rates will be attenuated by providing an orifice plate over the discharge pipe which will restrict the flows discharging to the legal point of discharge. The sizing of this orifice plate has been undertaken using the DRAINS model for the development. The model has confirmed that the orifice plate will have a diameter of 190mm.

The table below summarises the discharge flows from the site.

Development Scenario	% Impermeable	Discharge Flow Rates (L/s)		
		5 Year Design Storm	20 Year Design Storm	100 Year Design Storm
Pre-Development	10	328	463	595
Post – Development	60	278	359	584

Table 1: Site Discharge Flows

Output from the DRAINS model is included in Appendix B of this report.

7. Water Quality Treatment

As discussed in section 3.2 of this report Northern Beaches Council have set targets for the reduction of water borne pollution being conveyed from the site through the stormwater drainage system.

This section of the report demonstrates the Stormwater Quality Improvement Devices (SQID's) to be implemented and the Pollutant Export Modelling undertaken to demonstrate the effectiveness of the treatment system in achieving the reduction targets set by council.

7.1 Potential Pollutants

There are a wide range of potential stormwater pollutant sources which occur from urbanised catchments, many which can be managed through appropriate stormwater quality treatment. Typical urban pollutants may include:

- Atmospheric deposition
- Erosion (including that from subdivision and building activities)
- Litter and debris
- Traffic emissions and vehicle wear
- Animal droppings
- Pesticides and fertilisers
- Application, storage and wash-off of car oil, detergents and other household and commercial solvents and chemicals
- Solids accumulation and growth in stormwater systems
- Weathering of buildings

These pollutants in urban stormwater can be placed into various categories as follows. The pollutants underlined below are able to be readily modelled:

- Suspended Solids
- Litter
- Nutrients such as Nitrogen and Phosphorous
- Biological oxygen demand (BOD) and chemical oxygen demand (COD) materials
- Micro-organisms
- Toxic organics
- Trace metals
- Oils and surfactants

While only the key pollutants underlined above will be examined within the modelling, the stormwater Quality Improvement Devices implemented are expected to assist in reducing a wide range of pollutants. For example, heavy metals are commonly associated with, and bound to fine sediments. Thus reducing the discharge of fine sediment during the construction and operational phases will also reduce the discharge of heavy metals to existing stormwater systems.

7.2 Pollutant Reduction System

In order to achieve the pollutant reduction targets specified in section 3.3 of this report a series of treatment devices are proposed with together form a treatment train. The diagram below shows the proposed treatment train for this development.

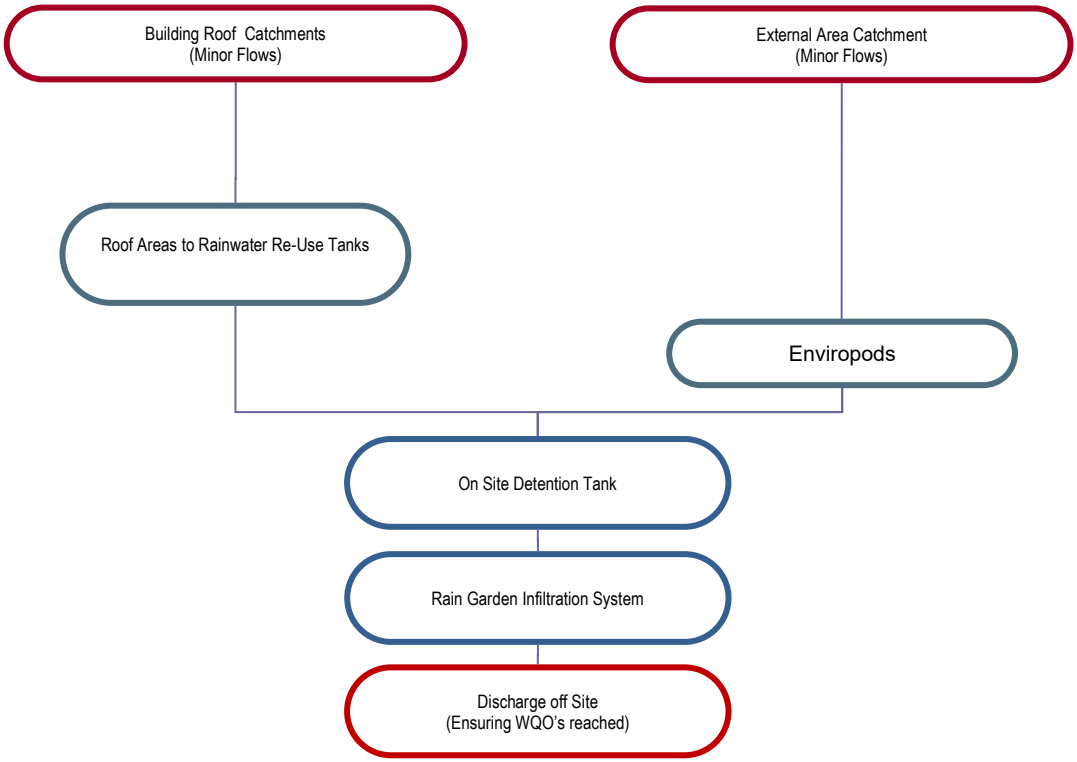

Figure 4: Proposed Water Quality Treatment Train

Further discussion on each element of this treatment train is provided below.

7.2.1 Rainwater Tanks

As shown in the proposed treatment train, the roof water from the building will drain to rainwater tanks and will be used for irrigation. The use of rainwater tanks will allow for a reduction of TSS by the settling of particles over time and through the screening of water before it enters the tank.

A 130Kl tank is proposed for the development.

7.2.2 EnviroPod Pit Inlet Trap (or approved equivalent)

EnviroPod's (or other similar approved equivalents) provide effective removal of TSS and gross pollutants. EnviroPod's are a filter cage system which are inserted into roadway gully pits to filter and remove pollutants before the water enters the piped drainage system. It is proposed to placed EnviroPod filters within every pit in the roadway.

The MUSIC modelling parameters for this device are set by the manufacturer, Stormwater 360.

Parameters	TSS	TP	TN	GP
Input (mg/L)	100	10	50	14.8
Output (mg/L)	53	10	50	0
Reduction (%)	47	0	0	100

Figure 5: EnviroPod Pit Inlet Trap (Source: Stormwater 360)

7.2.3 Rain Garden

Bio-retention systems are vegetated areas where stormwater is passed through densely planted filter media (loamy sand) allowing the plants to absorb the collected and stored nutrients. Bio-retention basins utilise temporary ponding above the vegetated surface to increase the volume of stored water for treatment. Bio-retention systems can take a number of forms but all have common features including the extended detention depth above the media surface, the filter media and a low level drainage media and subsoil system. These are shown in the figure below.

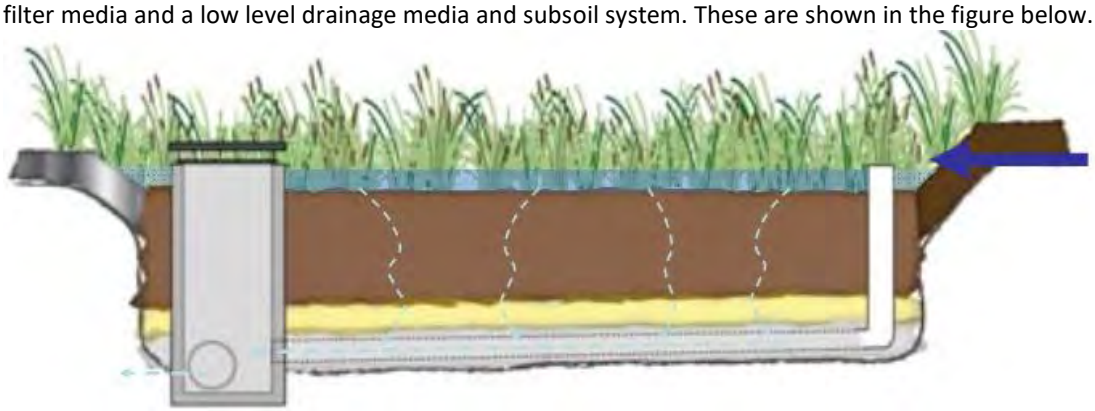

Figure 6: Typical Section of a generic Bio-retention system (Source: Water by Design)

7.3 Pollutant Reduction Modelling

In order to demonstrate that the proposed treatment train meets the required reduction targets, pollutant reduction modelling is proposed using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Software program Version 5.0 by eWater CRC. Pollutant export rates are currently only available for Total Suspended Solids (TSS), Total Nitrogen (TN), Total Phosphorous (TP) and Gross Pollutants (GP). Therefore only quantitative modelling for TSS, TN, TP & GP has been undertaken using MUSIC.

Modelling has only been undertaken on the post-development proposal with SQID's installed so as to demonstrate the percentage reduction for each pollutant type.

7.3.1 MUSIC Program Setup

This section explains the setup of the MUSIC model with the detailed pollutant reduction calculations being included in the MUSIC results in Appendix C.

For Music Modelling (using MUSIC 6.2.1) the following parameters have been used:

Table 2: MUSIC modelling parameters

Model Parameters	
Meteorological Data:	Sydney
Evaporation Data:	Period: 1959
Time Step:	6 minute

Table 3: Catchment modelling parameters

Node Description	**Area (Ha)**	**Percentage Impervious (%) / Area Impervious (Ha)**		**Land Use Rainfall and Pollutant Parameters**
Building Roof Catchment	0.364	100	0.364	Urban Residential
External Areas	0.160	100	0.160	Urban Residential
Bypass Area	0.243	0	0	Revegitated
	Total: 0.767Ha	Effective FI 68%		

7.3.2 MUSIC Results & Parameters

MUSIC Model

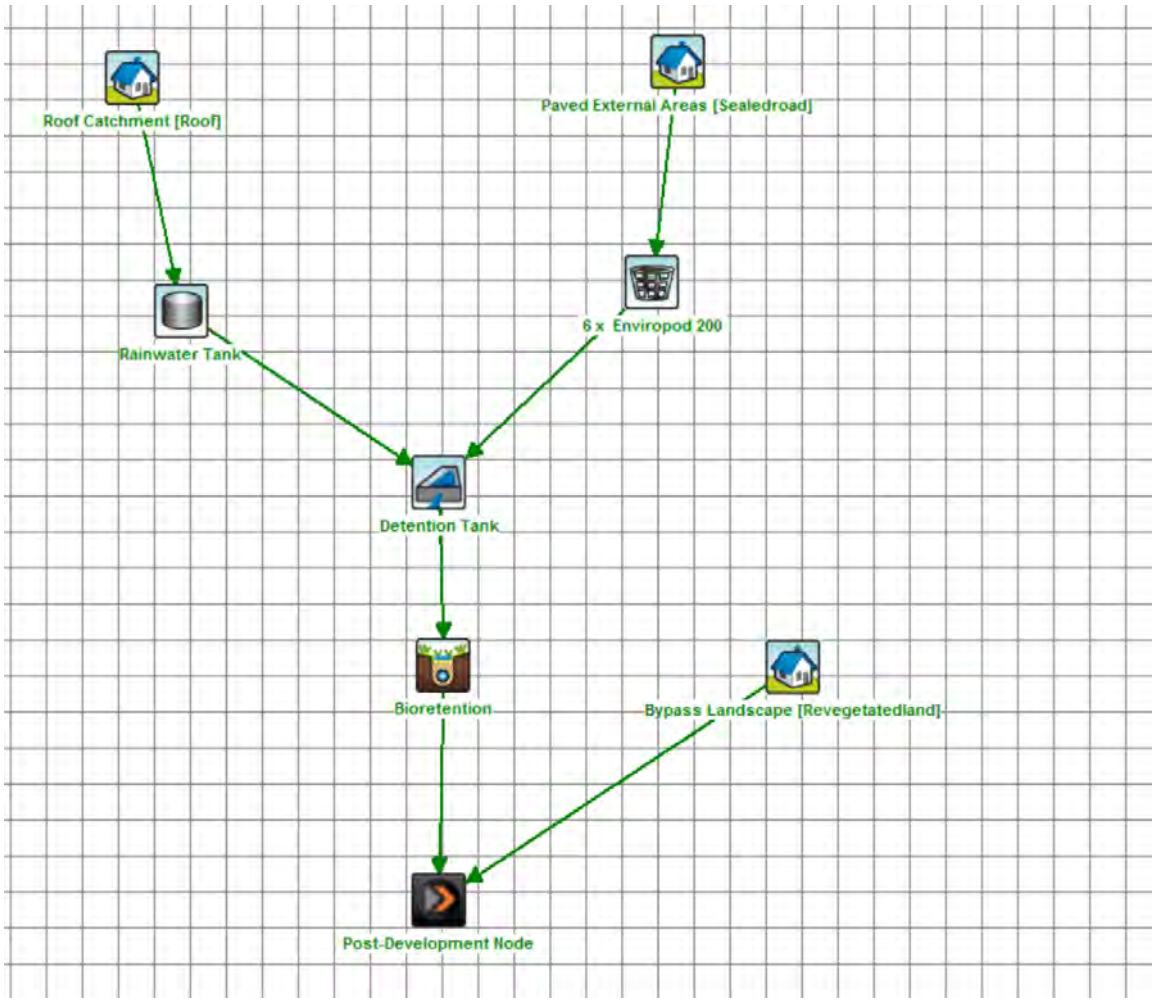

Figure 7 MUSIC Model

MUSIC Output

	Sources	Residual Load	% Reduction
Flow (ML/yr)	8.18	5.54	32.4
Total Suspended Solids (kg/yr)	956	120	87.5
Total Phosphorus (kg/yr)	2.13	0.452	78.8
Total Nitrogen (kg/yr)	17.6	6.27	64.4
Gross Pollutants (kg/yr)	171	0	100

Figure 8 MUSIC Results

MUSIC Runoff Generation Parameters

The following properties have been used in the MUSIC Modelling based on the Land Use Rainfall and Pollutant Parameters.

Table 4: Recommended MUSIC Runoff Generation Parameters

Parameter	Urban Residential
Rainfall Threshold (mm)	1.0
Soil Capacity (mm)	120
Initial Storage (%)	25
Field Capacity	80
Infiltration Capacity Coefficient a	200
Infiltration Capacity Coefficient b	1.00
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Drainage Rate (%)	5
Daily Deep Seepage Rate (%)	0

MUSIC Concentration Parameters

Table 5: MUSIC Concentration Parameters for Parramatta Catchments

Land-use Type	Parameters	TSS Log10 mg/L		TP Log10 mg/L		TN Log10 mg/L	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow
Roof Catchment	Mean	1.1	1.3	-0.82	-0.89	0.32	0.30
	STD Dev	0.17	0.32	0.19	0.25	0.12	0.19
External Areas	Mean	1.2	2.43	-0.85	-0.3	0.11	0.34
	STD Dev	0.17	0.32	0.19	0.25	0.12	0.19
Vegetated Bypass	Mean	1.15	1.95	-1.22	-0.66	-0.05	0.30
	STD Dev	0.17	0.32	0.19	0.25	0.12	0.19

7.3.3 Pollutant Reduction Results

A number of management measures have been considered with a focus on reducing polluted runoff volumes from the site. The WSUD principals proposed for stormwater treatment includes the following SQID's:

- Rainwater Tank
- Detention Tank
- Gross Pollutant Traps
- Raingarden

The effectiveness of the treatment devices proposed in the above section has been modelled using MUSIC with the overall treatment train efficiency results shown in Table 6 below.

Table 6: Treatment Train Efficiencies

Indicator	Total Site Reduction	Site Targets	Target Achieved
Gross Pollutants	100%	90%	Yes
Total Suspended Solids (TSS)	87.5%	85%	Yes
Total Phosphorus (TP)	78.8%	60%	Yes
Total Nitrogen (TN)	64.4%	45%	Yes

From the results presented above it can be seen that the proposed SQID's mean that the stormwater quality treatment meets with the reduction targets set for the development.

8. Erosion & Sedimentation Control

Landcom have published a design guide entitled "Managing Urban Stormwater - Soils and Construction" which is regarded as the standard to which erosion and sedimentation control should be designed to within NSW. Northern Beaches Council specifies compliance with the Landcom design guide in there Design Guidelines Subdivision/Developments.

The control of erosion and sedimentation describes the measures incorporated during and following construction of a new development to prevent the pollution and degradation of the downstream watercourse.

A Soil and Water Management Plan has prepared as part of the development application documentation and is included in Appendix A of this report.

Common control measures adopted are:

- Sedimentation fences;
- Sedimentation basins;
- Stormwater drainage inlet protection;
- Overland flow diversion swales;
- Shaker Grids and wash downs for vehicles leaving the construction site;
- Dust control measures.

The maintenance of these control measures throughout their intended lifespan will ensure that the risk of erosion and sedimentation pollution of the downstream watercourse will be minimized.

Appendix A – Civil Drawings

CIVIL ENGINEERING WORKS

SHEET LIST TABLE

Sheet Number	Sheet Title
CI-000-01	COVER SHEET
CI-007-01	SPECIFICATION NOTES - SHEET 1 OF 2
CI-007-02	SPECIFICATION NOTES - SHEET 2 OF 2
CI-050-01	GENERAL ARRANGEMENT PLAN
CI-060-01	SITEWORKS PLAN
CI-070-01	SEDIMENTATION & EROSION CONTROL PLAN
CI-402-01	ROADS LONGSECTIONS
CI-403-01	TYPICAL ROAD SECTIONS
CI-405-01	MC01 - ROAD CROSS SECTIONS - SHEET 1 OF 4
CI-405-02	MC01 - ROAD CROSS SECTIONS - SHEET 2 OF 4
CI-405-03	MC01 - ROAD CROSS SECTIONS - SHEET 3 OF 4
CI-405-04	MC01 - ROAD CROSS SECTIONS - SHEET 4 OF 4
CI-405-11	MC02 - ROAD CROSS SCETIONS - SHEET 1 OF 5
CI-405-12	MC02 - ROAD CROSS SCETIONS - SHEET 2 OF 5
CI-405-13	MC02 - ROAD CROSS SCETIONS - SHEET 3 OF 5
CI-405-14	MC02 - ROAD CROSS SCETIONS - SHEET 4 OF 5
CI-405-15	MC02 - ROAD CROSS SCETIONS - SHEET 5 OF 5
CI-406-01	ROADS DETAILS
CI-440-01	PAVEMENT PLAN
CI-480-01	SIGNAGE & LINEMARKING PLAN
CI-500-01	STORMWATER DRAINAGE CATCHMENT PLAN
CI-520-01	STORMWATER MANAGEMENT PLAN
CI-526-01	STORMWATER MANAGEMENT DETAILS

JACKSON TEECE
Architecture

1 EARTHWORKS

1.1 GENERAL

1.1.1 Extent of Contract

This specification is for the carrying out of all earthworks indicated on the drawings. It is the Contractor's responsibility to assess the nature of the soil being cut or filled and to select plant which will achieve the specified results. The Contractor shall also make his own assessment of the quantities of earthworks to be carried out, including the accuracy of existing contours and any effect on the levels of the in-situ material due to the operations selected by the Contractor.

1.1.2 Standards

Earthworks shall be completed in accordance with:

- Local Authority Standards and Specifications
- AS 3798-1996 Guidelines on Earthworks for Commercial and Residential Developments
- AS 1289 Methods of Testing Soils for Engineering Purposes
- AS 2870-1996 Residential Slabs and Footings – Construction
- AS 1726-1993 Geotechnical Site Investigations.

1.1.3 Existing Services

The Contractor shall familiarise himself and all personnel on Site, under his direction, with the location of all existing services on and adjacent to the Site and he shall be responsible for the cost of repairing any damage caused to existing services. This repair work shall be carried out by the relevant Authority and shall be arranged by the Contractor.

1.1.4 Disturbance to Private Properties

The Contractor shall not cause any damage to, and shall take reasonable precautions to avoid excessive disturbance to any private property due to dust, vibration, noise, etc., resulting from these works. The Contractor shall not enter onto private property without the written consent of the land-owner.

1.1.5 Natural or Existing Vegetation

In areas not requiring earthworks, access for machines shall not be permitted. Any unauthorised disturbance shall be remediated to the full satisfaction of the Local Authority or relevant government department and all costs borne by the Contractor.

1.2 EARTHWORKS GEOTECHNICAL CERTIFICATION

Where applicable, all cut and fill operations are to be undertaken in accordance with the recommendations of the Geotechnical Report supplied with this tender as amended throughout the Contract under the instruction and supervision of the Geotechnical Consultant to achieve Level One Certification. The Geotechnical Consultant is to be engaged to provide a full time inspection and testing service on all earthworks and is to establish the location and frequency of sampling and testing of the earthworks operations to allow certification.
Where no Geotechnical Consultant or report has been established prior to Tender, the Contractor is to engage his own Geotechnical Consultant to supervise and certify all earthworks operations as directed by the drawings and the Local Authority requirements.

1.3 QUALITY ASSURANCE – EARTHWORKS

The Contractor shall produce, and submit to the Superintendent, verified records to confirm that the specification requirements have been achieved as follows:

	Item	Test/Record	Frequency
a)	Topsoil stripping	Contractor's Certificate	1 per project
b)	Finished Earthworks levels	Surveyed as-constructed drawing showing finished contours	1 per project
c)	Compaction - bulk fill	Compaction Certificate	As directed by the Local Authority and/or Geotechnical Testing Authority
d)	Compaction - method specification	Contractor's Certificate confirming roller, passes, water used etc	As directed by the Local Authority and/or Geotechnical Testing Authority
NB.	Compaction tests should be adequately distributed so as to give a good representation of the whole area, including additional testing within 2 metres of corners and edges of earthworked area.		
e)	Stabilisation (Hydromulch):		
	Mix details	Supplier's Certificate	1 per mix
	Application rate	Supplier's Certificate	1 per project
f)	Retaining Walls:		
	Independent Certification (Design)	Independent Structural Certification of Retaining Wall Design to suit in-situ soils	1 per wall type per location
	Foundation Compaction	Compaction Certificate	As directed by the Local Authority and/or Geotechnical Testing Authority
	Backfill Compaction	Compaction Certificate	As directed by the Local Authority and/or Geotechnical Testing Authority
	Finished Walls	As-constructed profiles with tolerances and locations	1 per 30m length of wall

The Contractor is to utilise and submit the standard Quality Assurance forms as contained in Appendix 2 to demonstrate the above quality assurance items.

1.4 CLEARING

Clearing must be approved by the Superintendent, the Arborist and the Specialist Fauna Consultant (where applicable) prior to clearing works commencing. The Contractor is to confirm whether all permits and requirements are in place prior to commencing clearing.
Clearing and grubbing shall be carried out in accordance with the appropriate Local Authority Specification for Clearing and Grubbing and Earthworks. The extent of clearing and grubbing shall be as shown on the approved earthworks plan, VMP or Landscaping drawings (where applicable). Written confirmation from the Local Authority is required confirming any variation from these documents before commencement of any works. Clearing works shall not commence until all approved landscaping plans and vegetation management plans are available on site. If there are any discrepancies between these plans, any trees in question shall be retained until advised in writing by the Local Authority, via the Superintendent.
As a minimum the clearing shall consist of removal from the area designated in the drawings of all trees, standing or fallen, and other vegetation, boulders and rubbish and shall include the grubbing out of all stumps and tree roots to a depth of 600mm below the natural surface or 400mm below the finished cut surface, whichever is the lower, and disposing of all spoils resulting from the clearing and grubbing. Any holes left after grubbing shall be filled and compacted to the same density as that of the surrounding undisturbed soil.
As little as possible of the surface soil shall be removed during clearing operations.
The Contractor shall take precautions to minimise damage to growing trees and shrubs, fences and other improvements outside the designated areas, and any damage shall be made good. Trees that are shown as being retained on the approved drawings, Vegetation Management Plan or identified on site shall not be damaged in any way during construction. Any costs required for any remedial works to damaged trees will be the responsibility of the Contractor.
The spoils of all clearing and grubbing operations shall be removed from the Site. No spoils of clearing and grubbing shall be pushed beyond the limits of the site, or burnt.
The tender shall include the provision of temporary fencing as shown on tender drawings.

1.5 RUBBISH MATERIAL

Rubbish material such as concrete, bricks, any other building waste or material which is deemed unsuitable for use as fill shall be considered "Unsuitable Material" for the duration of the contract. Removal of any rubbish material which is visible from a site inspection at the time of tendering shall form part of the contract works. The Contractor shall allow for the removal and dumping of this material off site within their tender.
In cases where rubbish material is left by others after the close of tenders, or is discovered during excavations and could not reasonably have been expected at the time of tendering, the material shall be removed from site as directed by the Superintendent and shall form a variation to the Contract.

1.6 MULCHING / CHIPPING

All tree trunks, branches and stumps smaller than or equal to 400mm in diameter, including leafy material, shall be mulched (unless noted otherwise) and neatly stockpiled in a site to be determined by the Superintendent.
Mulched material shall be generally 75mm maximum length and 15mm maximum diameter and shall be that material passing a 100mm maximum screen.
Chipping of logs between 200mm and 400mm diameter is acceptable (subject to Superintendent approval) however the chipped and mulched material shall be stockpiled in separate heaps.
All mulch and chippings are the property of the Principal and processed mulch/chippings shall not be used for any other purpose, nor removed from the site without specific approval from the Superintendent.
The intent of these works and this specification is to maximise the volume of mulch/chippings for use on stabilising fill batters and the contractor shall undertake all works accordingly.
Due to the risk of self-combustion, stockpiles are to be placed in areas away from bushland and assets, preferably on cleared land. Where this cannot be achieved, sufficient firebreaks should be created such that stockpiles are accessible to water carts from all sides of the stockpile.
Where practical, stockpiles shall be positioned where they will be in passing view of workers to assist in monitoring.
The tops of stockpiles shall be struck flat and are to be thinned out to a height not exceeding 2m.
Water carts are not to be driven over stockpiles as they may cause burnt material to collapse under the weight of the machine.
In the event of a small fire or smoke arising from a stockpile, the heap shall be smothered with sand or water. Where the fire or smoke persists, the stockpile shall be thinned out and sand or water shall be reapplied until under control.
Where a stockpile is in close proximity to water access, a pipe with sprinkler shall be attached to the top of the heap.

1.7 STRIPPING OF TOPSOIL

The existing topsoil shall be stripped from all areas to be earthworked, prior to the commencement of the earthworks, and stockpiled on site.
Topsoil is defined as the layer of surface material containing humus, roots, plants and organic material exceeding one percent by weight.
The Contractor shall allow in his Tender the cost to remove and dispose of excess topsoil offsite.

1.8 CUTTING TO DESIGN LEVELS ***AMEND***

Following the removal of topsoil and proof rolling (if specified by the Geotechnical Certifier), areas shown to be cut shall be cut to achieve the levels shown on the drawings.
Any areas which are over excavated shall be refilled to the design levels shown on the drawings. Any refilling shall be placed as specified in "Filling to Design Levels" section below.
Where no fill is to be applied, cut surfaces shall be finished by further proof rolling as directed by the Geotechnical Certifier.
Any area in which rock is excavated within a future lot area, the rock shall be over-excavated to a minimum depth of 600mm below finished level and suitably crushed and replaced (where achievable) or replaced with compacted structural fill as directed by the Geotechnical Certifier.
The Contractor shall make reasonable efforts to ascertain whether any rock exists within 600mm of the surface by test pitting or other methods.

1.9 FILLING TO DESIGN LEVELS

Fill material shall be placed as directed by the Geotechnical Certifier, which shall be varied to suit the material being placed, and the method of compaction.
The Contractor shall assess the fill quantities required within the earthworks area and allow to import any shortfall of fill. All associated costs shall be included in the tender.
Each layer of fill material shall be compacted in accordance with the Local Authority standards and specifications, and as directed by the Geotechnical Certifier. As a minimum, compaction shall achieve a minimum density ratio of 95% as obtained in test AS 1289.5.4.1 with maximum dry density determined in accordance with AS 1289.5.2.1 (modified compactive effort).
The Contractor is to have any material, which is proposed to be re-utilised in trenches or earthworked areas, tested to determine characteristics to allow suitable compaction to be achieved.
The Contractor is to ensure that all materials are placed in layers and at a moisture content as directed by the Geotechnical Certifier to achieve the desired compaction.

1.10 EXCESS SPOIL

Where after the completion of earthworks there is excess spoil it shall be placed on site as shown on the drawings. Where no direction is given on the drawings, all excess spoil shall be removed from the site at the Contractor's expense.

1.11 TOPSOIL

1.11.1 Re-spreading Topsoil

The topsoil for respreading shall be assessed and blended on site to comprise not more than 20 percent by weight of vegetable and humus material, not more than 20 percent below the 75 micron sieve size and a maximum soil particle size of 50mm. The topsoil shall be free of vegetation pieces larger than 200mm in any one direction. Topsoil shall be spread uniformly to a thickness not less than 50mm and not more than 100mm. The Contractor shall allow in his tender for the removal of all excess topsoil from site. The Contractor is to seek direction from the Superintendent prior to the removal of excess topsoil from the site.

1.12 TOLERANCES

The completed earthworks levels shall be within plus 100mm or minus 0mm of the design levels without retaining walls shown on the drawings. Where retaining walls exist or will exist in the future, the earthworks tolerance shall be within plus 50mm or minus 0mm of the design levels shown on the drawings. The design levels are the levels on the completed earthworks including respread topsoil.

1.13 TESTING BY AN INDEPENDENT GEOTECHNICAL CERTIFIER

Earthworks shall be progressively tested in accordance with the Local Authority standards and specifications to an independent Level One Geotechnical Certification (unless specified otherwise) as defined in Appendix B of AS3798-1996, to demonstrate that the specified relative compaction has been achieved.
Field density testing shall be completed and certified by an independent NATA registered laboratory. The laboratory shall calibrate field density testing apparatus against laboratory tests. Field density tests may consist of sand replacement to AS 1289.5.3.1 or nuclear density tests to AS 1289.5.8.4 to 5.8.9.
The Contractor shall allow for the independent Geotechnical Certifier to provide a testing and inspection supervision service on all earthworks suitable to the level of geotechnical certification required. The Geotechnical Certifier shall establish the type, number and frequency of the testing regime appropriate for the works involved.
General fill shall be tested by means of sand replacement or nuclear density tests.
The frequency of testing shall be as listed in the clause "Quality Assurance - Earthworks" of this specification.
All costs for this testing shall be incorporated in the tender.
Additional tests may be directed by the Superintendent and the Contractor shall arrange for the performance of such tests. Where the results of such tests indicate that the specified densities have been achieved, the cost of the tests will be paid by the Principal through a Provisional Sum for testing.
The results of all tests shall be recorded on the appropriate forms as included in this specification.

1.14 EARTHWORKS AS-CONSTRUCTED INFORMATION

On the completion of the following stages of earthworks, the Contractor shall provide a detailed survey pick-up of As-Constructed levels over the earthworked area using an Engineering Surveyor:

- Over excavation surface levels (on top of rock) prior to the placement of structural fill, and
- On the finished earthworked surface level.

Practical completion will not be granted until this information has been provided to the satisfaction of the Superintendent.

1.15 STABILISATION

1.15.1 Stabilisation by Topsoil and Seeding

Surface stabilisation shall be carried out with a minimum 50mm and maximum 100mm layer of seeded topsoil across all disturbed areas as specified in the drawings (unless otherwise noted). Where the Contractor has insufficient topsoil to achieve this minimum topsoil thickness the Contractor shall obtain the Superintendent's direction before proceeding further.

1.15.2 Hydromulching

Hydromulching shall be applied (unless noted otherwise) by a Sub-contractor specialising in this work as directed by the contract and drawings. The Contractor shall obtain the Sub-Contractor's recommendations and submit these to the Superintendent.
In the absence of specialist advice, hydromulching shall consist of a mixture of 1,200kg to 1,400kg newspaper, 200 litres of stabiliser (eg Gluon 240) and 10,000 litres of water. The hydromulch shall be thoroughly mixed and applied by pressurised spray at the rate of 40kl to 50kl per hectare.

Prior to spraying the hydromulch, if specified by the Superintendent, the area shall be fertilised with Superphosphate at the rate of 200kg per hectare. Seed shall be included in the hydromulch mix as follows:

Cereal Rye	100kg per hectare
Wimmera or Merredin Rye	20kg per hectare
Serena, Circle Valley or Rose Clover	20kg per hectare

1.16 FINISH

All finished surfaces shall be graded to the finished presentation stage prior to hydromulching, including:

- Rolling the finished earthworks prior to topsoil spreading
- Evenly graded changes between design levels and contours
- All wheel tracks and other disturbances levelled out
- Removal of all debris or rock pieces greater than 100mm in any direction from the surface
- Removal of all spoil heaps
- Rolling or smudge boarding the finished topsoil surface.

1.17 RETAINING WALLS

1.17.1 General

The Contractor shall allow for the co-ordination and engagement of a suitably qualified structural and geotechnical consultant to provide the detailed design and construction certification of the retaining walls to suit the in-situ site soil conditions, applicable surcharge loading for the wall location and the general application of the wall.
The Contractor shall fully supervise and coordinate the construction of all retaining walls within the Contract. The Contractor shall co-ordinate the wall certifier to ensure full design and construction certification can be submitted during and at the completion of the works in accordance with the Local Authority or Building Certifier requirements. Failure to submit certification will result in the wall being removed and replaced at the Contractor's expense to the satisfaction of the Superintendent.
Any discrepancies between the drawings, specification and current or preferred work practices shall be brought to the attention of the Superintendent prior to closing of Tenders.
Where retaining walls form part of the Contract works, any general arrangement or structural details shown on the construction drawings shall be treated as preliminary only, unless specifically noted otherwise.
For all proposed standard or proprietary product walls (eg Concrib, Besser Block, Concrete Sleeper etc) the design specification, materials, preparation, installation, backfill and workmanship is to be in accordance with the manufacturer's specification and certification requirements.

1.17.2 Retaining Wall Building License

The Contractor shall obtain a Building License from the relevant Local Authority in accordance with the Preliminaries section of this specification as required by the Authority.

1.17.3 Setting Out for Constructing Retaining Walls

The Contractor shall allow in his tender for all costs associated with engaging the Licensed Surveyor to set out and check the location of all retaining walls prior to and at the end of construction. Such cost shall be borne by the Contractor.

1.17.4 Subsoil Drainage Lines Behind Retaining Walls

All retaining walls are to have appropriate granular drainage backing material with a subsoil drainage line installed in accordance with the relevant Authority requirements. All subsoil lines are to grade at a minimum of 1:200 and be connected to the closest stormwater drainage pit or daylighted with appropriate scour protection in a location which does not result in nuisance flows or the potential for long term blockage.

1.17.5 Safety Fencing

Wall heights of 1m and over shall have a safety fence installed along the back of the wall. The fence as a minimum shall include star-iron pickets hammered securely into the ground with two strands of sighter-wire and high visibility plastic mesh. Fence height shall be minimum 1.2m in height. Star-iron pickets are to be installed with plastic protective caps.

1.17.6 Retaining Wall As-Constructed Requirements

The Contractor shall produce As-Constructed profiles of wall cross sections for actual heights and widths and As-Constructed plans of wall positions. The Contractor shall mark up the retaining wall sections to illustrate any changes that occurred during construction.
The As-Constructed information shall be signed and certified as accurate and correct by the Contractor's certifier and Surveyor before being submitted to the Superintendent for approval. Costs to provide As-Constructed information shall be part of the Contractor's tender.
The Contractor shall provide compaction test certificates to all retaining wall foundation and backfill in accordance with Quality Assurance and Testing provisions of this specification.
The Contractor shall submit foundation compaction test results prior to construction of walls commencing or before subsequent backfill layers as appropriate. The Superintendent may request additional testing in accordance with the Provisional Sum section of this specification.

1.17.7 Tolerances

For all walls the level at the top of the wall shall be no more than -0mm to +50mm overall from the design level.
Wall faces shall not deviate from the design as shown.
Walls shall at all times be contained within the designated site or lot boundary including all footings and drainage backing layers.

1.17.8 Fees and Charges

The Contractor shall apply for all building licenses and obtain approvals to carry out the work as required by the Local Authority.
The Contractor shall pay all fees associated with building licenses and approvals.

2 FOOTPATHS

2.1 GENERAL

All footpath works shall be constructed in accordance with the drawings and the relevant Local Authority specification and will be subject to inspection and the approval of the relevant Local Authority and the Superintendent.
In relation to the footpaths portion of the specification, the term Local Authority will be taken to mean the Local Shire Council or the Local Main Roads Department where applicable to the works being undertaken. The term footpath in this specification will be deemed to cover all pathways, cycleways or the like designated on the tender drawings.
Any instructions from the Local Authority pertaining to the works shall be issued by that Authority to the Superintendent.
The extent of footpaths to be constructed is as shown on the drawings.
Footpaths may not be constructed until after all utility services, drainage, sewerage, major verge clearing and kerbing have been completed.

2.2 CLEARING

The footpath alignment shall be cleared for the full width of the footway reserve or as noted on the drawings.
Clearing shall be carried out in accordance with the "Clearing" clause in the Earthworks section.

2.3 SUB-GRADE

The entire width of the proposed footpath shall be cut or filled as necessary.
After excavation or filling, compacting, trimming and boxing out, the finished surface of the footpath sub-grade shall conform to the shape and dimensions shown in the drawings.
Sub-grade is to be compacted to not less than 95% of the maximum dry density obtained in modified maximum dry density compaction tests (AS 1289.5.2.1-2003) to a minimum depth below the surface of 300mm.
All filling shall be placed in generally horizontal layers not exceeding 250mm and compacted prior to the placing of further material.
Where required by the Local Authority a sand bed of clean sand, free from roots, clay or any deleterious matter shall be placed and compacted to the designed footpath width. The bedding shall be compacted in accordance with the relevant Local Authority standard or to not less than 90% of the maximum dry density obtained in the modified maximum dry density compaction tests (AS 1289.5.2.1-2003).

2.4 CAST IN-SITU CONCRETE PATHS

2.4.1 Dimensions

The footpath shall be constructed with a cross-fall as allocated by the relevant Local Authority towards the kerb unless otherwise noted on the drawings. The finished thickness of the slab to be a minimum of 100mm or as specified by the Local Authority. The width of the path shall be as shown on the drawings.

2.4.2 Construction

Where the path is constructed in the road reserve, the longitudinal profile of the path shall be the same as the longitudinal profile of the adjacent kerbing. Elsewhere, the path longitudinal profile will be such as to achieve a uniform smooth grading and alignment, and generally conform to the surrounding finished ground or as shown on the drawings.
No concrete shall be poured until the sand bedding and or subgrade has been approved by the Superintendent.

2.4.3 Concrete

The concrete used in this construction shall conform to AS 3600 and be provided by an approved pre-mixed concrete supplier, conforming with AS 1379. Each batch provided shall be supported with evidence of strength slump, aggregase size, etc.
The concrete strength aggregate size and slump should be as specified by the Local Authority.
The concrete, when placed, must be well tamped to remove all voids and to work fines to the surface for troweling.

2.4.4 Contraction and Expansion Joints

Contraction and expansion joints in footpaths shall be constructed in accordance with the Local Authority specifications, or when silent, the following shall apply:

- Contraction joints are to be placed at 2m intervals.
- Expansion joints are to be placed at every third contraction joint and to the surround of all utility manholes or covers and against the back of kerb (where applicable).

All joints shall be aligned with joints in the kerbing where the path is against the back of kerb.

2.4.5 Finish

A brushed finish shall be provided to the surface of the slab with joints and edges polished in accordance with the Local Authority specifications.
The alignment of the edge of the path is to be straight and true to line. Deviations from alignment or from specified width will not be accepted. The path shall be parallel with the kerbing in vertical and horizontal alignment.

2.4.6 Protection

Barricade, warning signs and lights shall be erected to prevent damage of the footpath from vehicles and pedestrians for not less than 24 hours after completion or if rainfall during the curing period is apparent.
The Contractor is responsible for protection of the path against damage of any kind during the period of setting and curing of the concrete.

2.4.7 Clean Up and Backfilling

All cement droppings, slurry, etc. and surplus materials to be removed from site.
All formwork, pegs, stakes, etc. shall be removed after the curing of the path has been completed.
After removal of the formwork, and acceptance of the path by the Superintendent and the Local Authority, the path shall be backfilled with topsoil. Backfilling shall be compacted to not less than 90% of the maximum dry density obtained in modified maximum dry density compaction tests (AS 1289.5.2.1-2003) and shaped level with the top of path.

3 STORMWATER DRAINAGE

3.1 GENERAL

All stormwater works shall be constructed in accordance with the tender drawings and the relevant Local Authority Specification and standard drawings, and will be subject to inspections and approval of the relevant Local Authority and the Superintendent. Any discrepancy between the Local Authority standards and those shown on the tender drawings shall be referred to the Superintendent prior to construction.
In relation to the stormwater portion of the specification, the term Local Authority will be taken to mean the Local Shire Council or the Local Main Roads Department where applicable to the works being undertaken.
Where works are not municipal works, all works shall be constructed in accordance with the tender drawings and AS 3500.3.
Any instructions from the Authority pertaining to the works shall be issued by that Authority to the Superintendent.
The Contractor shall provide a minimum of 48 hours notice, to the Superintendent so a joint audit inspection of each stage of construction can be arranged with the Local Authority. The Contractor shall also attend. Each stage shall be inspected prior to commencing the next or following stage. The Contractor shall rectify any areas considered unacceptable due to poor workmanship or materials and this shall be reinspected prior to continuing with the next stage of work.
Joint audit inspections with the Contractor, the Superintendent and a Local Authority Representative shall be actioned on the following basis:

- When the stormwater pipes and other structures have been laid to final line and level and prior to backfilling of the trenches; and
- After junction pits, gullies and other structures have been constructed and the backfilling of trenches completed.

Quality Assurance – Drainage
Prior to commencing on the next stage of the works, the Contractor shall produce and submit to the Superintendent certified records to confirm that the Local Authority specifications and requirements have been achieved. Where the Local Authority specifications are silent, the following minimum testing regime shall be applied:

Item as Specified	Test/Record	Frequency
Materials Specification	Supplier's Certificate	1 per delivery
Drain set-out	Contractor's Survey record	1 per drain line
Drain Construction	Survey as-constructed details (as per standard form - see Appendix 2). Invert levels Access chamber locations Access chamber cover levels Bedding details Gully locations Gully type/level Pipe size/type	1 per drain line
Drain Testing	CCTV Testing	1 per drain line
Backfill	Contractor's Certificate	1 per drain line
Compaction	Compaction Certificate (as per standard form – See Appendix 2)	3 tests per drain line per layer (incl trench base) and adjacent to chambers.

The contractor shall note on the record where any item fails to meet the specified requirements, including the planned remedial action to be taken.

3.2 TOLERANCES

The Local Authority standards are to be used to establish the allowable tolerance in relation to Stormwater Drainage works. Where the Local Authority standards are silent, the following construction tolerances shall be achieved by the Contractor:

Grades steeper than 1:500	± 10% of design grade and ± 20mm of design invert level
Grades flatter than 1:500	up to 10% steeper, but not less than 5% flatter than design grade and ± 10mm of design invert levels

The horizontal deviation of any piped or box culverted drain shall not exceed 25mm from the true alignment. There shall be no obvious sharp changes of direction.

3.3 MATERIALS

3.3.1 Australian Standards

All workmanship and materials used in the works shall conform to the current Local Authority standards where such standard exists. Where such standard does not exist, the current Australian Standard shall apply.

3.4 SETTING OUT

3.4.1 General

The drawings show centre lines, grades, lengths, diameters, invert levels at entry and exit of drains and the location of access chambers.
The distances shown between access chambers are mostly scaled measurements and are for the Contractor's guidance only. In all instances access chambers are to be constructed in the locations shown. Centre lines and invert levels are to be strictly adhered to and no alterations shall be made except on the written authority of the Superintendent.

3.4.2 Setting out of Drainage Lines and Structures

All set out shall be undertaken by an Engineering Surveyor, arranged for by the Contractor at his expense.
The centre of each access chamber shall be pegged and at least two reference stakes placed offset from the access chamber centreline.
The Contractor's Engineering Surveyor shall provide the Contractor's Foreman with a copy of his survey record for each drain. The record shall indicate all reference pegs, offset pegs, RLs of dumpy pegs, access chamber to access chamber distance, and the distance to house connections (where applicable). Records shall be retained by the Foreman on Site and shall be available for inspection by the Superintendent.

3.5 EXCAVATION

3.5.1 General

Tenderers must form their own opinion, and take what tests on site they consider necessary to ascertain what the nature of the ground is, sub-surface strata and ground water levels.
Clearing, topsoil and stabilisation shall be carried out in accordance with the Earthworks section of this specification.

3.5.2 Rock Excavation

The Contractor is to allow in his tender for all excavation works including the removal of all rock.
Rock for the purpose of variations is as defined in the Preliminaries section of this specification.
Blasting shall be undertaken as specified below.

3.5.3 Dewatering

The Contractor shall allow within his Tender the cost of all dewatering and any additional construction costs due to wet ground conditions.
In the event of water being encountered, the Contractor shall make adequate provision to ensure that the excavation is kept free from water during the process of concrete pouring and for a period of at least 24 hours after the concrete pour. No bedding or pipes shall be laid in water and trenches are to be kept free from water until refill is commenced.

3.5.4 Trench Excavation

Trenches are to be cut to line and gradient. The line of cut for each side of the trench shall be marked out on the surface before excavation commences.
The trench widths shall be kept to a minimum consistent with the bed width requirements and the requirements of adequate working space and timbering.
Tunnelling shall be only carried out where directed by the Superintendent, and the Contractor shall submit details of tunnelling method prior to commencement for the approval of the Superintendent.
Should the bed of the trench be over excavated, then the over excavated volume shall be replaced in accordance with the Earthworks section of this specification.
All trench excavation shall be made in a safe manner with all trenches either being shored or battered back to achieve this. The Contractor shall comply with the Construction Safety section of this specification.
Trenches shall be kept free from water, debris and falling earth.
The final trimming of the bottom 150mm of trench excavation should not be carried out until immediately prior to concreting or placement of pipe bedding. Excavation must be completed for a minimum of 10 metres length ahead of pipe laying.

3.5.5 Drainage Structure Excavation

Excavation for all drainage structures must be made to the correct depth and of sufficient dimension to allow the base and walls to be constructed as needed.

The Contractor shall be responsible for safety at all times.

3.5.6 Blasting

Blasting shall be only carried out with the approval of the Superintendent and prior to any blasting, the Superintendent and the Contractor shall inspect all necessary safety precautions. Handling, safety precautions and storage of explosives shall be in accordance with the requirements of the Mines Regulation Act 1946, the Explosives and Dangerous Goods Act 1961, AS 2187 Part 1 1984 and AS 2187 Part 2, Rules for the Storage and Handling of Explosives, AS 2188, Magazines for Handling of Explosives and such other precautions as the Superintendent may require.
Blasting shall only be carried out by a person holding a current permit.

3.5.7 Excavation in Existing Roadways, Footpaths etc.

Excavation is to be kept to a minimum in existing roadways, footpaths and other paved areas, ensuring that damage to such structures is kept to a minimum. The Local Authority shall be notified and that Authority's approval received prior to commencing work in roadways and footpaths.

3.5.8 Measurement of Excavation

Measurement of excavation for the purpose of costing variations shall be in accordance with the minimum trench dimensions shown on the drawings, and measurement shall comply with AS 1181 "Method of Measurement of Civil Engineering Works."

3.5.9 Obstruction to Traffic

Excavation material shall be deposited in an area causing the least interference to vehicular and pedestrian traffic.
At all times when the works are left unattended, all excavation in public areas shall be fenced off with warning signs and lighting and the Contractor shall ensure that they remain in a safe condition.
These safety precautions shall be subject to the approval of the Superintendent.

3.6 DRAIN CONSTRUCTION

3.6.1 Pipe Setting

All pipes shall be set in a straight line between access chambers or between access chambers and headwalls. On inspection by the Superintendent, any pipe not placed in a straight line shall be replaced at the cost of the Contractor.
Pipes shall be set in an upstream direction unless otherwise approved by the Superintendent.
All pipes are to be jointed in accordance with the relevant Australian Standards and manufacturer's specification.

3.6.2 RC Concrete Pipe Jointing

Spigot and socket pipes shall be jointed with the spigot fully home in the socket and rubber ring joint. Pipes shall be laid such that the sockets face upstream.

3.6.3 PVC Pipe Jointing

PVC pipes shall be jointed with the spigot fully home in the socket and the joint solvent cemented. The solvent cement used shall be the product recommended by the pipe manufacturer. The solvent cement shall be applied using a clean brush to both surfaces of the joint after these surfaces have been cleaned.

3.6.4 Pipe Bedding

All pipes shall be bedded in accordance with the relevant Local Authority specifications. Pipes constructed in dry sand conditions shall be bedded on a shaped trench base. Pipes constructed in wet ground conditions shall be bedded in accordance with the local Authority standards, or where silent, on a minimum 100mm crushed rock bedding.

3.7 DRAINAGE STRUCTURES

All drainage structures shall be constructed in accordance with the relevant Local Authority standards.

3.8 STEP IRONS

Step irons shall be placed in all drainage structures in accordance with the relevant Local Authority specifications.

REV	DESCRIPTION	DRAWN	APP'D	DATE
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C	ISSUED FOR APPROVAL	CPO	IAH	14.02.20
B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

DRAWN:	CPO
DESIGNED:	GLE
VERIFIED:	IAH 01.06.18
APPROVED FOR TENDER:	RET 04.03.19
APPROVED FOR CONSTRUCTION:	-/-/-

JACKSON TEECE
Architecture

ARCHITECT/CLIENT

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

SPECIFICATION NOTES - SHEET 1 OF 2

TITLE

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
AS SHOWN	38509	CI-007-01	C

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3.9 ROCK PITCHING

Rocks shall generally weigh in excess of 10 Kg each and the greatest dimension of any rock shall not exceed 1.5 times its least dimension.

Rock shall be hard, sound and durable, shall be set on a sand bed in a close fitting pattern and watered and rammed into position. Where no mortar is specified, all rock pitching should be placed on geofabric for the full extent.

Where specified as mortared rock pitching, the joints between stones shall be raked clean for their full depth and filled with a 3 parts sand to 1 part Portland Cement mortar. All rocks are to be securelly positioned with adequate mortar to ensure that will not loosen or break away. Thickness of mortar between rocks to be a minimum as listed below:

- Half the depth of the proposed rocks for rocks between 150mm and 300mm in diameter;
- One third the depth of the proposed rocks for rocks larger than 300mm up to 600mm in diameter;
- Absolute minimum of 75mm for smaller rocks.

Mortared rock pitching is to be placed around all headwalls (to front and sides) regardless of whether they are upstream or downstream structures. Where no extent is shown, rock pitching in front of outlet headwall structures is to extend a minimum distance as determined by the applicable Main Roads specifications. Where no key is shown on headwall structures, mortared rock pitching is to be placed below the headwall for a minimum of 400mm length.

4.1 BACKFILLING

4.1.1 General

Backfilling of pipe trenches shall not be carried out until mains have been measured by the Superintendent.

The fact of any such work being backfilled does not relieve the Contractor in any way of his responsibilities and he may be called upon to uncover and repair such work, at his own cost, any pipeline declared by the Superintendent as unsatisfactory at any time until the end of the defects period. Any such repair work shall be subject to retesting at the Contractor's cost.

Backfilling of all pipes shall be in accordance with Local Authority standards. Where these standards are silent, then the following sections shall apply.

4.1.2 Plain Pipes

Structural fill shall be used for backfilling to a height of 300mm above the top of pipes and shall be compacted by means of an approved mechanical or a pneumatic tamper to not less than a density ratio of 90% as obtained in AS 1289.5.4.1 (modified compactive effort).

Care shall be taken so as not to disturb the pipe. Backfilling of the remainder of the trench shall be in accordance with the Earthworks section of this specification.

4.1.3 Perforated Pipes

Selected 10mm filter aggregate shall be used for bedding and backfilling to the pipe and shall be not less than 150mm thickness below and above the pipe and for the full width of the trench which shall be not less than 150mm either side of the pipe. The remainder of the trench shall be backfilled in accordance with the Earthworks section of this specification.

4.1.4 Restoration of Existing Streets and Laneways

After refilling, trenches in existing road reserves or laneways are to be maintained in a safe condition for traffic and pedestrians.

The final surface treatment shall be to the standard of the Local Authority and the Contractor shall obtain a letter from the Local Authority, indicating its approval of the final surface treatment, and submit a copy of this letter to the Superintendent.

4.2 TESTING OF TRENCH BACKFILL DENSITY

The trench backfill density shall be tested in accordance with the Earthworks and Quality Assurance – Drainage sections of this specification.

Trench compaction tests are to be taken on each layer of backfill as specified in the relevant Local Authority guidelines, and all certification forwarded to the Superintendent. Compaction is to conform to the relevant Authority Standards but where these are silent, shall be compacted at its optimum moisture content to a density of not less than 95% of the maximum modified dry density in accordance with modified maximum dry density tests (AS 1289.5.2.1-2003).

4.3 TESTING REGIME

All testing of drainage works is to be undertaken in accordance with the Local Authority specifications including any required CCTV testing.

The Contractor shall supply all equipment, labour and materials necessary for testing of the drainage in accordance with the Local Authority specifications.

4.4 AS-CONSTRUCTED SURVEY AND DOCUMENTATION

4.4.1 Survey

Using the Contractor's quality assurance measure up (see Quality Assurance - Drainage), the As-Constructed survey shall be carried out and the results recorded by the Contractor's Engineering Surveyor. The costs of all As-Constructed information requirements are to be incorporated into the Contractor's tender.

The As-Constructed requirements are as per the Preliminaries section of this specification.

The survey shall include all invert levels at access chambers, gully pits, headwalls and endwalls, centre to centre distance of pits, distances from centre of pits to headwalls or endwalls, size of pipes, types of pipes and bedding, location of pits in relation to adjacent boundaries, reduced levels of access chamber and entry pit covers.

4.4.2 Certification of As-Constructed Information

These drawings when completed shall be signed and certified as accurate and correct by the Engineering Surveyor and Contractor before submitting to the Superintendent who will then forward onto the Local Authority for their approval.

1.1.3 Acceptance

Acceptance of the works will follow the satisfactory completion of the works, authority inspection and acceptance of As-Constructed documentation.

1.5 CLEANING UP

Any damage done by the Contractor or his employees to buildings, fences, services, driveways etc. shall be immediately made good to the approval of the Superintendent.

During the period of the Contract, the Contractor shall clean up the construction site and remove all surplus construction material and debris from the site. At the completion of the Contract the Site shall be clean and tidy, all excavations filled flush with the natural ground level, and all excess material removed.

The Contractor shall immediately reinstate any subsidence over trenches occurring at any time during the defects liability period.

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A	ISSUED FOR TENDER	CPO	RET	05.03.19

DRAWN:	CPO
DESIGNED:	GLE
VERIFIED:	IAH 01.06.18
APPROVED FOR TENDER:	RET 04.03.19
APPROVED FOR CONSTRUCTION:	...

JACKSON TEECE
Architecture

ARCHITECT/CLIENT

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

SPECIFICATION NOTES - SHEET 2 OF 2

TITLE

38509-CI-007-02.dwg

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
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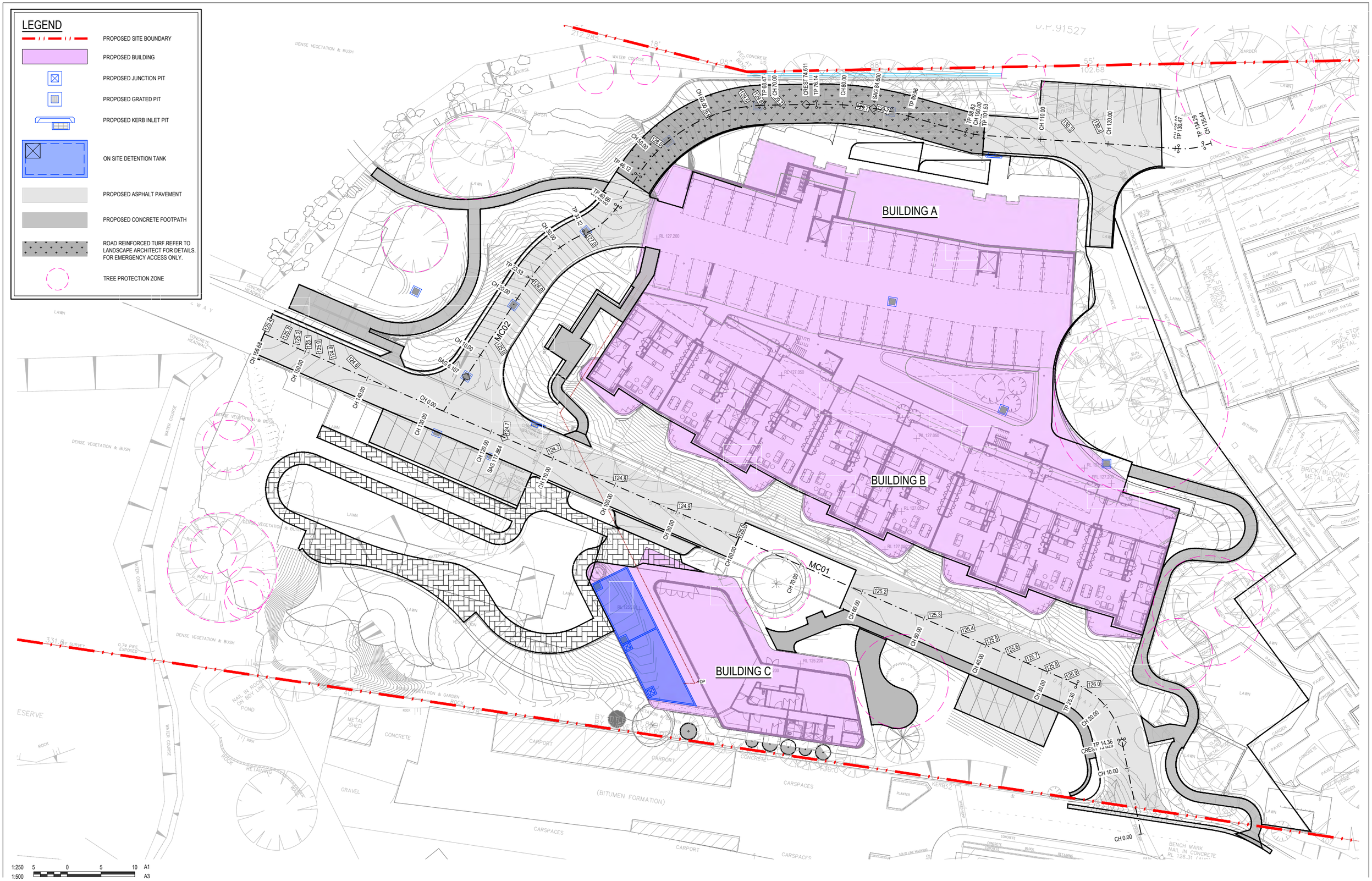

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181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

GENERAL ARRANGEMENT PLAN

TITLE

38509-CI-050-01.dwg

WOOD & GRIEVE ENGINEERS

FOR APPROVAL

NOT FOR CONSTRUCTION

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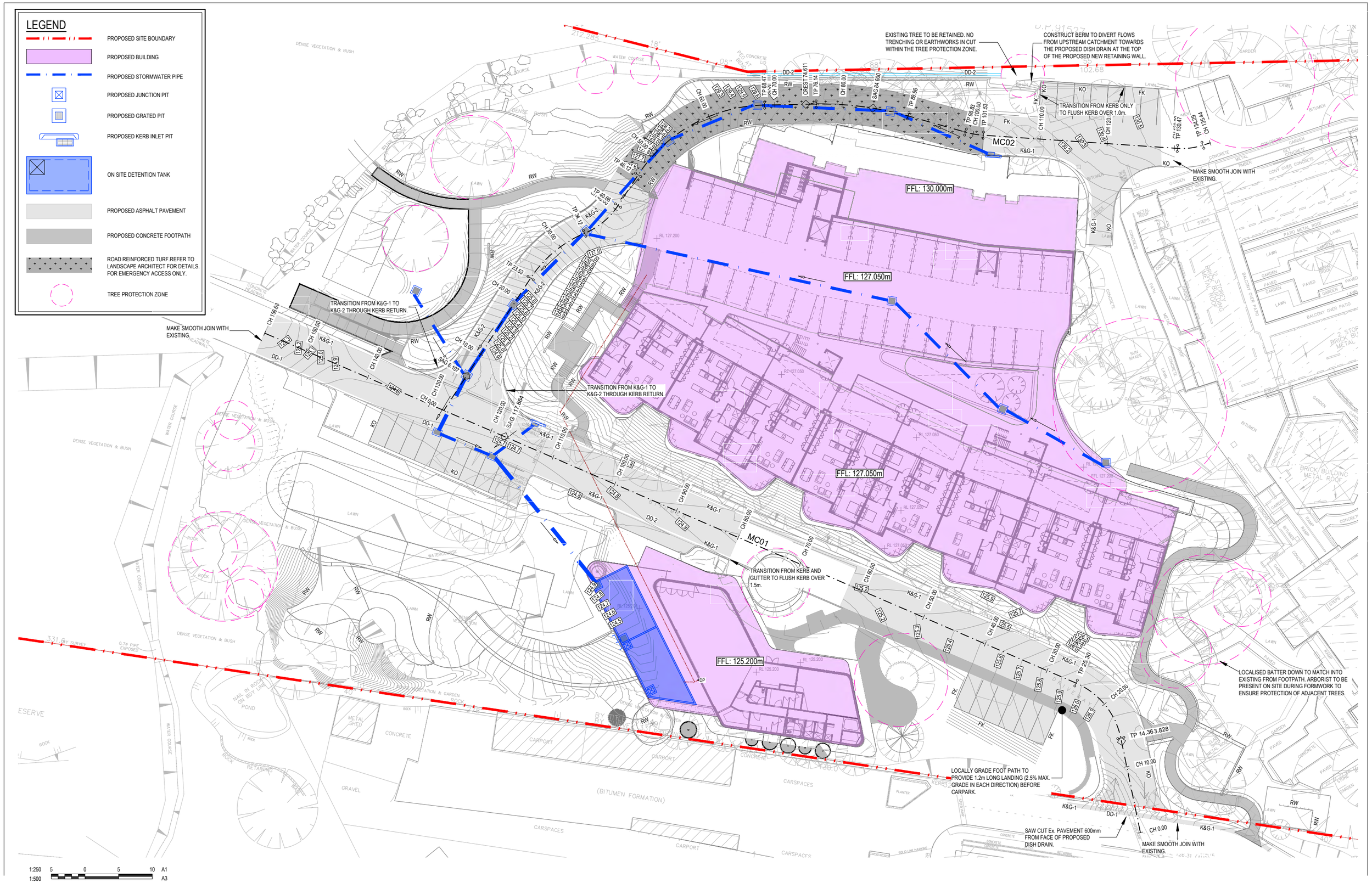

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181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

SITEWORKS PLAN

TITLE

38509-CI-060-01.dwg

WOOD & GRIEVE ENGINEERS

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SCALE @ A1	PROJECT No	DRAWING No	REV
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LEGEND

- PROPOSED SITE BOUNDARY
- VEHICLE SHAKEDOWN DEVICE
- PROPOSED SILT FENCE
- SANDBAG PIT PROTECTION
- PROPOSED JUNCTION PIT
- PROPOSED GRATED PIT
- PROPOSED KERB INLET PIT
- TREE PROTECTION ZONE

NOTE:

REFER DRAWING CI-076-01 FOR EROSION AND SEDIMENT CONTROL DETAILS

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181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

SEDIMENTATION & EROSION CONTROL PLAN

TITLE

WOOD & GRIEVE ENGINEERS

FOR APPROVAL

NOT FOR CONSTRUCTION

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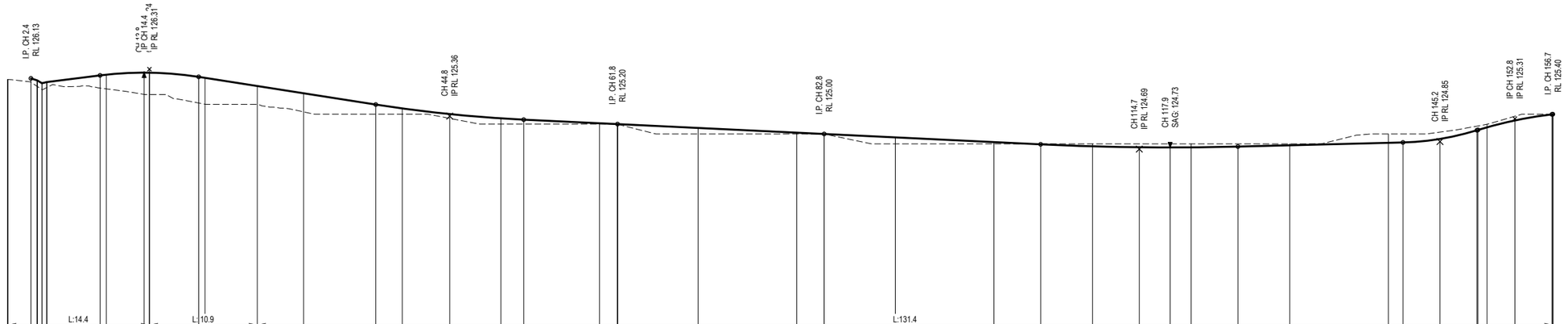
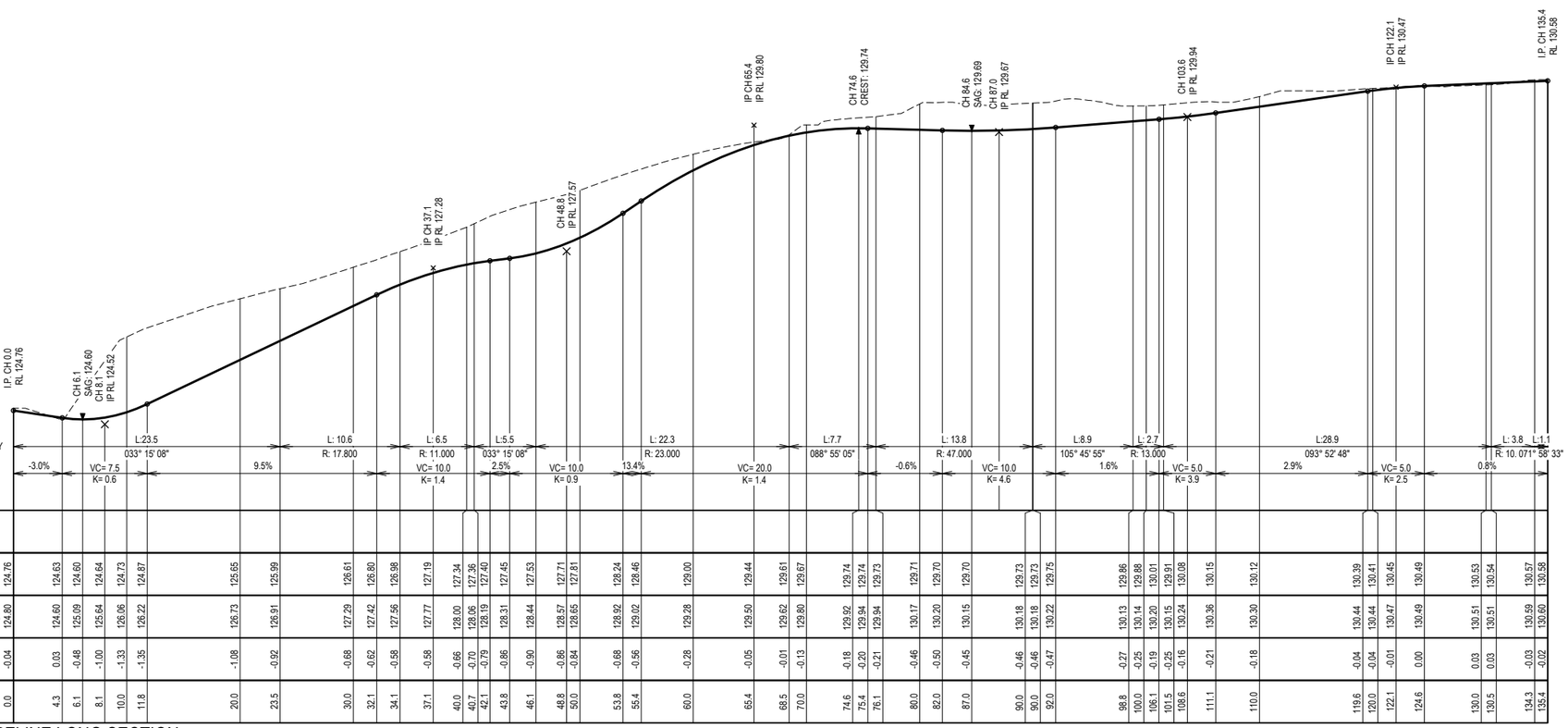


MC01 CENTRELINE LONG SECTION

HORIZONTAL SCALE 1:250
VERTICAL SCALE 1:50



MC02 CENTRELINE LONG SECTION

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VERTICAL SCALE 1:50

1:250 5 0 5 10 A1
1:500 HORIZONTAL A3

1:50 1 0.5 0 1 2 A1
1:100 VERTICAL A3

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181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

ROADS LONGSECTIONS

TITLE

WOOD & GRIEVE ENGINEERS

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NOT FOR CONSTRUCTION

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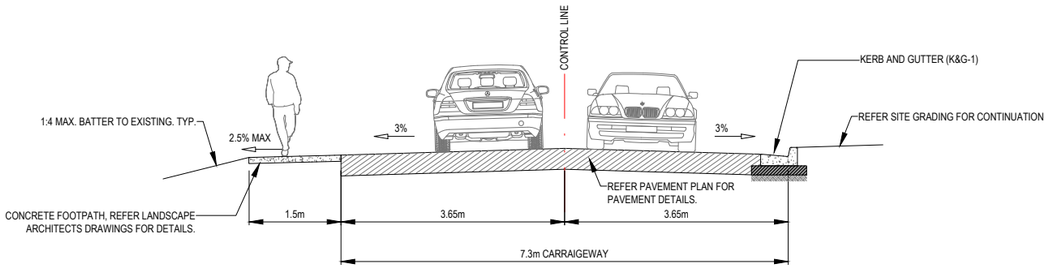

TYPICAL ROAD CROSS SECTION - MC01

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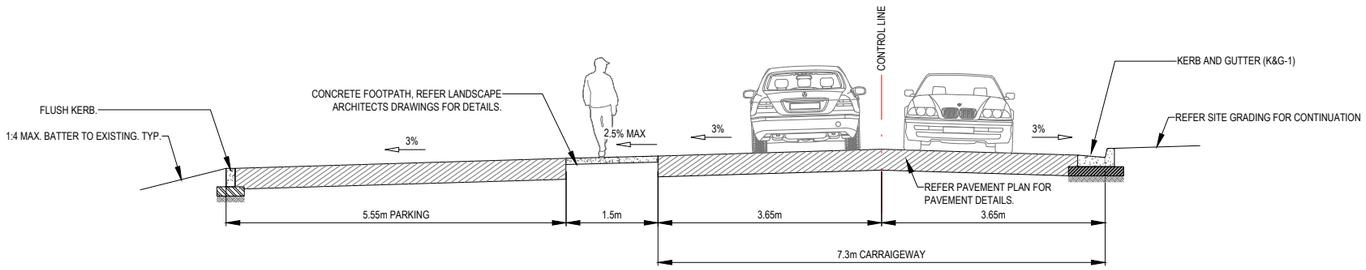

TYPICAL ROAD CROSS SECTION WITH PARKING - MC01 (AT SITE ENTRY)

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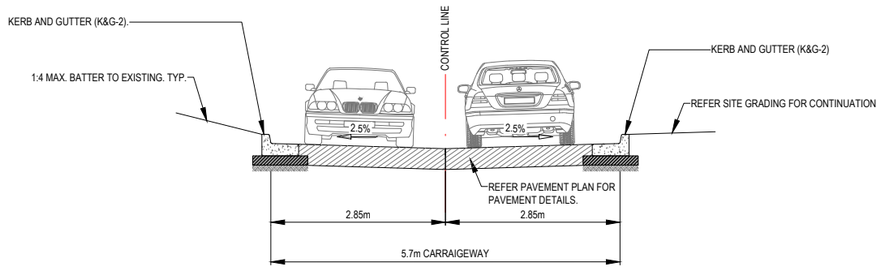

TYPICAL ROAD CROSS SECTION - MC02

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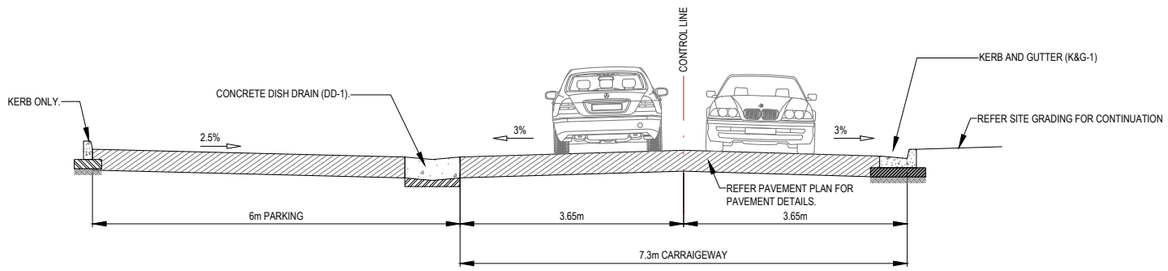
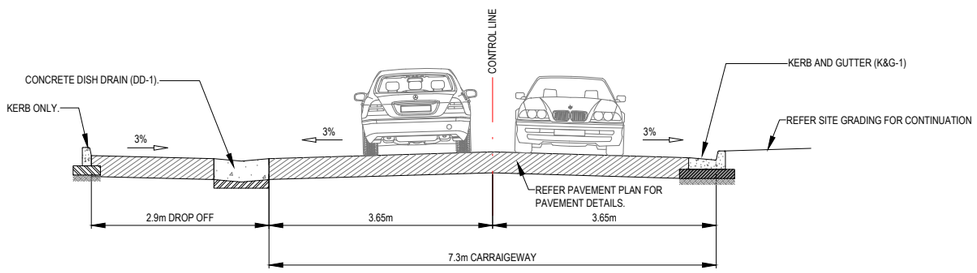


TYPICAL ROAD CROSS SECTION WITH PARKING - MC01 (AT BUILDING "C")

(SCALE 1:50)



TYPICAL ROAD CROSS SECTION WITH DROP OFF BAY - MC01 (AT BUILDING "C")

(SCALE 1:50)

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181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

TYPICAL ROAD SECTIONS

TITLE

WOOD & GRIEVE ENGINEERS

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NOT FOR CONSTRUCTION

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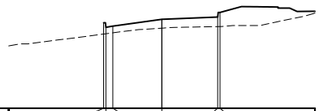

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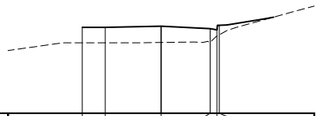
MC01 - CH 10.000



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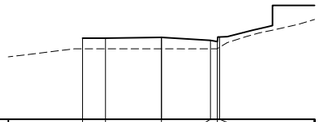
MC01 - CH 19.834



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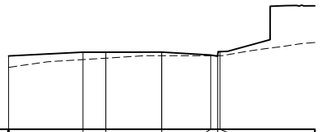
MC01 - CH 25.303



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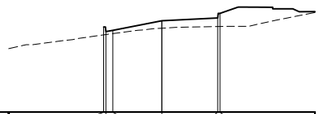
MC01 - CH 40.000



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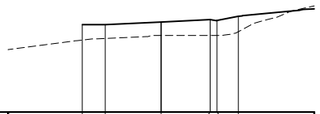
MC01 - CH 09.150



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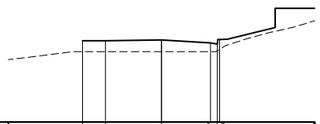
MC01 - CH 15.000



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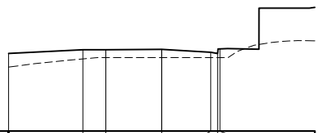
MC01 - CH 25.000



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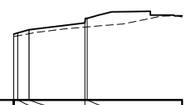
MC01 - CH 35.000



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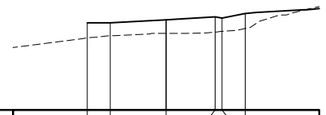
MC01 - CH 05.592



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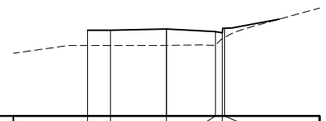
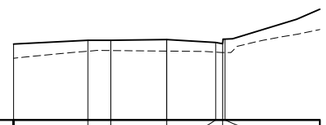
MC01 - CH 14.365



DATUM: 123.300

W.A.E. LEVELS								
DESIGN LEVELS		126.10	126.10	126.14	126.05	126.01	126.16	
EXISTING LEVELS		125.60	125.60	125.60	125.61	125.82	125.86	
CUT / FILL		0.50	0.50	0.53	0.44	0.19	0.30	
OFFSET		-5.15	-3.65	0.00	3.20	3.65	3.80	

MC01 - CH 20.000



DATUM: 123.200

W.A.E. LEVELS								
DESIGN LEVELS	125.68	125.80	125.80	125.82	125.73	125.69	125.84	
EXISTING LEVELS	125.61	125.44	125.47	125.45	125.41	125.40	125.40	
CUT / FILL	0.46	0.36	0.33	0.38	0.32	0.29	0.44	
OFFSET	-10.00	-5.15	-3.65	0.00	3.20	3.65	3.80	

MC01 - CH 30.000

1:200 2 0 2 4 6 8 10 A1
1:400 A3
HORIZONTAL

1:100 1 0 1 2 3 4 5 A1
1:200 A3
VERTICAL

REV	DESCRIPTION	DRAWN	APP'D	DATE
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C	ISSUED FOR APPROVAL	CPO	IAH	14.02.20
B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

DRAWN:	CPO
DESIGNED:	GLE
VERIFIED:	IAH 01.06.18
APPROVED FOR TENDER:	RET 04.03.19
APPROVED FOR CONSTRUCTION:	... ./../..

JACKSON TEECE
Architecture

ARCHITECT/CLIENT

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

MC01 - ROAD CROSS SECTIONS - SHEET 1 OF 4

TITLE

WOOD & GRIEVE ENGINEERS

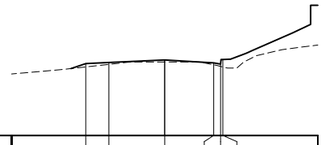
FOR APPROVAL

NOT FOR CONSTRUCTION

AS SHOWN	38509	CI-405-01	C
SCALE @ A1	PROJECT No	DRAWING No	REV

38509-CI-405-01.dwg

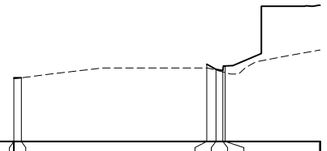
14/02/2020 12:39:07 PM



DATUM: 122.800

W.A.E. LEVELS							
DESIGN LEVELS	125.15	125.18	125.27	125.17	125.13	125.28	
EXISTING LEVELS	125.04	125.12	125.20	125.11	125.06	125.04	
CUT / FILL	0.11	0.06	0.07	0.06	0.07	0.24	
OFFSET	-5.15	-3.65	0.00	3.20	3.65	3.80	

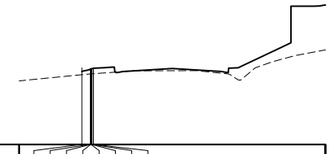
MC01 - CH 55.000



DATUM: 122.600

W.A.E. LEVELS										
DESIGN LEVELS	124.68	124.68	125.12	124.96	124.92	125.07				
EXISTING LEVELS	124.68	124.68	125.00	124.93	124.87	124.85				
CUT / FILL	0.03	0.00	0.12	0.03	0.05	0.22				
OFFSET	-10.00	-9.51	2.60	3.20	3.65	3.80				

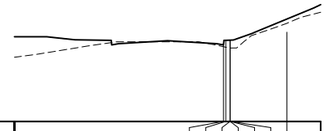
MC01 - CH 70.000



DATUM: 122.500

W.A.E. LEVELS										
DESIGN LEVELS	125.00	124.98	124.98	124.98	124.98	124.98	124.98	124.99		
EXISTING LEVELS	124.78	124.80	124.80	124.80	124.80	124.81	124.81	124.81		
CUT / FILL	0.23	0.17	0.17	0.17	0.18	0.18	0.18	0.18		
OFFSET	-5.91	-5.35	-5.32	-5.32	-5.30	-5.28	-5.24	-5.15		

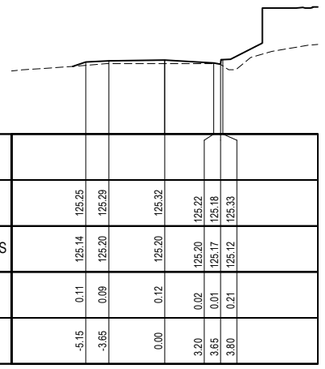
MC01 - CH 85.000



DATUM: 122.200

W.A.E. LEVELS										
DESIGN LEVELS	124.70	124.85								
EXISTING LEVELS	124.64	124.62	124.60	124.60	124.60	124.60	125.40			
CUT / FILL	0.06	0.23								
OFFSET	3.65	3.80	4.08	4.09	4.09	4.09	7.79			

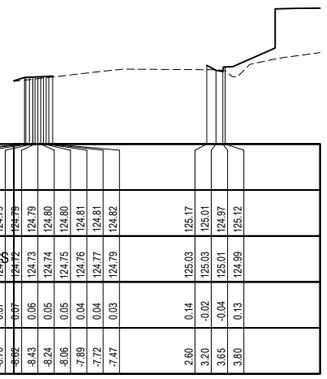
MC01 - CH 100.000



DATUM: 122.900

W.A.E. LEVELS							
DESIGN LEVELS	125.25	125.29	125.32	125.22	125.18	125.33	
EXISTING LEVELS	125.14	125.20	125.20	125.20	125.17	125.12	
CUT / FILL	0.11	0.09	0.12	0.02	0.01	0.21	
OFFSET	-5.15	-3.65	0.00	3.20	3.65	3.80	

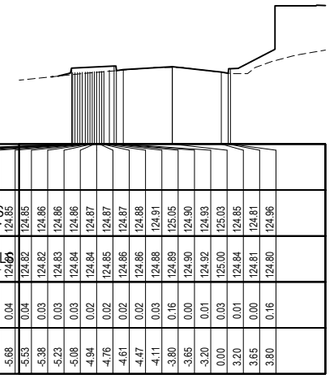
MC01 - CH 50.000



DATUM: 122.600

W.A.E. LEVELS										
DESIGN LEVELS	124.79	124.79	124.79	124.79	124.79	124.80	124.81	124.82		
EXISTING LEVELS	124.72	124.72	124.72	124.72	124.73	124.74	124.75	124.76	124.77	124.79
CUT / FILL	0.07	0.07	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.03
OFFSET	-9.51	-9.22	-8.99	-8.76	-8.42	-8.43	-8.24	-8.06	-7.89	-7.72	-7.47	2.60	3.20	3.65	3.80

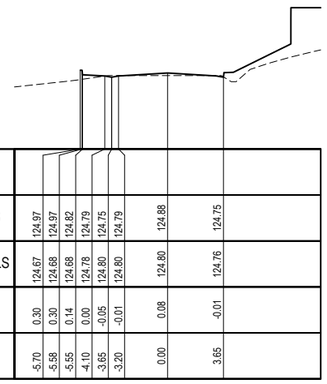
MC01 - CH 65.000



DATUM: 122.500

W.A.E. LEVELS																				
DESIGN LEVELS	124.85	124.85	124.85	124.85	124.85	124.85	124.85	124.85	124.86	124.86	124.86	124.87	124.87	124.87	124.88	124.91	125.05	124.90	124.93	124.96
EXISTING LEVELS	124.81	124.81	124.81	124.81	124.81	124.81	124.81	124.80	124.82	124.82	124.83	124.84	124.84	124.85	124.86	124.86	124.89	124.90	124.92	125.00
CUT / FILL	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.16	0.00	0.01	0.03
OFFSET	-6.30	-6.18	-6.03	-5.88	-5.68	-5.53	-5.38	-5.23	-5.08	-4.94	-4.76	-4.61	-4.47	-4.11	-3.80	-3.65	-3.20	0.00	3.20	3.65	3.80

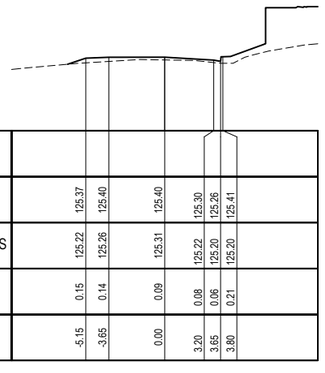
MC01 - CH 80.000



DATUM: 122.400

W.A.E. LEVELS										
DESIGN LEVELS	124.97	124.97	124.82	124.79	124.75	124.79	124.88	124.75		
EXISTING LEVELS	124.67	124.68	124.68	124.78	124.80	124.80	124.80	124.76		
CUT / FILL	0.30	0.30	0.14	0.00	-0.05	-0.01	0.08	-0.01		
OFFSET	-5.70	-5.58	-5.55	-4.10	-3.65	-3.20	0.00	3.65		

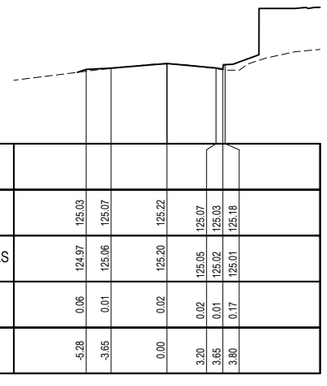
MC01 - CH 95.000



DATUM: 123.000

W.A.E. LEVELS							
DESIGN LEVELS	125.37	125.40	125.40	125.30	125.26	125.41	
EXISTING LEVELS	125.22	125.26	125.31	125.22	125.20	125.20	
CUT / FILL	0.15	0.14	0.09	0.08	0.06	0.21	
OFFSET	-5.15	-3.65	0.00	3.20	3.65	3.80	

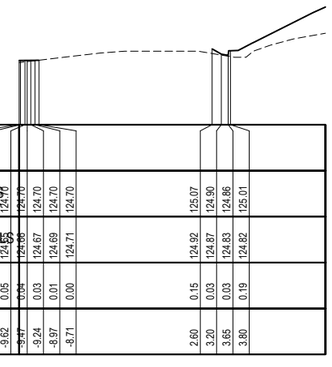
MC01 - CH 45.000



DATUM: 122.600

W.A.E. LEVELS							
DESIGN LEVELS	125.03	125.07	125.22	125.07	125.03	125.18	
EXISTING LEVELS	124.97	125.06	125.20	125.05	125.02	125.01	
CUT / FILL	0.06	0.01	0.02	0.02	0.01	0.17	
OFFSET	-5.28	-3.65	0.00	3.20	3.65	3.80	

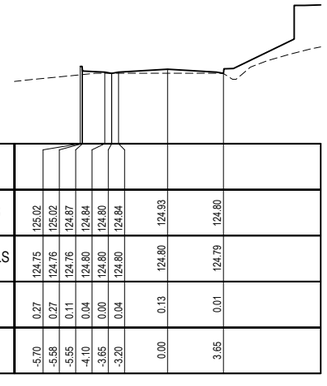
MC01 - CH 60.000



DATUM: 122.600

W.A.E. LEVELS																				
DESIGN LEVELS	124.70	124.70	124.70	124.70	124.70	124.70	124.70	124.70												
EXISTING LEVELS	124.63	124.63	124.63	124.65	124.66	124.67	124.69	124.71	124.92	124.87	124.83	124.82								
CUT / FILL	0.07	0.06	0.05	0.05	0.04	0.03	0.01	0.00	0.15	0.03	0.03	0.19								
OFFSET	-10.00	-9.91	-9.62	-9.47	-9.24	-8.97	-8.71	2.60	3.20	3.65	3.80									

MC01 - CH 75.000



DATUM: 122.500

W.A.E. LEVELS									
DESIGN LEVELS	125.02	125.02	124.87	124.84	124.80	124.84	124.93	124.80	
EXISTING LEVELS	124.75	124.76	124.76	124.80	124.80	124.80	124.80	124.79	
CUT / FILL	0.27	0.27	0.11	0.04	0.00	0.04	0.13	0.01	
OFFSET	-5.70	-5.58	-5.55	-4.10	-3.65	-3.20	0.00	3.65	

MC01 - CH 90.000

1:200 2 0 2 4 6 8 10 A1
1:400 A3
HORIZONTAL

1:100 1 0 1 2 3 4 5 A1
1:200 A3
VERTICAL

REV	DESCRIPTION	DRAWN	APP'D	DATE
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C	ISSUED FOR APPROVAL	CPO	IAH	14.02.20
B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

DRAWN:	CPO
DESIGNED:	GLE
VERIFIED:	IAH 01.06.18
APPROVED FOR TENDER:	RET 04.03.19
APPROVED FOR CONSTRUCTION:	... J.J..

JACKSON TEECE
Architecture

ARCHITECT/CLIENT

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

MC01 - ROAD CROSS SECTIONS - SHEET 2 OF 4

TITLE

38509-CI-405-01.dwg

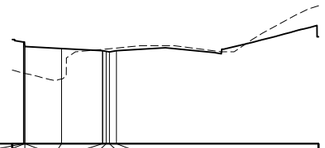
WOOD & GRIEVE ENGINEERS

FOR APPROVAL

NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
AS SHOWN	38509	CI-405-02	C

14/02/2020 12:39:13 PM



DATUM: 121.600

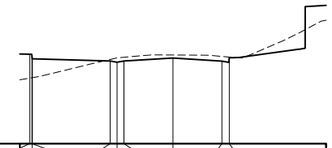
W.A.E. LEVELS										
DESIGN LEVELS	124.77	124.77	124.77	124.71	124.64	124.61	124.60	124.64		
EXISTING LEVELS	123.75	123.89	123.89	123.71	124.68	124.69	124.70	124.72		
CUT / FILL	1.02	0.88	0.88	0.99	-0.04	-0.08	-0.10	-0.09		
OFFSET	-9.27	-9.18	-9.18	-6.78	-4.10	-3.86	-3.65	-3.20		

MC01 - CH 114.472

DATUM: 121.700

W.A.E. LEVELS										
DESIGN LEVELS			124.75	124.75	124.75	124.75	124.75	124.75	124.75	124.75
EXISTING LEVELS			124.80	124.80	124.80	124.80	124.80	124.80	124.80	124.80
CUT / FILL			-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
OFFSET			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

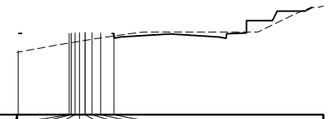
MC01 - CH 125.000



DATUM: 122.000

W.A.E. LEVELS										
DESIGN LEVELS	124.92	124.77	124.77	124.70	124.66	124.70	124.80	124.69	124.80	
EXISTING LEVELS	124.96	124.16	124.16	124.75	124.80	124.82	124.90	124.85	124.83	
CUT / FILL	0.78	0.62	0.62	-0.05	-0.14	-0.12	-0.10	-0.15	-0.02	
OFFSET	-9.35	-9.19	-9.19	-4.10	-3.65	-3.20	0.00	3.20	3.68	

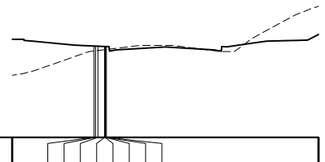
MC01 - CH 135.125



DATUM: 122.500

W.A.E. LEVELS										
DESIGN LEVELS		125.15	125.15	125.17	125.17	125.18	125.18	125.17	125.15	
EXISTING LEVELS	124.96	124.84	124.85	124.87	124.90	124.93	124.96	125.01	125.07	
CUT / FILL		0.31	0.30	0.29	0.28	0.25	0.21	0.16	0.08	
OFFSET	-9.93	-6.60	-6.47	-6.22	-5.92	-5.56	-5.11	-4.54	-3.68	

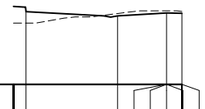
MC01 - CH 150.000



DATUM: 121.800

W.A.E. LEVELS										
DESIGN LEVELS										
EXISTING LEVELS	124.62	124.62	124.63	124.66	124.66	124.66	124.66	124.67		
CUT / FILL										
OFFSET	-4.66	-4.56	-4.40	-3.97	-3.94	-3.92	-3.90	-3.85		

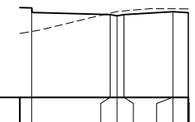
MC01 - CH 110.000



DATUM: 122.400

W.A.E. LEVELS										
DESIGN LEVELS	124.77		124.63	124.73	124.73	124.73	124.73	124.72		
EXISTING LEVELS	124.40		124.71	124.80	124.80	124.80	124.80	124.78		
CUT / FILL	0.37		-0.08	-0.07	-0.07	-0.07	-0.07	-0.06		
OFFSET	-9.18		-3.20	0.00	0.00	0.00	0.00	1.00		

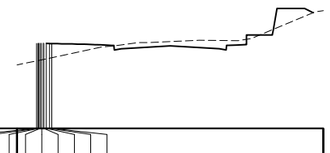
MC01 - CH 120.000



DATUM: 122.000

W.A.E. LEVELS										
DESIGN LEVELS	124.92		124.70	124.66	124.70	124.80	124.80	124.76		
EXISTING LEVELS	124.15		124.75	124.80	124.82	124.89	124.89	124.89		
CUT / FILL	0.77		-0.05	-0.14	-0.12	-0.09	-0.09	-0.12		
OFFSET	-9.22		-4.10	-3.65	-3.20	0.00	0.00	1.00		

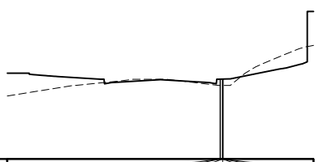
MC01 - CH 135.000



DATUM: 122.200

W.A.E. LEVELS										
DESIGN LEVELS	124.92	124.98	124.98	124.98	124.98	124.98	124.97	124.97	124.97	
EXISTING LEVELS	124.43	124.43	124.44	124.45	124.47	124.49	124.51			
CUT / FILL	0.57	0.57	0.56	0.55	0.54	0.53	0.51	0.48	0.46	
OFFSET	-8.73	-8.64	-8.57	-8.49	-8.39	-8.26	-8.09	-7.88	-7.73	

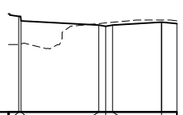
MC01 - CH 145.000



DATUM: 122.200

W.A.E. LEVELS										
DESIGN LEVELS										
EXISTING LEVELS			124.60	124.60	124.60	124.60	124.60	124.60		
CUT / FILL										
OFFSET			3.90	3.92	4.06	4.07	4.07	4.08	4.10	

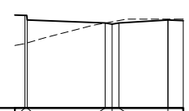
MC01 - CH 105.000



DATUM: 121.800

W.A.E. LEVELS										
DESIGN LEVELS	124.92	124.77		124.63	124.59	124.63		124.73	124.68	
EXISTING LEVELS	124.10	124.03		124.68	124.71	124.73		124.80	124.77	
CUT / FILL	0.81	0.75		-0.05	-0.11	-0.09		-0.07	-0.09	
OFFSET	-9.33	-9.18		-4.10	-3.65	-3.20		0.00	1.00	

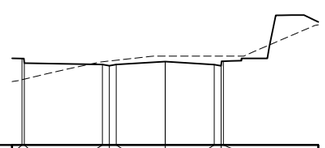
MC01 - CH 115.000



DATUM: 121.900

W.A.E. LEVELS										
DESIGN LEVELS	124.92	124.77		124.68	124.64	124.68		124.77	124.75	
EXISTING LEVELS	124.02	124.02		124.67	124.71	124.75		124.80	124.80	
CUT / FILL	0.92	0.75		0.00	-0.08	-0.08		-0.03	-0.05	
OFFSET	-9.34	-9.19		-4.10	-3.65	-3.20		0.00	1.00	

MC01 - CH 130.000



DATUM: 122.100

W.A.E. LEVELS										
DESIGN LEVELS	124.92	124.77		124.73	124.69	124.73		124.82	124.72	124.68	124.83
EXISTING LEVELS	124.25	124.25		124.81	124.84	124.87		125.00	125.00	125.00	125.00
CUT / FILL	0.69	0.52		-0.09	-0.16	-0.14		-0.18	-0.28	-0.32	-0.17
OFFSET	-9.35	-9.20		-4.10	-3.65	-3.20		0.00	3.20	3.65	3.80

MC01 - CH 140.000

1:200 2 0 2 4 6 8 10 A1
1:400 A3
HORIZONTAL

1:100 1 0 1 2 3 4 5 A1
1:200 A3
VERTICAL

REV	DESCRIPTION	DRAWN	APP'D	DATE
C	ISSUED FOR APPROVAL	CPO	IAH	14.02.20
B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

DRAWN:	CPO
DESIGNED:	GLE
VERIFIED:	IAH 01.06.18
APPROVED FOR TENDER:	RET 04.03.19
APPROVED FOR CONSTRUCTION:	

JACKSON TEECE Architecture

ARCHITECT/CLIENT

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

MC01 - ROAD CROSS SECTIONS - SHEET 3 OF 4

TITLE

38509-CI-405-01.dwg

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
AS SHOWN	38509	CI-405-03	C

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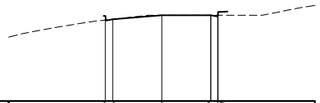
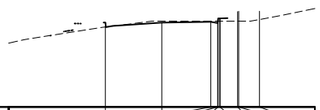


DATUM: 122.600

W.A.E. LEVELS									
DESIGN LEVELS		125.38	125.27		125.40	125.40	125.36	125.51	
EXISTING LEVELS		125.24	125.27		125.40	125.40	125.40	125.40	125.72
CUT / FILL		0.14	0.00		0.00	0.00	-0.04	0.11	
OFFSET		-3.68	-3.20		0.00	3.20	3.65	3.68	10.00

MC01 - CH 156.675



DATUM: 122.600

W.A.E. LEVELS											
DESIGN LEVELS		125.36		125.35	125.38	125.34	125.49	125.49			
EXISTING LEVELS		125.21		125.40	125.40	125.40	125.40	125.40	125.40	125.40	125.45
CUT / FILL		0.14		-0.05	-0.02	-0.06	0.09	0.09			
OFFSET		-3.68		0.00	3.20	3.65	3.68	3.80	4.95	5.02	6.38

MC01 - CH 155.000

1:200 2 0 2 4 6 8 10 A1
1:400 A3
HORIZONTAL

1:100 1 0 1 2 3 4 5 A1
1:200 A3
VERTICAL

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C	ISSUED FOR APPROVAL	CPO	IAH	14.02.20
B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

	CPO
	GLE
	IAH 01.06.18
	RET 04.03.19
	... ../../..

JACKSON TEECE
Architecturs

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

MC01 - ROAD CROSS SECTIONS - SHEET 4 OF 4

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

AS SHOWN | 38509 | CI-405-04 | C

38509-CI-405-01.dwg

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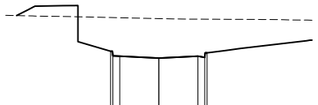
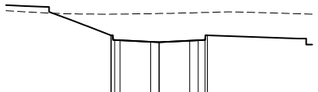


DATUM: 123.000

W.A.E. LEVELS								
DESIGN LEVELS		125.28	125.13	125.12	125.06	125.12	125.08	125.23
EXISTING LEVELS		126.39	126.38	126.38	126.35	126.33	126.33	126.33
CUT / FILL		-1.10	-1.25	-1.26	-1.29	-1.21	-1.25	-1.10
OFFSET		-3.15	-3.00	-2.55	0.00	2.55	3.00	3.15

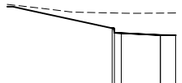
MC02 - CH 13.750



DATUM: 123.800

W.A.E. LEVELS												
DESIGN LEVELS		126.18	126.18	126.03	126.02	125.97	125.96	126.01	126.02	126.03	126.18	
EXISTING LEVELS		126.87	126.87	126.87	126.87	126.88	126.89	126.91	126.92	126.93	126.93	
CUT / FILL		-0.69	-0.69	-0.84	-0.85	-0.92	-0.94	-0.91	-0.90	-0.90	-0.75	
OFFSET		-3.15	-3.12	-2.90	-2.55	-0.55	0.00	2.00	2.55	3.00	3.15	

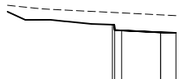
MC02 - CH 23.163



DATUM: 124.400

W.A.E. LEVELS						
DESIGN LEVELS		126.72	126.57	126.56	126.49	126.49
EXISTING LEVELS		127.22	127.21	127.21	127.21	127.22
CUT / FILL		-0.50	-0.65	-0.65	-0.72	-0.73
OFFSET		-3.15	-3.00	-2.55	0.00	1.00

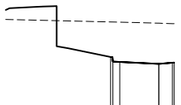
MC02 - CH 28.823



DATUM: 125.000

W.A.E. LEVELS						
DESIGN LEVELS		127.30	127.13	127.11	127.05	127.04
EXISTING LEVELS		127.70	127.70	127.69	127.62	127.60
CUT / FILL		-0.40	-0.57	-0.57	-0.57	-0.56
OFFSET		-3.15	-3.00	-2.55	0.00	1.00

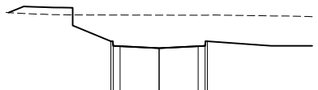
MC02 - CH 35.000



DATUM: 122.700

W.A.E. LEVELS							
DESIGN LEVELS		124.95	124.80	124.79	124.73	124.77	124.77
EXISTING LEVELS		126.10	126.10	126.09	126.06	126.04	126.04
CUT / FILL		-1.15	-1.29	-1.30	-1.33	-1.28	-1.27
OFFSET		-3.15	-3.00	-2.55	0.00	0.89	1.00

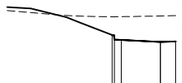
MC02 - CH 10.000



DATUM: 123.600

W.A.E. LEVELS									
DESIGN LEVELS		125.88	125.73	125.72	125.65	125.72	125.73	125.88	
EXISTING LEVELS		126.73	126.73	126.74	126.73	126.73	126.73	126.73	
CUT / FILL		-0.86	-1.01	-1.02	-1.08	-1.01	-1.00	-0.85	
OFFSET		-3.15	-3.00	-2.55	0.00	2.55	3.00	3.15	

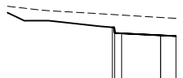
MC02 - CH 20.000



DATUM: 124.100

W.A.E. LEVELS						
DESIGN LEVELS		126.35	126.20	126.19	126.13	126.15
EXISTING LEVELS		126.95	126.95	126.95	126.98	126.99
CUT / FILL		-0.59	-0.74	-0.76	-0.85	-0.84
OFFSET		-3.15	-3.00	-2.55	0.00	1.00

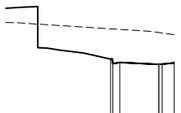
MC02 - CH 25.000



DATUM: 124.900

W.A.E. LEVELS						
DESIGN LEVELS		127.24	127.06	127.05	126.98	126.96
EXISTING LEVELS		127.66	127.66	127.64	127.56	127.54
CUT / FILL		-0.42	-0.60	-0.60	-0.58	-0.58
OFFSET		-3.15	-3.00	-2.55	0.00	1.00

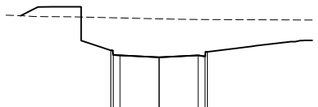
MC02 - CH 34.119



DATUM: 122.600

W.A.E. LEVELS							
DESIGN LEVELS		124.81	124.66	124.70	124.64	124.65	124.69
EXISTING LEVELS		125.80	125.80	125.78	125.68	125.67	125.61
CUT / FILL		-0.99	-1.13	-1.08	-1.04	-1.02	-0.92
OFFSET		-3.15	-3.00	-2.55	0.00	0.21	1.00

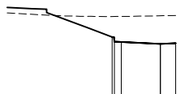
MC02 - CH 08.223



DATUM: 123.100

W.A.E. LEVELS									
DESIGN LEVELS		125.40	125.25	125.24	125.18	125.24	125.20	125.35	
EXISTING LEVELS		126.47	126.47	126.46	126.43	126.41	126.41	126.41	
CUT / FILL		-1.07	-1.21	-1.22	-1.26	-1.17	-1.21	-1.06	
OFFSET		-3.15	-3.00	-2.55	0.00	2.55	3.00	3.15	

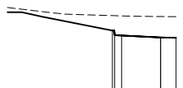
MC02 - CH 15.000



DATUM: 123.900

W.A.E. LEVELS						
DESIGN LEVELS		126.21	126.06	126.05	125.99	126.01
EXISTING LEVELS		126.88	126.89	126.89	126.91	126.92
CUT / FILL		-0.67	-0.82	-0.83	-0.92	-0.90
OFFSET		-3.15	-3.00	-2.55	0.00	1.00

MC02 - CH 23.527



DATUM: 124.500

W.A.E. LEVELS						
DESIGN LEVELS		126.83	126.68	126.67	126.61	126.60
EXISTING LEVELS		127.32	127.32	127.31	127.29	127.29
CUT / FILL		-0.49	-0.64	-0.64	-0.68	-0.69
OFFSET		-3.15	-3.00	-2.55	0.00	1.00

MC02 - CH 30.000

1:200 2 0 2 4 6 8 10 A1
1:400 A3

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C	ISSUED FOR APPROVAL	CPO	IAH	14.02.20
B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

	CPO
	GLE
	IAH 01.06.18
	RET 04.03.19
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JACKSON TEECE
Architecture

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

MC02 - ROAD CROSS SCETIONS - SHEET 1 OF 5

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

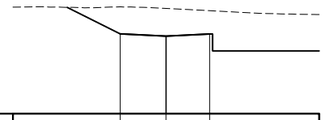
AS SHOWN | 38509 | CI-405-11 | C

38509-CI-405-11.dwg 14/02/2020 12:40:03 PM

DATUM: 125.300

W.A.E. LEVELS								
DESIGN LEVELS	127.46	127.44	127.42	127.36	127.35	127.34	127.33	127.32
EXISTING LEVELS	127.99	128.00	128.00	128.06	128.06	128.06	128.07	128.07
CUT / FILL	-0.53	-0.56	-0.58	-0.70	-0.71	-0.72	-0.74	-0.75
OFFSET	-3.15	-3.00	-2.55	0.00	0.24	0.44	0.87	1.00

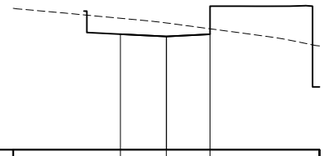
MC02 - CH 40.664



DATUM: 125.000

W.A.E. LEVELS			
DESIGN LEVELS	127.61	127.53	127.60
EXISTING LEVELS	128.49	128.44	128.36
CUT / FILL	-0.88	-0.90	-0.76
OFFSET	-3.00	0.00	2.85

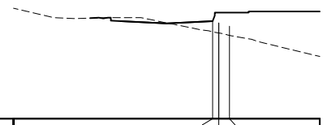
MC02 - CH 46.125



DATUM: 125.000

W.A.E. LEVELS			
DESIGN LEVELS	128.77	128.70	128.77
EXISTING LEVELS	129.29	129.14	128.95
CUT / FILL	-0.52	-0.44	-0.18
OFFSET	-3.00	0.00	2.85

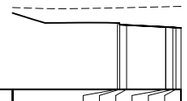
MC02 - CH 57.297



DATUM: 126.500

W.A.E. LEVELS			
DESIGN LEVELS	129.69		
EXISTING LEVELS	129.34	129.30	129.22
CUT / FILL	0.35		
OFFSET	3.00	3.40	4.10

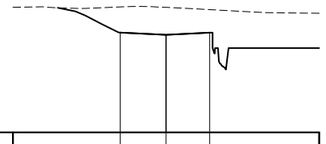
MC02 - CH 68.470



DATUM: 125.300

W.A.E. LEVELS								
DESIGN LEVELS	127.46	127.41	127.40	127.34	127.32	127.31	127.30
EXISTING LEVELS	127.96	127.96	127.97	128.00	128.00	128.00	128.01
CUT / FILL	-0.50	-0.55	-0.57	-0.66	-0.68	-0.69	-0.71
OFFSET	-3.15	-3.00	-2.55	0.00	0.47	0.67	1.00

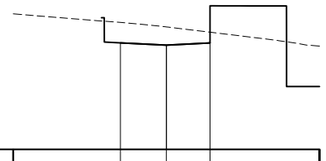
MC02 - CH 40.000



DATUM: 124.300

W.A.E. LEVELS				
DESIGN LEVELS	127.56	127.48	127.55	
EXISTING LEVELS	128.39	128.38	128.31	
CUT / FILL	-0.84	-0.90	-0.75	
OFFSET	-3.00	0.00	2.85	

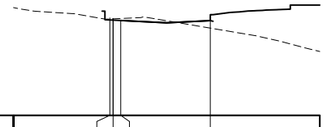
MC02 - CH 45.000



DATUM: 125.000

W.A.E. LEVELS				
DESIGN LEVELS	128.48	128.40	128.47	
EXISTING LEVELS	129.14	129.00	128.82	
CUT / FILL	-0.67	-0.60	-0.35	
OFFSET	-3.00	0.00	2.85	

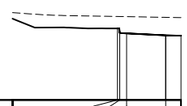
MC02 - CH 55.000



DATUM: 126.400

W.A.E. LEVELS					
DESIGN LEVELS			129.50	129.49	
EXISTING LEVELS	129.54	129.55	129.56	129.25	
CUT / FILL			-0.07	0.24	
OFFSET	-3.71	-3.50	-3.00	2.85	

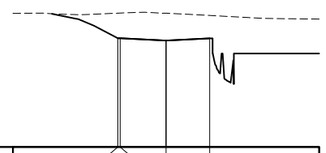
MC02 - CH 65.000



DATUM: 125.100

W.A.E. LEVELS					
DESIGN LEVELS	127.43	127.28	127.27	127.21	127.20
EXISTING LEVELS	127.82	127.82	127.82	127.80	127.79
CUT / FILL	-0.39	-0.54	-0.55	-0.59	-0.59
OFFSET	-3.15	-3.00	-2.55	0.00	1.00

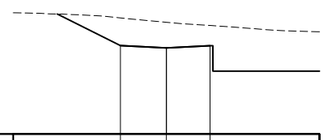
MC02 - CH 37.391



DATUM: 124.000

W.A.E. LEVELS				
DESIGN LEVELS	127.55	127.55	127.47	127.54
EXISTING LEVELS	128.37	128.37	128.37	128.29
CUT / FILL	-0.82	-0.82	-0.89	-0.75
OFFSET	-3.15	-3.00	0.00	2.85

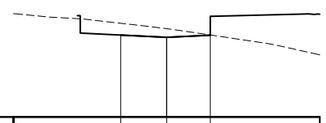
MC02 - CH 44.739



DATUM: 125.000

W.A.E. LEVELS			
DESIGN LEVELS	127.88	127.81	127.88
EXISTING LEVELS	128.79	128.65	128.54
CUT / FILL	-0.90	-0.84	-0.66
OFFSET	-3.00	0.00	2.85

MC02 - CH 50.000



DATUM: 126.400

W.A.E. LEVELS			
DESIGN LEVELS	129.07	129.00	129.07
EXISTING LEVELS	129.46	129.28	129.08
CUT / FILL	-0.38	-0.28	-0.01
OFFSET	-3.00	0.00	2.85

MC02 - CH 60.000

1:200 2 0 2 4 6 8 10 A1
1:400 A3

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C	ISSUED FOR APPROVAL	CPO	IAH	14.02.20
B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

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	IAH 01.06.18
	RET 04.03.19
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JACKSON TEECE
Architecture

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

MC02 - ROAD CROSS SCETIONS - SHEET 2 OF 5

38509-CI-405-11.dwg

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

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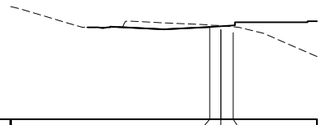
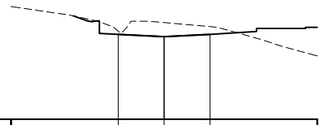


DATUM: 126.800

W.A.E. LEVELS			
DESIGN LEVELS	129.81		
EXISTING LEVELS	129.87	129.85	129.82
CUT / FILL	-0.06		
OFFSET	3.00	3.73	4.53

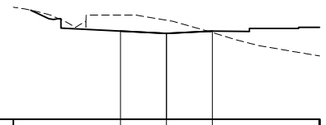
MC02 - CH 76.139



DATUM: 127.000

W.A.E. LEVELS			
DESIGN LEVELS	129.77	129.70	129.77
EXISTING LEVELS	129.88	130.16	130.02
CUT / FILL	-0.11	-0.46	-0.25
OFFSET	-3.00	0.00	3.00

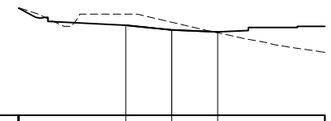
MC02 - CH 85.000



DATUM: 127.000

W.A.E. LEVELS			
DESIGN LEVELS	129.88	129.80	129.88
EXISTING LEVELS	130.40	130.23	129.83
CUT / FILL	-0.52	-0.43	0.04
OFFSET	-3.00	0.00	3.00

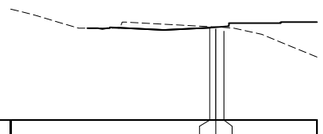
MC02 - CH 95.000



DATUM: 127.100

W.A.E. LEVELS			
DESIGN LEVELS	130.04	129.88	129.82
EXISTING LEVELS	130.40	130.14	129.79
CUT / FILL	-0.36	-0.25	0.03
OFFSET	-3.00	0.00	3.00

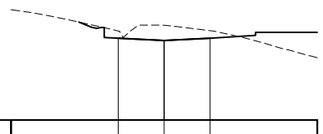
MC02 - CH 100.183



DATUM: 126.800

W.A.E. LEVELS			
DESIGN LEVELS	129.82		
EXISTING LEVELS	129.85	129.84	129.82
CUT / FILL	-0.04		
OFFSET	3.00	3.39	3.92

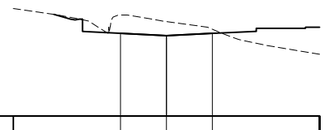
MC02 - CH 75.000



DATUM: 127.100

W.A.E. LEVELS			
DESIGN LEVELS	129.77	129.70	129.77
EXISTING LEVELS	130.01	130.20	130.02
CUT / FILL	-0.24	-0.50	-0.25
OFFSET	-3.00	0.00	3.00

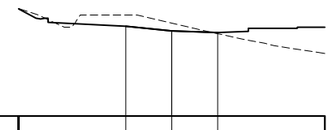
MC02 - CH 83.049



DATUM: 127.100

W.A.E. LEVELS			
DESIGN LEVELS	129.80	129.73	129.80
EXISTING LEVELS	130.40	130.18	129.94
CUT / FILL	-0.60	-0.46	-0.13
OFFSET	-3.00	0.00	3.00

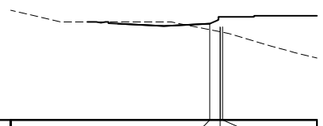
MC02 - CH 90.000



DATUM: 127.100

W.A.E. LEVELS			
DESIGN LEVELS	130.03	129.88	129.83
EXISTING LEVELS	130.40	130.13	129.79
CUT / FILL	-0.37	-0.25	0.04
OFFSET	-3.00	0.00	3.00

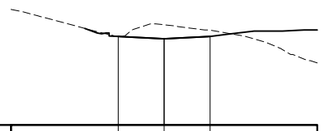
MC02 - CH 100.000



DATUM: 126.600

W.A.E. LEVELS			
DESIGN LEVELS	129.74		
EXISTING LEVELS	129.55	129.48	129.46
CUT / FILL	0.20		
OFFSET	3.00	3.68	3.84

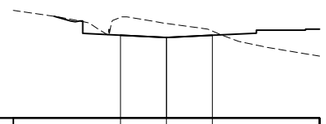
MC02 - CH 70.000



DATUM: 126.900

W.A.E. LEVELS			
DESIGN LEVELS	129.79	129.71	129.79
EXISTING LEVELS	129.80	130.17	130.00
CUT / FILL	-0.01	-0.46	-0.21
OFFSET	-3.00	0.00	3.00

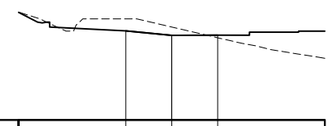
MC02 - CH 80.000



DATUM: 127.100

W.A.E. LEVELS			
DESIGN LEVELS	129.80	129.73	129.80
EXISTING LEVELS	130.38	130.18	129.94
CUT / FILL	-0.58	-0.46	-0.14
OFFSET	-3.00	0.00	3.00

MC02 - CH 89.959



DATUM: 127.100

W.A.E. LEVELS			
DESIGN LEVELS	130.01	129.86	129.87
EXISTING LEVELS	130.40	130.13	129.78
CUT / FILL	-0.39	-0.27	0.09
OFFSET	-3.00	0.00	3.00

MC02 - CH 98.834

1:200 2 0 2 4 6 8 10 A1
1:400 A3

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C	ISSUED FOR APPROVAL	CPO	IAH	14.02.20
B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

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JACKSON TEECE
Architecture

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

MC02 - ROAD CROSS SCETIONS - SHEET 3 OF 5

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

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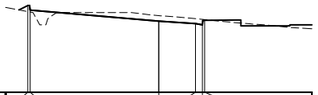


DATUM: 127.800

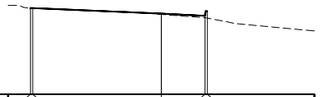
W.A.E. LEVELS							
DESIGN LEVELS	130.63	130.48	130.12	130.04	130.00	130.15	
EXISTING LEVELS	130.43	130.42	130.30	130.20	130.18	130.17	
CUT / FILL	0.20	0.06	-0.18	-0.16	-0.18	-0.02	
OFFSET	-8.55	-8.40	0.00	2.40	2.85	3.00	

MC02 - CH 110.000

DATUM: 128.100

W.A.E. LEVELS							
DESIGN LEVELS	130.64	130.49	130.41	130.39	~~130.32~~		
EXISTING LEVELS	130.20	130.20	130.44	130.43	~~130.42~~		
CUT / FILL	0.44	0.29	-0.04	-0.05	~~-0.10~~		
OFFSET	-8.55	-8.40	0.00	0.33	~~1.00~~		

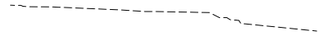
MC02 - CH 120.000



DATUM: 127.900

W.A.E. LEVELS							
DESIGN LEVELS	130.71	130.71	130.53	130.46	130.61		
EXISTING LEVELS	130.71	130.71	130.51	130.40	130.38		
CUT / FILL	0.00	0.00	0.03	0.06	0.23		
OFFSET	-8.55	-8.40	0.00	2.85	3.00		

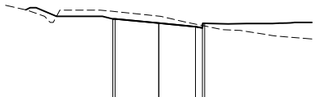
MC02 - CH 130.000



DATUM: 127.900

W.A.E. LEVELS	
DESIGN LEVELS	
EXISTING LEVELS	
CUT / FILL	
OFFSET	

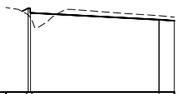
MC02 - CH 134.293



DATUM: 127.400

W.A.E. LEVELS							
DESIGN LEVELS	130.11	130.11	129.98	129.86	129.82	129.97	
EXISTING LEVELS	130.36	130.35	130.21	129.94	129.90	129.88	
CUT / FILL	-0.25	-0.24	-0.23	-0.08	-0.08	0.09	
OFFSET	-3.00	-2.85	0.00	2.40	2.85	3.00	

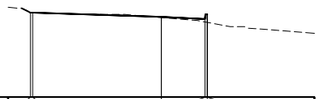
MC02 - CH 105.000



DATUM: 127.900

W.A.E. LEVELS					
DESIGN LEVELS	130.64	130.49	130.26	130.23	
EXISTING LEVELS	130.42	130.32	130.39	130.35	
CUT / FILL	0.22	0.17	-0.13	-0.12	
OFFSET	-8.55	-8.40	0.00	1.00	

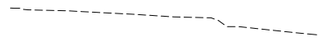
MC02 - CH 115.000



DATUM: 127.900

W.A.E. LEVELS							
DESIGN LEVELS	130.66	130.66	130.52	130.45	130.60	130.60	
EXISTING LEVELS	130.67	130.66	130.50	130.35	130.34	130.34	
CUT / FILL	-0.01	0.00	0.02	0.10	0.26	0.26	
OFFSET	-8.55	-8.40	0.00	2.85	3.00	3.00	

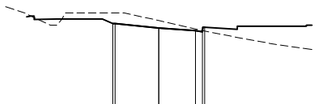
MC02 - CH 128.556



DATUM: 127.900

W.A.E. LEVELS	
DESIGN LEVELS	
EXISTING LEVELS	
CUT / FILL	
OFFSET	

MC02 - CH 132.382



DATUM: 127.200

W.A.E. LEVELS							
DESIGN LEVELS	130.05	130.05	129.91	129.82	129.78	129.93	
EXISTING LEVELS	130.40	130.40	130.15	129.87	129.82	129.81	
CUT / FILL	-0.35	-0.35	-0.25	-0.05	-0.04	0.13	
OFFSET	-3.00	-2.85	0.00	2.40	2.85	3.00	

MC02 - CH 101.531

DATUM: 127.900

W.A.E. LEVELS								
DESIGN LEVELS	130.63	130.63	130.48	130.47	130.17	130.09	130.05	130.20
EXISTING LEVELS	130.43	130.43	130.41	130.18	130.40	130.28	130.25	130.24
CUT / FILL	0.20	0.20	0.07	0.29	-0.23	-0.19	-0.20	-0.03
OFFSET	-8.55	-8.55	-8.40	-8.07	0.00	2.40	2.85	3.00

MC02 - CH 111.756

DATUM: 128.400

W.A.E. LEVELS								
DESIGN LEVELS	130.53	130.53	130.49	130.47	130.46	130.44		
EXISTING LEVELS	130.50	130.51	130.49	130.47	130.46	130.45		
CUT / FILL	0.03	0.03	0.00	0.00	0.00	-0.01		
OFFSET	-8.55	-8.40	0.00	0.32	0.54	1.00		

MC02 - CH 125.000

DATUM: 127.900

W.A.E. LEVELS	
DESIGN LEVELS	
EXISTING LEVELS	
CUT / FILL	
OFFSET	

MC02 - CH 130.470

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A	ISSUED FOR TENDER	CPO	RET	05.03.19

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JACKSON TEECE
Architecture

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

MC02 - ROAD CROSS SCETIONS - SHEET 4 OF 5

WOOD & GRIEVE ENGINEERS

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DATUM: 127.900

W.A.E. LEVELS	
DESIGN LEVELS	
EXISTING LEVELS	
CUT / FILL	
OFFSET	

MC02 - CH 135.440

DATUM: 127.900

W.A.E. LEVELS	
DESIGN LEVELS	
EXISTING LEVELS	
CUT / FILL	
OFFSET	

MC02 - CH 135.000

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1:400 A3

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B	ISSUED FOR TENDER	CPO	RET	11.03.19
A	ISSUED FOR TENDER	CPO	RET	05.03.19

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JACKSON TEECE
Architecture

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

MC02 - ROAD CROSS SCETIONS - SHEET 5 OF 5

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

AS SHOWN	38509	CI-405-15	C

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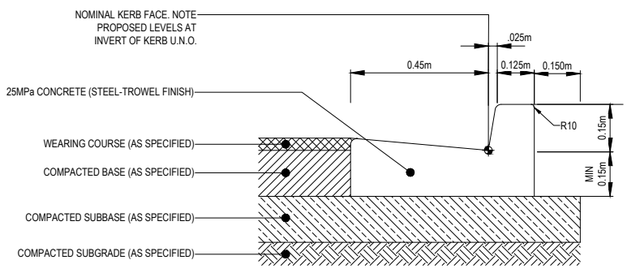

KERB AND GUTTER (K&G-1)

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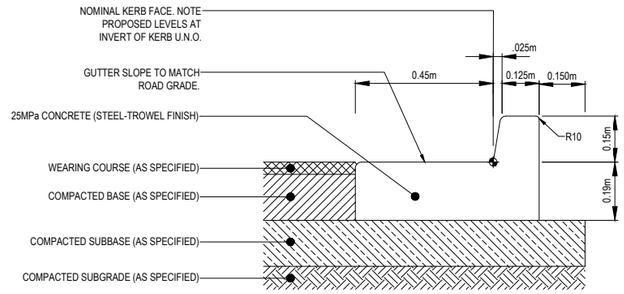

KERB AND GUTTER (K&G-2)

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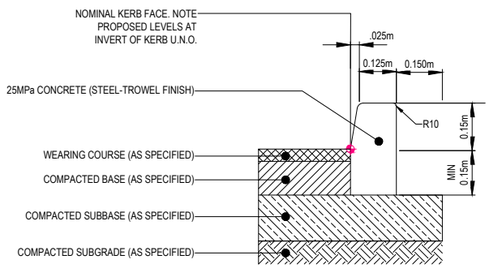

KERB ONLY (KO)

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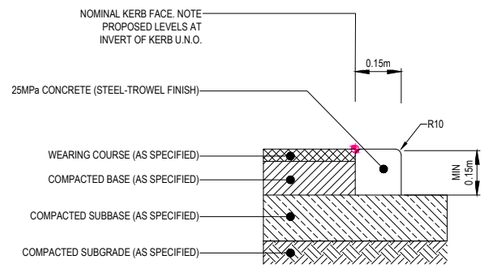
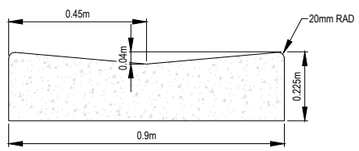


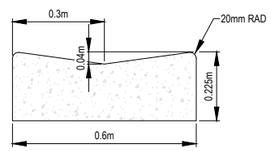
FLUSH KERB (FK)

(SCALE 1:10)



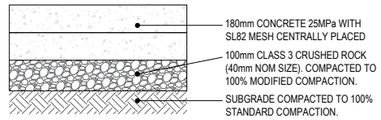
DISH DRAIN DETAIL (DD-1)

(SCALE 1:10)



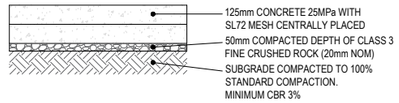
DISH DRAIN DETAIL (DD-2)

(SCALE 1:10)



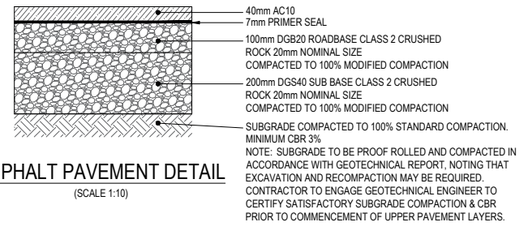
CONCRETE PAVEMENT DETAIL

(SCALE 1:10)



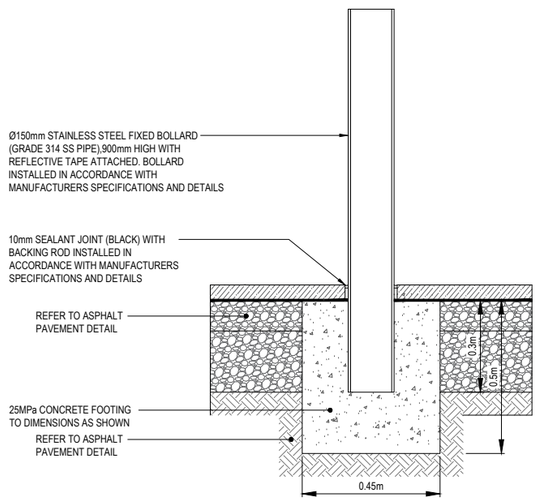
CONCRETE FOOTPATH DETAIL

(SCALE 1:10)



ASPHALT PAVEMENT DETAIL

(SCALE 1:10)



TYPICAL BOLLARD DETAIL

(SCALE 1:10)

1:10 0.1 0 0.1 0.2 0.3 0.4 0.5 A1
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JACKSON TEECE Architecture

ARCHITECT/CLIENT

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

ROADS DETAILS

TITLE

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
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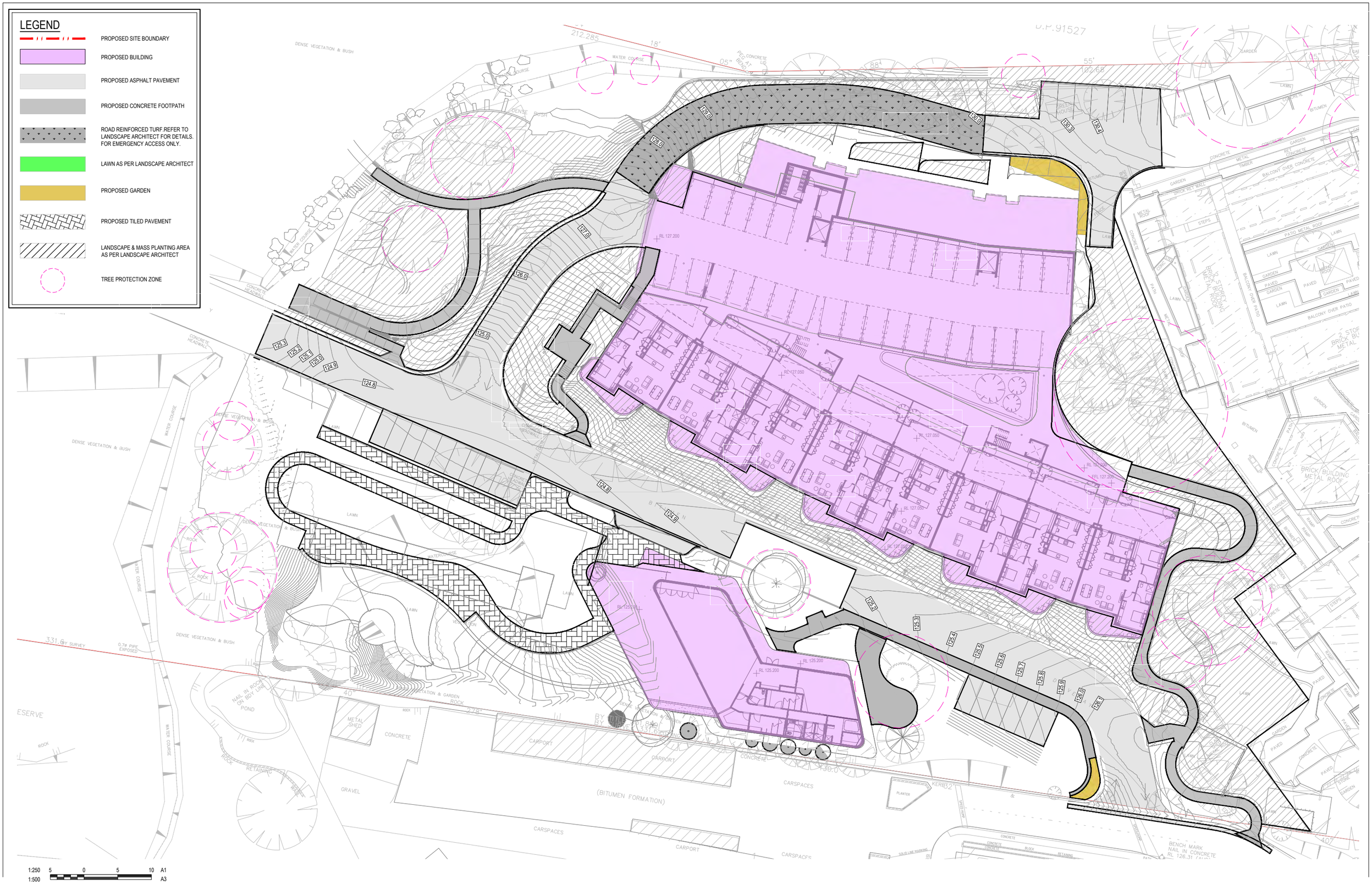

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JACKSON TEECE Architecture

ARCHITECT/CLIENT

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

PAVEMENT PLAN

TITLE

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WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
AS SHOWN	38509	CI-440-01	C

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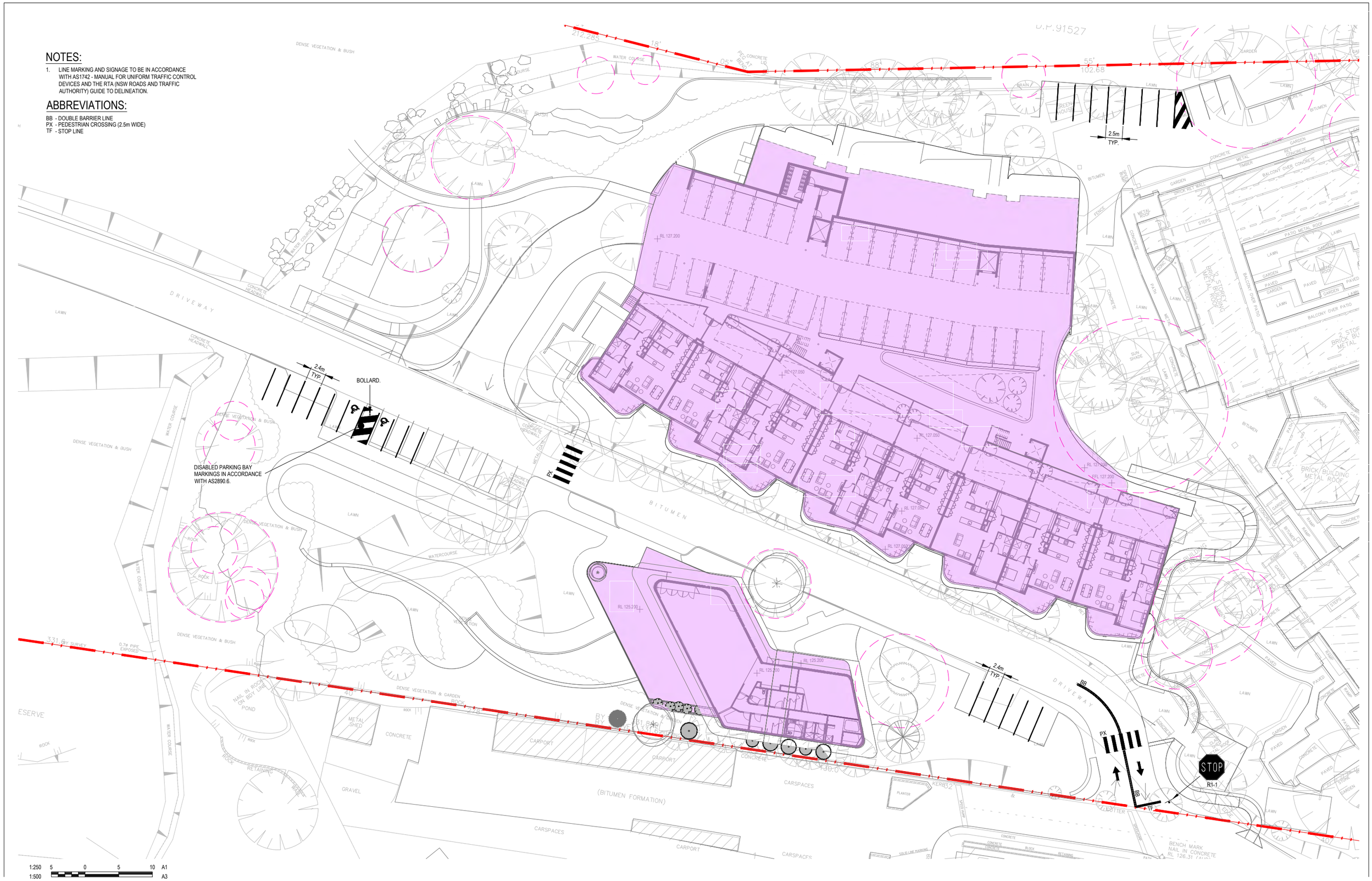
NOTES:

1. LINE MARKING AND SIGNAGE TO BE IN ACCORDANCE WITH AS1742 - MANUAL FOR UNIFORM TRAFFIC CONTROL DEVICES AND THE RTA (NSW ROADS AND TRAFFIC AUTHORITY) GUIDE TO DELINEATION.

ABBREVIATIONS:

BB - DOUBLE BARRIER LINE
PX - PEDESTRIAN CROSSING (2.5m WIDE)
TF - STOP LINE



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JACKSON TEECE Architecture

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181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

SIGNAGE & LINEMARKING PLAN

TITLE

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
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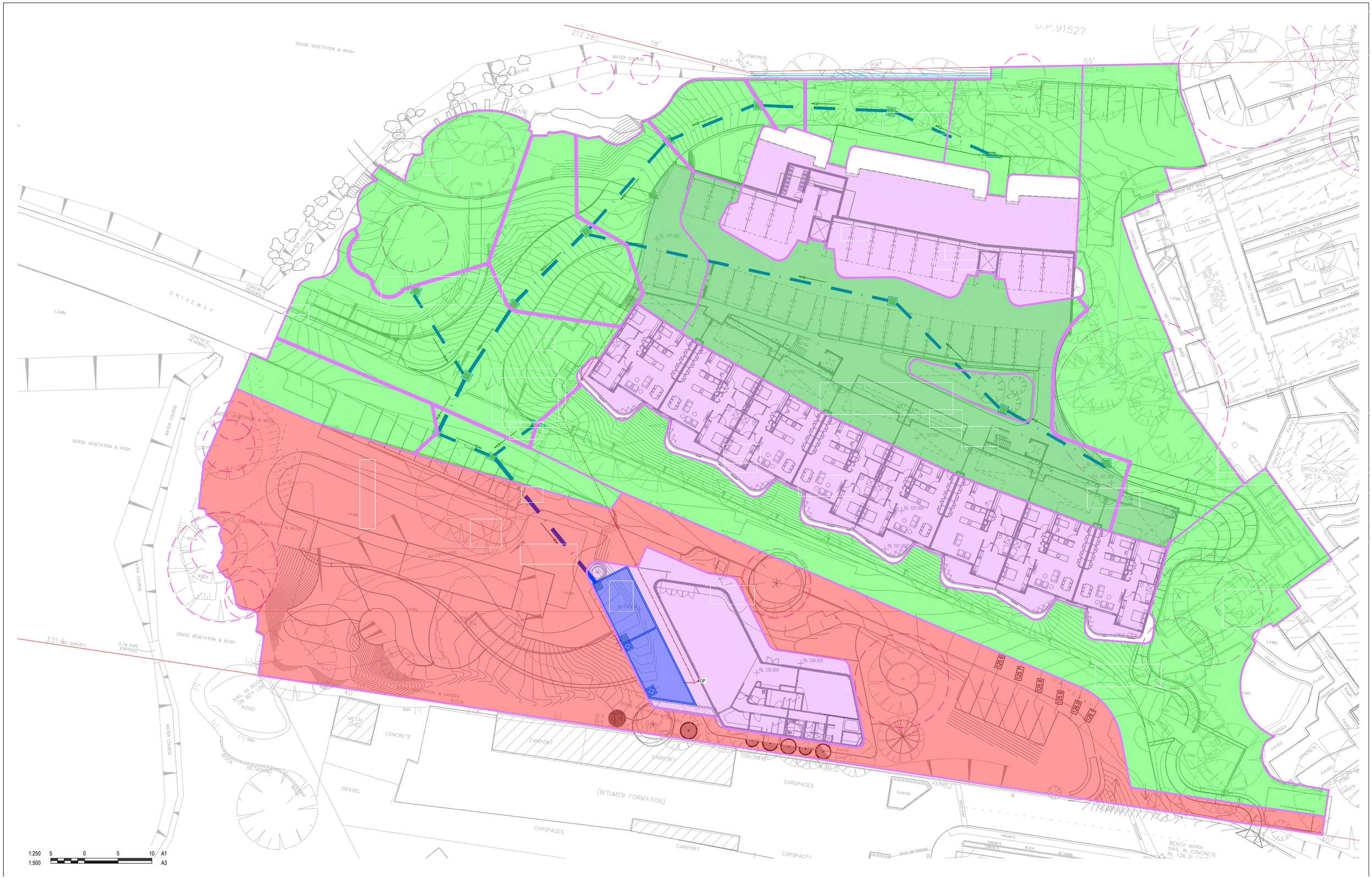

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A	ISSUED FOR TENDER	CPO	RET	05.03.19

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JACKSON TEECE Architectures

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181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

STORMWATER DRAINAGE
CATCHMENT PLAN

TITLE

WOOD & GRIEVE ENGINEERS

FOR APPROVAL

NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
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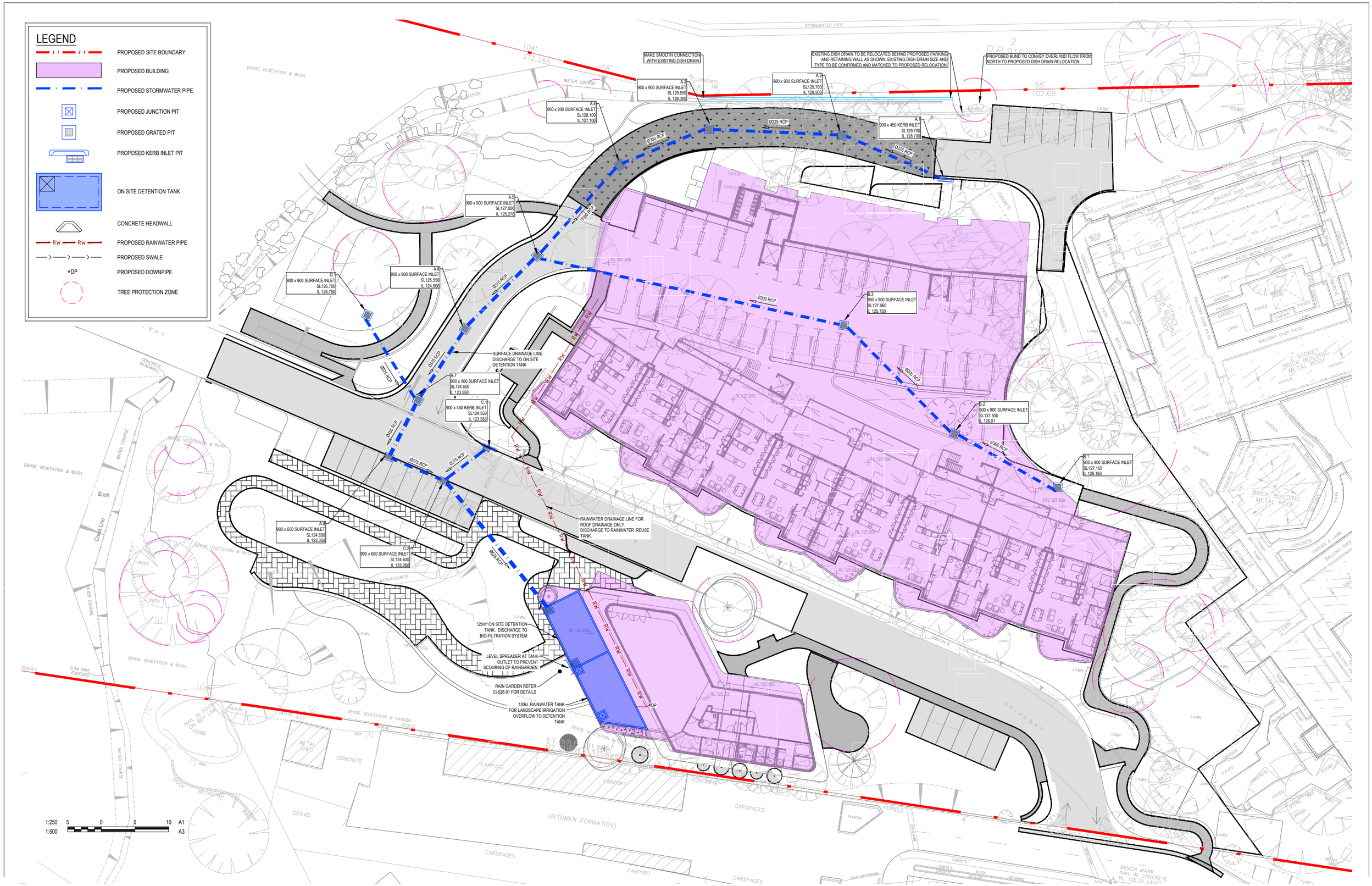

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B	ISSUED FOR TENDER	CPO	RET	05.03.19
A	ISSUED FOR DA APPROVAL	CPO	IAH	01.06.18

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APPROVED FOR TENDER:	RET 04.03.19
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JACKSON TEECE Architecture

ARCHITECT/CLIENT

181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

STORMWATER MANAGEMENT PLAN

TITLE

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WOOD & GRIEVE ENGINEERS

FOR APPROVAL

NOT FOR CONSTRUCTION

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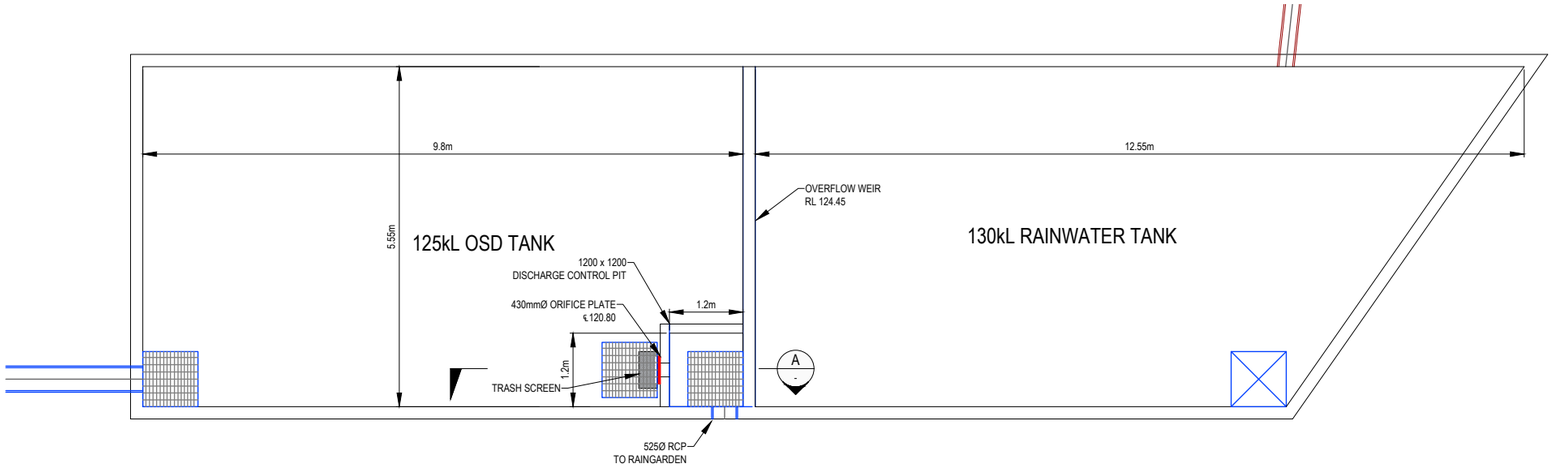
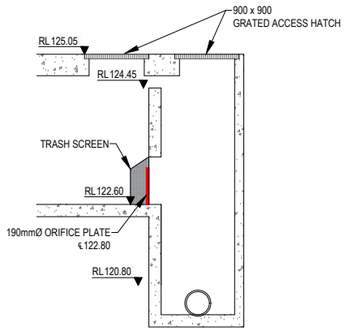


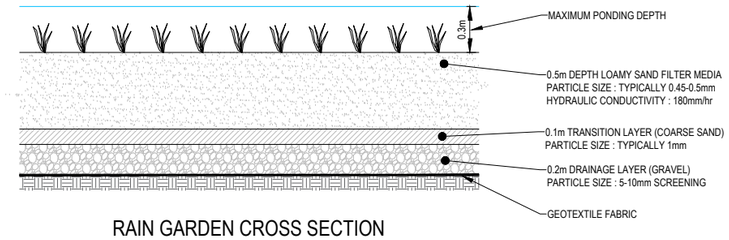
ON SITE DETENTION & RAINWATER TANK PLAN

SCALE 1:50



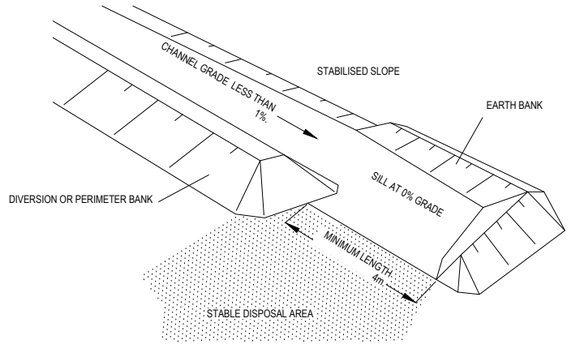
ON SITE DETENTION DISCHARGE CONTROL PIT SECTION

SCALE 1:50



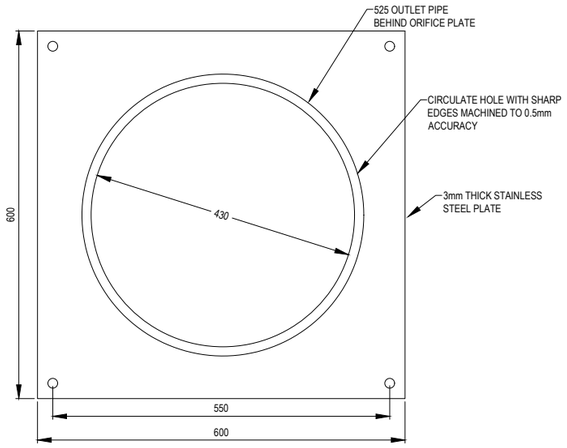
RAIN GARDEN CROSS SECTION

SCALE 1:20



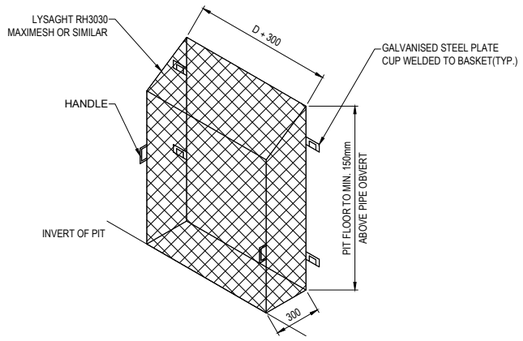
LEVEL SPREADER (OR SILL)

N.T.S



ORIFICE PLATE DETAIL

SCALE 1:5



SCREEN MESH DETAIL

N.T.S.

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1:10 A3

1:50 1 0.5 0 1 2 A1
1:100 A3

1:100 1 0 1 2 3 4 5 A1
1:200 A3

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JACKSON TEECE
Architecture

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181 ALLAMBIE ROAD
ALLAMBIE HEIGHTS
NSW

PROJECT

STORMWATER MANAGEMENT
DETAILS

TITLE

WOOD & GRIEVE ENGINEERS

FOR APPROVAL
NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
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Appendix B – DRAINS Output

Appendix B – DRAINS Output

5 Year Model Output

DRAINS results prepared from Version 2018.01

PIT / NODE DETAILS Version 8

Name	Max HGL	HGL	Max Pond Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Max Surface Freeboard (m)	Max Pond (cu.m/s)	Min Overflow	Constraint
A.1	125.99	127.22	0.004	0.1	1.21	0.000	Inlet Capacity	
A.2	125.73	127.22	0.004	0.1	1.47	0.000	Inlet Capacity	
A.3	125.52		0.002		1.32	0.000	None	
A.4	124.64		0.004		1.19	0.000	None	
A.5	124.13		0.004		1.17	0.000	None	
A.6	123.46	124.56	0.004	0.2	1.08	0.000	Inlet Capacity	
Roof	124.86		0.163					
RWT	124.57		0.000					
B.1	124.16	125.04	0.032	0.5	0.84	0.000	Inlet Capacity	

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm	
PreDev Catchment		0.328	0.045	0.292	5.00	8.00	8.00	AR&R 5 year, 2 hours storm, average 35.5 mm/h, Zone 1
A.1 Catch		0.004	0.004	0.000	5.00	6.00	6.00	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
A.2 Catch		0.004	0.004	0.000	5.00	6.00	6.00	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
A.3 Catch		0.002	0.002	0.000	5.00	6.00	6.00	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
A.4 Catch		0.004	0.004	0.000	5.00	6.00	6.00	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
A.5 Catch		0.004	0.004	0.000	5.00	6.00	6.00	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
A.6 Catch		0.004	0.004	0.000	5.00	6.00	6.00	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
Roof Catch		0.163	0.163	0.000	5.00	6.00	6.00	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
Bypass Catch		0.168	0.045	0.131	5.00	8.00	8.00	AR&R 5 year, 2 hours storm, average 35.5 mm/h, Zone 1
B.1 Catch		0.032	0.000	0.032	5.00	8.00	8.00	AR&R 5 year, 2 hours storm, average 35.5 mm/h, Zone 1

Outflow Volumes for Total Catchment (0.63 impervious + 1.48 pervious = 2.11 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 5 year, 5 minutes storm, average 162 mm/h, Zone 1	285.12	116.50 (40.9%)	78.88 (92.6%)	37.62 (18.8%)
AR&R 5 year, 10 minutes storm, average 126 mm/h, Zone 1	443.52	230.73 (52.0%)	126.20 (95.2%)	104.53 (33.6%)
AR&R 5 year, 15 minutes storm, average 107 mm/h, Zone 1	564.96	317.95 (56.3%)	162.48 (96.3%)	155.47 (39.2%)

Appendix B – DRAINS Output

AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1	661.76	386.06 (58.3%)	191.40 (96.8%)	194.65 (41.9%)
AR&R 5 year, 30 minutes storm, average 77.0 mm/h, Zone 1	813.12	469.34 (57.7%)	236.63 (97.4%)	232.72 (40.8%)
AR&R 5 year, 45 minutes storm, average 62.0 mm/h, Zone 1	982.08	573.00 (58.3%)	287.11 (97.8%)	285.90 (41.5%)
AR&R 5 year, 1 hour storm, average 54.0 mm/h, Zone 1	1140.48	672.96 (59.0%)	334.43 (98.1%)	338.53 (42.3%)
AR&R 5 year, 1.5 hours storm, average 42.2 mm/h, Zone 1	1336.90	772.76 (57.8%)	393.11 (98.4%)	379.64 (40.5%)
AR&R 5 year, 2 hours storm, average 35.5 mm/h, Zone 1	1499.52	861.59 (57.5%)	441.70 (98.6%)	419.89 (39.9%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
1.000	0.004	0.71	125.972	125.729	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
1.001	0.009	1.42	125.702	125.515	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
1.002	0.011	1.51	125.482	124.640	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
1.003	0.015	1.72	124.600	124.127	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
1.004	0.019	1.78	124.082	123.459	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
1.005	0.055	0.96	123.439	123.443	AR&R 5 year, 1.5 hours storm, average 42.2 mm/h, Zone 1
1.006	0.110	2.76	121.387	121.205	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
2.000	0.164	2.32	124.864	124.573	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
2.001	0.164	2.36	124.573	124.286	AR&R 5 year, 20 minutes storm, average 94.0 mm/h, Zone 1
3.000	0.032	2.33	124.093	123.459	AR&R 5 year, 2 hours storm, average 35.5 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S		Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF2	0	0	-999.0000		0	0	0		
OF5	0	0	0.000	0	0	0	0		
OF10	0	0	0.000	0	0	0	0		
OF21	0	0	-0.000	0	0	0	0		
OF27	0	0	0.000	0	0	0	0		
OF32	0	0	0.000	0	0	0	0		
OF36	0	0	0.000	0	0	0	0		
OF35	0	0	0.000	0	0	0	0		
OF39	0.168	0.168	0.000	0.095	0.09	5.03	0.92		AR&R 5 year, 2 hours storm, average 35.5 mm/h, Zone 1
OF41	0	0	0.000	0	0	0	0		

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
OSD Tank		123.44	38.7	0.110	0.110	0.000
Bio	120.98	0.0	0.000	0.000	0.000

CONTINUITY CHECK for AR&R 5 year, 2 hours storm, average 35.5 mm/h, Zone 1

Node	Inflow	Outflow	Storage Change	Difference

	(cu.m)	(cu.m)	(cu.m)	%	
DS.1	343.38	343.38	0.00	0.0	
A.1	7.00	7.02	0.00	-0.3	
A.2	14.02	14.12	0.00	-0.7	
A.3	17.62	17.57	0.00	0.3	
A.4	24.57	24.59	0.00	-0.1	
A.5	31.59	31.61	0.00	-0.1	
A.6	68.48	68.40	0.00	0.1	
OSD Tank		323.34	323.34	0.00	-0.0
Bio	323.34	323.34	0.00	0.0	
Roof	254.80	254.92	0.00	-0.0	
RWT	254.92	254.94	0.00	-0.0	
N42	195.15	195.15	0.00	0.0	
Bypass	195.15	195.15	0.00	0.0	
B.1	29.77	29.87	0.00	-0.3	

Run Log for 38509 run at 16:34:05 on 30/5/2018
No water upwelling from any pit. Freeboard was adequate at all pits.
The maximum flow in these overflow routes is unsafe: OF39

20 Year Design Output
DRAINS results prepared from Version 2018.01

PIT / NODE DETAILS Version 8

Name	Max HGL	HGL	Max Pond Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Max Surface Freeboard (m)	Max Pond (cu.m/s)	Min	Overflow	Constraint
A.1	126.00	127.22	0.006	0.1	1.20	0.000	Inlet Capacity		
A.2	125.74	127.22	0.006	0.1	1.46	0.000	Inlet Capacity		
A.3	125.53		0.003		1.31	0.000	None		
A.4	124.65		0.006		1.17	0.000	None		
A.5	124.14		0.006		1.16	0.000	None		
A.6	124.07	124.56	0.006	0.3	0.47	0.000	Inlet Capacity		
Roof	125.27		0.214						
RWT	124.78		0.000						
B.1	124.19	125.05	0.046	0.6	0.81	0.000	Inlet Capacity		

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm		
PreDev Catchment			0.463	0.060	0.414	5.00	8.00	8.00	AR&R 20 year, 2 hours storm, average 47.4 mm/h, Zone 1
A.1 Catch		0.006	0.006	0.000	5.00	6.00	6.00		AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
A.2 Catch		0.006	0.006	0.000	5.00	6.00	6.00		AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
A.3 Catch		0.003	0.003	0.000	5.00	6.00	6.00		AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
A.4 Catch		0.006	0.006	0.000	5.00	6.00	6.00		AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
A.5 Catch		0.006	0.006	0.000	5.00	6.00	6.00		AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1

Appendix B – DRAINS Output

A.6 Catch	0.006	0.006	0.000	5.00	6.00	6.00	AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
Roof Catch	0.214	0.214	0.000	5.00	6.00	6.00	AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
Bypass Catch	0.235	0.061	0.186	5.00	8.00	8.00	AR&R 20 year, 2 hours storm, average 47.4 mm/h, Zone 1
B.1 Catch	0.046	0.000	0.046	5.00	8.00	8.00	AR&R 20 year, 2 hours storm, average 47.4 mm/h, Zone 1

Outflow Volumes for Total Catchment (0.63 impervious + 1.48 pervious = 2.11 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 20 year, 5 minutes storm, average 208 mm/h, Zone 1	366.08	195.13 (53.3%)	103.06 (94.2%)	92.07 (35.9%)
AR&R 20 year, 10 minutes storm, average 164 mm/h, Zone 1	577.28	361.57 (62.6%)	166.16 (96.3%)	195.41 (48.3%)
AR&R 20 year, 15 minutes storm, average 139 mm/h, Zone 1	733.92	482.26 (65.7%)	212.96 (97.1%)	269.30 (52.3%)
AR&R 20 year, 20 minutes storm, average 123 mm/h, Zone 1	865.92	585.53 (67.6%)	252.40 (97.6%)	333.13 (54.9%)
AR&R 20 year, 30 minutes storm, average 102 mm/h, Zone 1	1077.12	728.70 (67.7%)	315.50 (98.0%)	413.20 (54.7%)
AR&R 20 year, 45 minutes storm, average 83.0 mm/h, Zone 1	1314.72	896.76 (68.2%)	386.49 (98.4%)	510.27 (55.3%)
AR&R 20 year, 1 hour storm, average 72.0 mm/h, Zone 1	1520.64	1044.01 (68.7%)	448.01 (98.6%)	596.00 (55.9%)
AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1	1774.06	1200.35 (67.7%)	523.73 (98.8%)	676.63 (54.4%)
AR&R 20 year, 2 hours storm, average 47.4 mm/h, Zone 1	2002.21	1349.32 (67.4%)	591.89 (98.9%)	757.43 (53.9%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
1.000	0.006	0.77	125.979	125.741	AR&R 20 year, 20 minutes storm, average 123 mm/h, Zone 1
1.001	0.012	1.52	125.709	125.526	AR&R 20 year, 20 minutes storm, average 123 mm/h, Zone 1
1.002	0.014	1.63	125.488	124.654	AR&R 20 year, 20 minutes storm, average 123 mm/h, Zone 1
1.003	0.019	1.87	124.607	124.143	AR&R 20 year, 20 minutes storm, average 123 mm/h, Zone 1
1.004	0.025	1.92	124.091	124.066	AR&R 20 year, 20 minutes storm, average 123 mm/h, Zone 1
1.005	0.068	0.43	124.060	124.057	AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
1.006	0.124	3.11	121.447	121.205	AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
2.000	0.215	3.03	125.274	124.780	AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
2.001	0.215	3.04	124.780	124.300	AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1
3.000	0.046	2.58	124.106	124.066	AR&R 20 year, 2 hours storm, average 47.4 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF2	0	0	-999.0000	0	0	0		
OF5	0	0	0.000 0	0	0	0		

OF10	0	0	0.000	0	0	0	0	
OF21	0	0	-0.000	0	0	0	0	
OF27	0	0	0.000	0	0	0	0	
OF32	0	0	0.000	0	0	0	0	
OF36	0	0	0.000	0	0	0	0	
OF35	0	0	0.000	0	0	0	0	
OF39	0.235	0.235	0.000	0.105	0.10	5.80	0.99	AR&R 20 year, 2 hours storm, average 47.4 mm/h, Zone 1
OF41	0	0	0.000	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
OSD Tank		124.06	80.2	0.124	0.124	0.000
Bio	120.98	0.0	0.000	0.000	0.000

CONTINUITY CHECK for AR&R 20 year, 1.5 hours storm, average 56.0 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage (cu.m)	Change %	Difference
DS.1	521.86	521.86	0.00	0.0	
A.1	8.30	8.32	0.00	-0.2	
A.2	16.62	16.64	0.00	-0.2	
A.3	20.79	20.82	0.00	-0.2	
A.4	29.12	29.15	0.00	-0.1	
A.5	37.45	37.40	0.00	0.1	
A.6	93.72	94.39	0.00	-0.7	
OSD Tank		396.63	396.62	0.00	-0.0
Bio	396.62	396.62	0.00	0.0	
Roof	302.12	302.21	0.00	-0.0	
RWT	302.21	302.24	0.00	-0.0	
N42	282.76	282.76	0.00	0.0	
Bypass	282.76	282.76	0.00	0.0	
B.1	47.97	48.03	0.00	-0.1	

Run Log for 38509 run at 16:35:07 on 30/5/2018
No water upwelling from any pit. Freeboard was adequate at all pits.
The maximum flow in these overflow routes is unsafe: OF39

100 Year Design Output
DRAINS results prepared from Version 2018.01

PIT / NODE DETAILS Version 8

Name	Max HGL	HGL	Max Pond Flow Arriving (cu.m/s)	Max Pond (cu.m)	Max Surface Volume (m)	Freeboard	Min (cu.m/s)	Overflow	Constraint
A.1	126.01	127.22	0.007	0.1	1.19	0.000	Inlet Capacity		
A.2	125.75	127.22	0.007	0.1	1.45	0.000	Inlet Capacity		
A.3	125.54		0.004		1.30	0.000	None		
A.4	124.74		0.007		1.09	0.000	None		
A.5	124.80		0.007		0.50	0.000	None		
A.6	124.69	124.69	0.007	4.1	0.00	0.000	Outlet System		
Roof	126.21		0.266						
RWT	125.48		0.000						

B.1	124.75	125.06	0.059	0.7	0.25	0.000	Inlet Capacity

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
PreDev Catchment	0.595	0.074	0.534	5.00	8.00	8.00	AR&R 100 year, 2 hours storm, average 63.0 mm/h, Zone 1
A.1 Catch	0.007	0.007	0.000	5.00	6.00	6.00	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
A.2 Catch	0.007	0.007	0.000	5.00	6.00	6.00	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
A.3 Catch	0.004	0.004	0.000	5.00	6.00	6.00	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
A.4 Catch	0.007	0.007	0.000	5.00	6.00	6.00	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
A.5 Catch	0.007	0.007	0.000	5.00	6.00	6.00	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
A.6 Catch	0.007	0.007	0.000	5.00	6.00	6.00	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
Roof Catch	0.266	0.266	0.000	5.00	6.00	6.00	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
Bypass Catch	0.301	0.075	0.239	5.00	8.00	8.00	AR&R 100 year, 2 hours storm, average 63.0 mm/h, Zone 1
B.1 Catch	0.059	0.000	0.059	5.00	8.00	8.00	AR&R 100 year, 2 hours storm, average 63.0 mm/h, Zone 1

Outflow Volumes for Total Catchment (0.63 impervious + 1.48 pervious = 2.11 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 269 mm/h, Zone 1	473.44	300.67 (63.5%)	135.14 (95.5%)	165.53 (49.9%)
AR&R 100 year, 10 minutes storm, average 213 mm/h, Zone 1	749.76	531.43 (70.9%)	217.69 (97.2%)	313.73 (59.7%)
AR&R 100 year, 15 minutes storm, average 182 mm/h, Zone 1	960.96	704.71 (73.3%)	280.80 (97.8%)	423.92 (62.9%)
AR&R 100 year, 20 minutes storm, average 161 mm/h, Zone 1	1133.44	844.50 (74.5%)	332.33 (98.1%)	512.18 (64.4%)
AR&R 100 year, 30 minutes storm, average 134 mm/h, Zone 1	1415.04	1059.69 (74.9%)	416.46 (98.5%)	643.23 (64.8%)
AR&R 100 year, 45 minutes storm, average 111 mm/h, Zone 1	1758.22	1329.37 (75.6%)	518.99 (98.8%)	810.38 (65.7%)
AR&R 100 year, 1 hour storm, average 96.0 mm/h, Zone 1	2027.52	1540.20 (76.0%)	599.45 (99.0%)	940.75 (66.2%)
AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1	2376.00	1794.24 (75.5%)	703.57 (99.1%)	1090.67 (65.5%)
AR&R 100 year, 2 hours storm, average 63.0 mm/h, Zone 1	2661.16	2002.06 (75.2%)	788.76 (99.2%)	1213.30 (65.0%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
1.000	0.007	0.83	125.985	125.751	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1

1.001	0.015	1.68	125.713	125.537	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
1.002	0.017	1.75	125.494	124.736	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
1.003	0.031	0.63	124.721	124.798	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
1.004	0.037	0.34	124.796	124.690	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
1.005	0.090	0.57	125.095	125.149	AR&R 100 year, 20 minutes storm, average 161 mm/h, Zone 1
1.006	0.136	3.42	121.541	121.205	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
2.000	0.265	3.75	126.213	125.477	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
2.001	0.264	3.74	125.476	125.149	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1
3.000	0.063	0.57	124.726	124.690	AR&R 100 year, 2 hours storm, average 63.0 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S		Max Q D/S		Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF2	0	0	0.000	0	0	0	0			
OF5	0	0	0.000	0	0	0	0			
OF10	0	0	0.000	0	0	0	0			
OF21	0	0	0.000	0	0	0	0			
OF27	0	0	0.000	0	0	0	0			
OF32	0	0	0.000	0	0	0	0			
OF36	0.147	0.147	0.000	0.060	0.05	4.00	0.82	AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1		
OF35	0	0	0.000	0	0	0	0			
OF39	0.301	0.301	0.000	0.114	0.12	6.44	1.04	AR&R 100 year, 2 hours storm, average 63.0 mm/h, Zone 1		
OF41	0	0	0.000	0	0	0	0			

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
OSD Tank		125.15	104.4	0.283	0.136	0.147
Bio	120.98	0.0	0.000	0.000	0.000

CONTINUITY CHECK for AR&R 100 year, 1.5 hours storm, average 75.0 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage (cu.m)	Change %	Difference
DS.1	817.66	817.66	0.00	0.0	
A.1	11.15	11.14	0.00	0.1	
A.2	22.29	22.28	0.00	0.0	
A.3	27.85	27.82	0.00	0.1	
A.4	38.97	38.90	0.00	0.2	
A.5	50.05	50.35	0.00	-0.6	
A.6	139.05	135.35	0.00	2.7	
OSD Tank		542.15	542.14	0.00	-0.0
Bio	542.14	542.14	0.00	0.0	
Roof	405.86	406.28	0.00	-0.1	
RWT	406.28	406.80	0.00	-0.1	
N42	432.07	432.07	0.00	0.0	
Bypass	432.07	432.07	0.00	0.0	
B.1	77.33	77.56	0.00	-0.3	

Appendix B – DRAINS Output

Run Log for 38509 run at 16:35:49 on 30/5/2018

The maximum water level in these storages exceeds the maximum elevation you specified: OSD Tank.
DRAINS has extrapolated the Elevation vs Storage table to a higher Elevation. Please provide accurate values for higher elevations.
No water upwelling from any pit.
Freeboard was less than 0.15m at A.6
Flows were safe in all overflow routes.

Appendix C – MUSIC Model Results

Appendix C – MUSIC Model Results

Source nodes
Location,Roof Catchment,Paved External Areas,Bypass Landscape
ID,1,5,8
Node Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Zoning Surface Type,Roof,Sealedroad,Revegetatedland
Total Area (ha),0.364,0.16,0.243
Area Impervious (ha),0.364,0.159397014925373,0
Area Pervious (ha),0,0.000602985074626861,0.243
Field Capacity (mm),80,80,80
Pervious Area Infiltration Capacity coefficient - a,200,200,200
Pervious Area Infiltration Capacity exponent - b,1,1,1
Impervious Area Rainfall Threshold (mm/day),1,1,1
Pervious Area Soil Storage Capacity (mm),120,120,120
Pervious Area Soil Initial Storage (% of Capacity),25,25,25
Groundwater Initial Depth (mm),10,10,10
Groundwater Daily Recharge Rate (%),25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5
Groundwater Daily Deep Seepage Rate (%),0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),1.3,2.43,1.95
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic
Stormflow Total Suspended Solids Serial Correlation,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-0.89,-0.3,-0.66
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic
Stormflow Total Phosphorus Serial Correlation,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0.3,0.34,0.3
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.1,1.2,1.15
Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial Correlation,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-0.82,-0.85,-1.22
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),0.32,0.11,-0.05
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0
Flow based constituent generation - enabled,Off,Off,Off
Flow based constituent generation - flow file, , ,
Flow based constituent generation - base flow column, , ,
Flow based constituent generation - pervious flow column, , ,
Flow based constituent generation - impervious flow column, , ,
Flow based constituent generation - unit, , ,
OUT - Mean Annual Flow (ML/yr),4.91,2.16,1.12
OUT - TSS Mean Annual Load (kg/yr),128,755,66.8
OUT - TP Mean Annual Load (kg/yr),0.750,1.24,0.164
OUT - TN Mean Annual Load (kg/yr),10.6,5.23,1.80
OUT - Gross Pollutant Mean Annual Load (kg/yr),119,52.2,0.00
Rain In (ML/yr),5.42212,2.38335,3.61971

ET Loss (ML/yr),0.514048,0.225955,2.50116
Deep Seepage Loss (ML/yr),0,0,0
Baseflow Out (ML/yr),0,0,0.591647
Imp. Stormflow Out (ML/yr),4.90808,2.1574,0
Perv. Stormflow Out (ML/yr),0,0,0.526913
Total Stormflow Out (ML/yr),4.90808,2.1574,0.526913
Total Outflow (ML/yr),4.90808,2.1574,1.11856
Change in Soil Storage (ML/yr),0,0,-7E-6
TSS Baseflow Out (kg/yr),0,0,9.05422
TSS Total Stormflow Out (kg/yr),127.962,755.393,57.7569
TSS Total Outflow (kg/yr),127.962,755.393,66.8111
TP Baseflow Out (kg/yr),0,0,0.039014
TP Total Stormflow Out (kg/yr),0.750111,1.24375,0.124487
TP Total Outflow (kg/yr),0.750111,1.24375,0.163501
TN Baseflow Out (kg/yr),0,0,0.54805
TN Total Stormflow Out (kg/yr),10.6426,5.23226,1.24862
TN Total Outflow (kg/yr),10.6426,5.23226,1.79667
GP Total Outflow (kg/yr),118.765,52.2044,0

No Imported Data Source nodes

USTM treatment nodes
Location,Rainwater Tank,Bioretention,Detention Tank
ID,2,4,6
Node Type,RainWaterTankNode,BioRetentionNodeV4,DetentionBasinNode
Lo-flow bypass rate (cum/sec),0,0,0
Hi-flow bypass rate (cum/sec),100,100,100
Inlet pond volume,0, ,0
Area (sqm),87.5,100,67.5
Initial Volume (m^3),0, ,
Extended detention depth (m),0.2,0.2,1.5
Number of Rainwater tanks,1, ,
Permanent Pool Volume (cubic metres),130, ,2
Proportion vegetated,0, ,0
Equivalent Pipe Diameter (mm),100, ,1
Overflow weir width (m),10,2,0.3
Notional Detention Time (hrs),0.467, ,9.86E3
Orifice Discharge Coefficient,0.6, ,0.6
Weir Coefficient,1.7,1.7,1.7
Number of CSTR Cells,2,3,1
Total Suspended Solids - k (m/yr),400,8000,8000
Total Suspended Solids - C* (mg/L),12,20,20
Total Suspended Solids - C** (mg/L),12, ,20
Total Phosphorus - k (m/yr),300,6000,6000
Total Phosphorus - C* (mg/L),0.13,0.13,0.13
Total Phosphorus - C** (mg/L),0.13, ,0.13
Total Nitrogen - k (m/yr),40,500,500
Total Nitrogen - C* (mg/L),1.4,1.4,1.4
Total Nitrogen - C** (mg/L),1.4, ,1.4
Threshold Hydraulic Loading for C** (m/yr),3500, ,3500
Horizontal Flow Coefficient, ,3,
Reuse Enabled,On,Off,Off
Max drawdown height (m),1.48571428571429, ,
Annual Demand Enabled,Off,Off,Off

Appendix C – MUSIC Model Results

Annual Demand Value (ML/year), , ,
Annual Demand Distribution, , ,
Annual Demand Monthly Distribution: Jan, , ,
Annual Demand Monthly Distribution: Feb, , ,
Annual Demand Monthly Distribution: Mar, , ,
Annual Demand Monthly Distribution: Apr, , ,
Annual Demand Monthly Distribution: May, , ,
Annual Demand Monthly Distribution: Jun, , ,
Annual Demand Monthly Distribution: Jul, , ,
Annual Demand Monthly Distribution: Aug, , ,
Annual Demand Monthly Distribution: Sep, , ,
Annual Demand Monthly Distribution: Oct, , ,
Annual Demand Monthly Distribution: Nov, , ,
Annual Demand Monthly Distribution: Dec, , ,
Daily Demand Enabled,On,Off,Off
Daily Demand Value (ML/day),0.0063, ,
Custom Demand Enabled,Off,Off,Off
Custom Demand Time Series File, , ,
Custom Demand Time Series Units, , ,
Filter area (sqm), ,100,
Filter perimeter (m), ,14,
Filter depth (m), ,0.5,
Filter Median Particle Diameter (mm), , ,
Saturated Hydraulic Conductivity (mm/hr), ,100,
Infiltration Media Porosity, ,0.35,
Length (m), , ,
Bed slope, , ,
Base Width (m), , ,
Top width (m), , ,
Vegetation height (m), , ,
Vegetation Type, ,Vegetated with Effective Nutrient Removal Plants,
Total Nitrogen Content in Filter (mg/kg), ,600,
Orthophosphate Content in Filter (mg/kg), ,30,
Is Base Lined?, ,No,
Is Underdrain Present?, ,Yes,
Is Submerged Zone Present?, ,No,
Submerged Zone Depth (m), , ,
B for Media Soil Texture,-9999,13,-9999
Proportion of upstream impervious area treated, , ,
Exfiltration Rate (mm/hr),0,0,0
Evaporative Loss as % of PET,0,100,100
Depth in metres below the drain pipe, , ,
TSS A Coefficient, , ,
TSS B Coefficient, , ,
TP A Coefficient, , ,
TP B Coefficient, , ,
TN A Coefficient, , ,
TN B Coefficient, , ,
Sfc, ,0.61,
S*, ,0.37,
Sw, ,0.11,
Sh, ,0.05,
Emax (m/day), ,0.008,
Ew (m/day), ,0.001,

Appendix C – MUSIC Model Results

IN - Mean Annual Flow (ML/yr),4.91,4.64,4.82
IN - TSS Mean Annual Load (kg/yr),128,157,399
IN - TP Mean Annual Load (kg/yr),0.750,0.748,1.25
IN - TN Mean Annual Load (kg/yr),10.6,8.25,10.0
IN - Gross Pollutant Mean Annual Load (kg/yr),119,0.00,0.00
OUT - Mean Annual Flow (ML/yr),2.67,4.42,4.64
OUT - TSS Mean Annual Load (kg/yr),51.7,50.5,157
OUT - TP Mean Annual Load (kg/yr),0.378,0.298,0.748
OUT - TN Mean Annual Load (kg/yr),5.50,4.69,8.25
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00
Flow In (ML/yr),4.90804,4.64089,4.82458
ET Loss (ML/yr),0,0.221265,0.0850746
Infiltration Loss (ML/yr),0,0,0
Low Flow Bypass Out (ML/yr),0,0,0
High Flow Bypass Out (ML/yr),0,0,0
Orifice / Filter Out (ML/yr),2.13987,2.86636,0.0786461
Weir Out (ML/yr),0.527306,1.55131,4.55943
Transfer Function Out (ML/yr),0,0,0
Reuse Supplied (ML/yr),2.23943,0,0
Reuse Requested (ML/yr),2.29794,0,0
% Reuse Demand Met,97.4538,0,0
% Load Reduction,45.657,4.80989,3.8657
TSS Flow In (kg/yr),127.962,156.689,399.228
TSS ET Loss (kg/yr),0,0,0
TSS Infiltration Loss (kg/yr),0,0,0
TSS Low Flow Bypass Out (kg/yr),0,0,0
TSS High Flow Bypass Out (kg/yr),0,0,0
TSS Orifice / Filter Out (kg/yr),41.1785,7.39103,1.60655
TSS Weir Out (kg/yr),10.5687,43.125,155.164
TSS Transfer Function Out (kg/yr),0,0,0
TSS Reuse Supplied (kg/yr),28.9992,0,0
TSS Reuse Requested (kg/yr),0,0,0
TSS % Reuse Demand Met,0,0,0
TSS % Load Reduction,59.5605,67.7603,60.7316
TP Flow In (kg/yr),0.750111,0.748307,1.24828
TP ET Loss (kg/yr),0,0,0
TP Infiltration Loss (kg/yr),0,0,0
TP Low Flow Bypass Out (kg/yr),0,0,0
TP High Flow Bypass Out (kg/yr),0,0,0
TP Orifice / Filter Out (kg/yr),0.306375,0.067488,0.0103158
TP Weir Out (kg/yr),0.0712789,0.23063,0.737966
TP Transfer Function Out (kg/yr),0,0,0
TP Reuse Supplied (kg/yr),0.295559,0,0
TP Reuse Requested (kg/yr),0,0,0
TP % Reuse Demand Met,0,0,0
TP % Load Reduction,49.6536,60.161,40.055
TN Flow In (kg/yr),10.6426,8.2494,10.0477
TN ET Loss (kg/yr),0,0,0
TN Infiltration Loss (kg/yr),0,0,0
TN Low Flow Bypass Out (kg/yr),0,0,0
TN High Flow Bypass Out (kg/yr),0,0,0
TN Orifice / Filter Out (kg/yr),4.38103,1.84889,0.113912
TN Weir Out (kg/yr),1.11458,2.84082,8.13815
TN Transfer Function Out (kg/yr),0,0,0

TN Reuse Supplied (kg/yr),3.872,0,0
TN Reuse Requested (kg/yr),0,0,0
TN % Reuse Demand Met,0,0,0
TN % Load Reduction,48.3621,43.1509,17.8711
GP Flow In (kg/yr),118.765,0,0
GP ET Loss (kg/yr),0,0,0
GP Infiltration Loss (kg/yr),0,0,0
GP Low Flow Bypass Out (kg/yr),0,0,0
GP High Flow Bypass Out (kg/yr),0,0,0
GP Orifice / Filter Out (kg/yr),0,0,0
GP Weir Out (kg/yr),0,0,0
GP Transfer Function Out (kg/yr),0,0,0
GP Reuse Supplied (kg/yr),0,0,0
GP Reuse Requested (kg/yr),0,0,0
GP % Reuse Demand Met,0,0,0
GP % Load Reduction,100,100,100
PET Scaling Factor, ,2.1,

Generic treatment nodes
Location, 6 x Enviropod 200
ID,7
Node Type,GPTNode
Lo-flow bypass rate (cum/sec),0
Hi-flow bypass rate (cum/sec),0.12
Flow Transfer Function
Input (cum/sec),0
Output (cum/sec),0
Input (cum/sec),10
Output (cum/sec),10
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Gross Pollutant Transfer Function
Enabled,True
Input (kg/ML),0
Output (kg/ML),0
Input (kg/ML),14.780776740251
Output (kg/ML),0
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),

Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Total Nitrogen Transfer Function
Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),10
Output (mg/L),8.7
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Total Phosphorus Transfer Function
Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),10
Output (mg/L),7
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),

Output (mg/L),
Input (mg/L),
Output (mg/L),
Total Suspended Solids Transfer Function
Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),100
Output (mg/L),46
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
TSS Flow based Efficiency Enabled,Off
TSS Flow based Efficiency,
TP Flow based Efficiency Enabled,Off
TP Flow based Efficiency,
TN Flow based Efficiency Enabled,Off
TN Flow based Efficiency,
GP Flow based Efficiency Enabled,Off
GP Flow based Efficiency,
IN - Mean Annual Flow (ML/yr),2.16
IN - TSS Mean Annual Load (kg/yr),755
IN - TP Mean Annual Load (kg/yr),1.24
IN - TN Mean Annual Load (kg/yr),5.23
IN - Gross Pollutant Mean Annual Load (kg/yr),52.2
OUT - Mean Annual Flow (ML/yr),2.16
OUT - TSS Mean Annual Load (kg/yr),347
OUT - TP Mean Annual Load (kg/yr),0.871
OUT - TN Mean Annual Load (kg/yr),4.55
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00
Flow In (ML/yr),2.15738
ET Loss (ML/yr),0
Infiltration Loss (ML/yr),0
Low Flow Bypass Out (ML/yr),0
High Flow Bypass Out (ML/yr),0
Orifice / Filter Out (ML/yr),0
Weir Out (ML/yr),0
Transfer Function Out (ML/yr),2.15738
Reuse Supplied (ML/yr),0
Reuse Requested (ML/yr),0
% Reuse Demand Met,0

% Load Reduction,0
TSS Flow In (kg/yr),755.392
TSS ET Loss (kg/yr),0
TSS Infiltration Loss (kg/yr),0
TSS Low Flow Bypass Out (kg/yr),0
TSS High Flow Bypass Out (kg/yr),0
TSS Orifice / Filter Out (kg/yr),0
TSS Weir Out (kg/yr),0
TSS Transfer Function Out (kg/yr),347.48
TSS Reuse Supplied (kg/yr),0
TSS Reuse Requested (kg/yr),0
TSS % Reuse Demand Met,0
TSS % Load Reduction,54
TP Flow In (kg/yr),1.24375
TP ET Loss (kg/yr),0
TP Infiltration Loss (kg/yr),0
TP Low Flow Bypass Out (kg/yr),0
TP High Flow Bypass Out (kg/yr),0
TP Orifice / Filter Out (kg/yr),0
TP Weir Out (kg/yr),0
TP Transfer Function Out (kg/yr),0.870622
TP Reuse Supplied (kg/yr),0
TP Reuse Requested (kg/yr),0
TP % Reuse Demand Met,0
TP % Load Reduction,30
TN Flow In (kg/yr),5.23226
TN ET Loss (kg/yr),0
TN Infiltration Loss (kg/yr),0
TN Low Flow Bypass Out (kg/yr),0
TN High Flow Bypass Out (kg/yr),0
TN Orifice / Filter Out (kg/yr),0
TN Weir Out (kg/yr),0
TN Transfer Function Out (kg/yr),4.55207
TN Reuse Supplied (kg/yr),0
TN Reuse Requested (kg/yr),0
TN % Reuse Demand Met,0
TN % Load Reduction,13
GP Flow In (kg/yr),52.2045
GP ET Loss (kg/yr),0
GP Infiltration Loss (kg/yr),0
GP Low Flow Bypass Out (kg/yr),0
GP High Flow Bypass Out (kg/yr),0
GP Orifice / Filter Out (kg/yr),0
GP Weir Out (kg/yr),0
GP Transfer Function Out (kg/yr),0
GP Reuse Supplied (kg/yr),0
GP Reuse Requested (kg/yr),0
GP % Reuse Demand Met,0
GP % Load Reduction,100

Other nodes
Location,Post-Development Node
ID,3
Node Type,PostDevelopmentNode

Appendix C – MUSIC Model Results

IN - Mean Annual Flow (ML/yr),5.54
IN - TSS Mean Annual Load (kg/yr),117
IN - TP Mean Annual Load (kg/yr),0.462
IN - TN Mean Annual Load (kg/yr),6.49
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00
OUT - Mean Annual Flow (ML/yr),5.54
OUT - TSS Mean Annual Load (kg/yr),117
OUT - TP Mean Annual Load (kg/yr),0.462
OUT - TN Mean Annual Load (kg/yr),6.49
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00
% Load Reduction,32.4
TSS % Load Reduction,87.7
TN % Load Reduction,63.3
TP % Load Reduction,78.6
GP % Load Reduction,100

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,1,4,2,6,5,7,8
Target node ID,2,3,6,4,7,6,3
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , , , , ,
Muskingum theta, , , , , , ,
IN - Mean Annual Flow (ML/yr),4.91,4.42,2.67,4.64,2.16,2.16,1.12
IN - TSS Mean Annual Load (kg/yr),128,50.5,51.7,157,755,347,66.8
IN - TP Mean Annual Load (kg/yr),0.750,0.298,0.378,0.748,1.24,0.871,0.164
IN - TN Mean Annual Load (kg/yr),10.6,4.69,5.50,8.25,5.23,4.55,1.80
IN - Gross Pollutant Mean Annual Load (kg/yr),119,0.00,0.00,0.00,52.2,0.00,0.00
OUT - Mean Annual Flow (ML/yr),4.91,4.42,2.67,4.64,2.16,2.16,1.12
OUT - TSS Mean Annual Load (kg/yr),128,50.5,51.7,157,755,347,66.8
OUT - TP Mean Annual Load (kg/yr),0.750,0.298,0.378,0.748,1.24,0.871,0.164
OUT - TN Mean Annual Load (kg/yr),10.6,4.69,5.50,8.25,5.23,4.55,1.80
OUT - Gross Pollutant Mean Annual Load (kg/yr),119,0.00,0.00,0.00,52.2,0.00,0.00

Catchment Details
Catchment Name,38509 - ALLAMBIE HEIGHTS MUSIC
Timestep,6 Minutes
Start Date,1/01/1959
End Date,31/12/1959 11:54:00 PM
Rainfall Station, 66062 SYDNEY
ET Station,Monthly User Defined
Mean Annual Rainfall (mm), 1490
Mean Annual ET (mm), 1260

Appendix C. Biodiversity Management Plan – Total Earth Care 2020

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Biodiversity Management Plan

William Charlton Village
Allambie Heights

Total Earth Care Pty Ltd
February 2020

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Biodiversity Management Plan

William Charlton Village
Allambie Heights

February 2020

Quality Control	© Total Earth Care Pty Ltd 2020		
Revision/Version No.	Rev A	**Date of Revision**	24 February 2020
Prepared by:	G Teear		
Approved by:	A McGahey & G Barron		
Prepared for:	Allambie Heights Village		
TEC Job No.	C11661		

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Executive Summary

Total Earth Care was engaged by Allambie Heights Village to prepare a Biodiversity Management Plan for the proposed independent living development at William Charlton Village, 181 Allambie Rd, Allambie Heights. The lot is a large block which currently consists of a residential aged care facility and associated buildings with an area of managed lawn and planted and remnant trees. The western half of the lot consists of remnant bushland intersected by an access road.

The proposed development includes the construction of two (2) additional buildings containing independent living units, a communal building, associated landscaping, internal access roads, car parking and required Asset Protection Zones (APZs).

A site survey was conducted on the 19th February 2020 by two (2) qualified Ecologists. Weed densities have been mapped and management zones allocated.

Mitigation methods and management actions provided in this report have been designed to address current management issues. This report separates the site into five (5) management zones and details management actions and performance criteria for the five (5) years following the construction to ensure that the remnant bushland within the site is maintained. Management actions include weed control, delineation of management zones, fencing no-go zones and management of an Outer Protection Area (OPA).

1 Introduction

1.1 Background

Total Earth Care (TEC) has been commissioned by Allambie Heights Village Ltd to prepare this Biodiversity Management Plan (BMP) for this the independent living development proposal at 181 Allambie Road to support the development application. The site is within the Northern Beaches LGA.

This BMP is written in accordance with the Biodiversity Management Plan Report Guidelines available on the Northern Beaches Council Website titled – "2014 112357 Guideline for preparing a Biodiversity Management Plan April 2014".

Site-specific plans and documents reviewed for this project:

- DA011 Site Plan, by Jackson Teece, dated 19/12/2019;
- L-SD-01 Landscape Concept Plan by Arterra Design Pty Ltd, dated 24/10/2019; and
- Bush Fire Assessment Report by Total Earth Care, dated February 2020.

1.2 Subject Site

The Subject Site (the Site) comprises the area of land likely to be directly or indirectly impacted by future development. The study area comprises the subject site in addition to the surrounding land that may be potentially indirectly affected by the development or affect the development. The locality encompasses a larger area that includes neighbouring properties and includes areas of native biodiversity values nearby. The subject site details are outlined in Table 1 and the boundaries and simplified plans are shown in Map 1. The architectural drawings are provided in Appendix A.

Table 1. Site Details

Property name	William Charlton Village
Site address	181 Allambie Rd
Property identifier (Lot and DP)	DP 752038 lot 2615
Local Government Area	Northern Beaches Council
Zoning	R2 Low Density Residential

1.3 Staff Qualifications

This report has been prepared by suitably qualified personnel. Their qualifications are below:

1.3.1 Andrew McGahey – 35 years experience

- Associate Diploma of Horticulture
- Certificate II in Bushland Regeneration
- Planning for Bush Fire Protection
- White Card (WHS General Construction Induction)
- Senior First Aid Certificate

1.3.2 Gillian Teear – 3 years experience

- Bachelor of Environmental Biology – University of Technology Sydney
- White Card (WHS General Construction Induction)
- First Aid and CPR
- Sydney Metropolitan Wildlife Course and Volunteer
- NSW Seabird Rescue First Responders Course
- UNSW Advanced Plant ID Course – 2018
- Van Klaphake – Eucalyptus ID Course – 2018
- Teresa James Cumberland Plain Woodland Plant ID Workshop – 2018
- Teresa James Biodiversity Site Assessment Workshop - 2018

1.3.3 Georgina Barron – 4 years experience

- Bachelor of Science (Biology) (1st Class Honours) The University of Sydney
  Honours project: Ecological benefits of invasive plants in novel ecosystems: does Lantana provide habitat for urban sensitive species?
- White Card (WHS General Construction Induction)
- First Aid and CPR
- Introduction to Animal Research (ITAR), Module 1: Fundamentals of Animal Research
- Introduction to Animal Research (ITAR), Module 3: Wildlife
- WIRES Possum & Glider Course
- WIRES Rescue & Intermediate Care Course

1.4 Relevant Legislation and Planning Instruments

Within the Northern Beaches Council LGA, relevant legislation and policies which apply to this BMP include:

- 10/50 Vegetation Clearing Code of Practice
- Biodiversity Conservation Act 2016 (NSW)
- Biosecurity Act 2015 (NSW)
- Bushfire Environmental Assessment Code 2006
- Environment Protection and Biodiversity Conservation Act 1999 (Cth)
- Environmental Planning and Assessment Act 1979 (NSW)
- Local Government Act 1993 (NSW)
- National Parks and Wildlife Act 1974 (NSW)
- Planning for Bushfire Protection 2006
- Protection of the Environment Operations Act 1999 (NSW)
- Rural Fires Act 1997 (NSW)
- State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004
- State Environmental Planning Policy (Exempt and Complying Development Codes)
- State Environmental Planning Policy (Housing for Seniors or People with a Disability) 2004
- State Environmental Planning Policy No 19-Bushland in Urban Areas
- State Environmental Planning Policy No 1-Development Standards
- State Environmental Planning Policy No 33-Hazardous and Offensive Development
- State Environmental Planning Policy No 36-Manufactured Home Estates
- State Environmental Planning Policy No 44-Koala Habitat Protection
- State Environmental Planning Policy No 55-Remediation of Land
- State Environmental Planning Policy (Primary Production and Rural Development) 2019

- State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017: Subject Land
- Warringah Development Control Plan 2011
- Warringah Local Environmental Plan 2011
- Water Management Act 2000 (NSW)

Title: Impact Area

Map No: 1

Site: William Charlton Village

Client: Allambie Heights Village

Date: February 2020

Project No: C11661

Author: G Teear

Legend

Remaining bushland

Impact Area

0 15 30 60 Meters

N

Data Source:
Total Earth Care
Nearmap

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Tel: 02 9913 1432 Fax: 02 9913 1434

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2 Methods

2.1 Desktop Research

A preliminary desktop study was conducted to assess the likelihood of the study area to support threatened species, populations or threatened ecological communities, or their habitats. All records of threatened species and populations within five (5) kilometres of the subject site (10km locality search) were obtained from the Office of Environment & Heritage (OEH) Wildlife Atlas database (DPIE 2020), and the Federal Environment Department of Environment Protected Matters search tool.

2.2 Site Survey

A diurnal survey was conducted over one (1) day on 19th February 2020. Weather conditions were warm and sunny (around 22˚C at 9am) with a light wind. The site survey was conducted by Georgina Barron and Gillian Teear. Their qualifications are provided in Section 1.3 of this report.

2.2.1 Botanical Survey

A general botanical survey was conducted with reference to existing vegetation community descriptions and mapping from previous TEC surveys of the site. Threatened flora likely to occur within the locality were surveyed using the NSW Guide to Surveying Threatened Plants (OEH 2016b). Surveys on the subject site were generally random meanders (DEC 2004), but focused on identifying native vegetation and included:

- The identification of native and exotic plant species according to Field Guide to the Native Plants of Sydney (Robinson, 2003), Flora of NSW, Volumes 1-4 (Harden 1992, 1993, 2000, 2002), Weeds of the south-east: an identification guide for Australia (Richardson et al, 2006) and PlantNET (Botanic Gardens Trust, 2008), with reference to recent taxonomic changes;
- Targeted searches for threatened plant species according to the “random meander” method (Cropper 1993);
- The identification and mapping of plant communities based on current site conditions, soils and species list, and previous vegetation mapping including The Native Vegetation of the Sydney Metropolitan Area Version 3.0 (OEH 2016a);
- An assessment of the natural resilience of the vegetation of the site;
- Identification of previous and current factors threatening the ecological function and survival of native vegetation on the site; and
- Determination of appropriate rehabilitation and bush regeneration techniques for the native vegetation of the site.

2.2.2 Fauna Survey

Incidental fauna observations and fauna habitats were recorded as part of the survey effort. This included noting the GPS locations of hollow bearing trees, describing notable habitat features such as termite mounds, target searches for indirect evidence of fauna such as scats and scratchings and brief targeted searches for associated fauna (Triggs 1984).

2.3 Limitations

The diurnal field survey was conducted over one (1) day during February 2020. The flora and fauna field survey was based on the recommendations of Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft (DECC, 2004) with particular reference to the size of the subject site and a relatively homogeneous wider urbanised landscape.

As stated by the DECC (2004) ‘The absence of a species from survey data does not necessarily mean it does not inhabit the survey area. It may simply means that the species was not detected at that time with the survey method adopted and the prevailing seasonal or climatic conditions.’ Therefore, the relative brevity of the survey and its timing mean that the full spectrum of flora and fauna species and ecological processes likely to occur on the site cannot be fully quantified or described in this report. These limitations have been partly addressed by identifying potential habitats for fauna species and assessing the potential for these species to occur on the site based on previous records, the type and condition of habitats present, the land use throughout the subject site, surrounds and the landscape context.

When reviewing maps please note that the hand-held GPS equipment used is only accurate to three (3) metres.

3 Site Description

3.1 Identification and description of the site and surrounds

3.1.1 General

The subject site is located in the suburb of Allambie Heights in the Northern Beaches LGA. The site is zoned as R2 Low Density Residential, with RE1 Public Recreation and SP1 Special Activities: Health Services Facilities characterising the surrounding area. The western and southern boundaries of the site are contiguous with the Manly Warringah War Memorial Park, a 375ha passive and active recreational bushland park. The northern boundary adjoins a Sydney Water bushland easement for a water reticulation pipe.

The remnant bushland section of the site has been partially developed by the previous lessee. A sealed road has been built on cut and filled soil through the centre of the site. Three (3) drains have been excavated into solid rock which have created de-facto creeks. In addition to residential dwellings, the site incorporates open lawns, landscaped gardens with exotic and native horticultural species plantings, and some remnant native vegetation.

3.1.2 Soils

The entirety of both the subject site and study area is contained within the Lambert Soil Landscape, as mapped by Chapman et al (1989). It derives from Hawkesbury Sandstone which consists of medium to coarse-grained quartz sandstone with minor shale and laminite lenses. Soils are shallow (<50 cm) discontinuous Earthy Sands (Uc5.11, Uc5.22) and Yellow Earths (Gn2.2) on crests and insides of benches; shallow (<20 cm) Siliceous Sands/Lithosols (Uc1.2) on leading edges; shallow to moderately deep (<150 cm) Leached Sands (Uc2.21), Grey Earths (Gn2.81) and Gleyed Podzolic Soils (Dg4.21) in poorly drained areas; and localised Yellow Podzolic Soils (Dy4.1, Dy5.2) where associated with shale lenses. Typical limitations of the soil include very high soil erosion hazard, rock outcrop, seasonally perched watertables, shallow, highly permeable soil and very low soil fertility (DPIE2013).

The soil in the eastern portion of the site and along the existing road shows a high level of disturbance associated with construction and demolition through excavation and filling. Sealed access ways and formalised drainage lines have also caused some level of soil disturbance outside of excavated areas. Notwithstanding, soils within some of the landscaped areas including lawns and garden beds have retained much of their original structure.

3.1.3 Topography, Aspect and Hydrology

The site is roughly rectangular in shape with the long axis orientated to the east and west. The western half of the site is substantially bushland while the centre is open parkland and the eastern end contains two (2) two-storey residential buildings and a number of smaller service buildings.

The bushland remnant has a south facing aspect and is located on moderately sloping land. The highest point is 134m above sea level (asl) and the lowest point is 117m asl. The median point is 114m asl. It has a 15% grade or 9° slope. The land is evenly benched along the contour from west to east with the steepest possible grade of 5% grade or 3° slope.

A 20m wide sandstone bench extends beyond and along the southern eastern boundary of the bushland interface. At the downslope edge of this bench is a stepped broken scarp of sandstone bedrock that flattens after approximately 20m. This ground then flattens and meets a vehicle access road. The bench has been excavated at its eastern end to create a narrow drain. This excavation is into solid rock and although it creates steeper ground it, does not support vegetation. This wetter gully is the steepest land adjacent to the site and has a 12% slope or 7°.

3.1.4 Riparian Lands and Waterways

Three (3) drainage lines were found on site. All appear to have been cut into sandstone and some areas concreted (See Figure 1). The drainage line at the western end of the site is a continuation of the drainage channel that runs along the northern side of the driveway through the site. The easterly drainage line that crosses the existing driveway would not have occurred naturally in this position within the topography and cannot be considered a creek line or waterway for the purpose of the developable land on site. None of these drainage lines have been mapped by the Office of Water as streams recognised by the Strahler System.

Map 6 shows the location of the drainage lines. A 10m buffer has been included in the map although it is unlikely that such an exclusion zone would be required.

Despite the artificial origin of the ephemeral creek lines, they provide breeding and foraging habitat for fish, amphibians, reptiles and invertebrates. Protection and recovery of riparian vegetation will help to ensure the viability of theses unofficial wildlife corridors. It will allow plant and animal species to access areas of suitable habitat and promote genetic diversity via dispersal vectors supported by these corridors. This process encourages diversity and sustainability within ecosystems.

Figure 1. Drainage lines.

3.2 The ecological value of existing bushland and bushland impacted upon by the proposed development.

The bushland portion of the site to the west, is mostly of high quality and is contiguous with the Manly Warringah War Memorial Park. It provides potential foraging sites for a range of threatened species. The bushland's location also provides a buffer between urban development and the reserve. Some of the bushland on the site is mapped on the NSW Biodiversity Values Map under the BC Act 2016. The site is part of the Curl Curl Creek catchment, which is recognised as a waterway of high ecological value in Warringah's Creek Management Study 2004.

3.2.1 Flora Habitat

Three (3) remnant native plant communities are identified on the site (see Map 3). These are:

- PCT 1824 – Coastal Sandstone Heath-Mallee (S_HL08)
- PCT 1783 – Sydney North Exposed Sandstone Woodland (S_DSF_11)
- PCT 1250 – Swamp Oak-Prickly Tea-tree-Swamp Paperbark Swamp Forest on Coastal Floodplains, Sydney Basin and South East Corner (S_DSF_09)

The February survey found that a significant portion of these native plant communities are in good to moderate condition with high levels of natural resilience in some areas (see Figure 2). No threatened flora species or Endangered Ecological Communities (EECs) have been identified on the site.

Areas of high density weeds were identified along the southern edge of the access road that heads west into the bushland part of the site. These are largely associated with the fill batter, below the central access road and drainage line. These areas are shown in Map 5. A number of mature Coral Trees

(*Erythrina × sykesii*) are located within the managed lawn area and the edges of the bushland area. Other weeds encroaching on bushland includes Morning Glory (*Ipomoea indica*), dense thickets of Lantana (*Lantana camara*), Crofton Weed (*Ageratina adenophora*) and Senna (*Senna pendula* var. *glabrata*).

A managed exotic lawn area in the central portion of the site, hosts some isolated native remnant trees from the local plant community, planted native trees and exotic trees.

The land holder obligations under the *Biosecurity Act 2015* are listed in Table 11 and Table 12 of Appendix E. Of the weed species present two (2) are listed as Weeds of National Significance (WONS): Lantana (*Lantana camara*) and Asparagus Fern (*Asparagus aethiopicus*).

Figure 2. Highly resilient bushland within PCT 1250 [left] and PCT 1783 [right].

3.2.2 Fauna Habitat

A total of fifteen (15) native vertebrate fauna species were recorded during the February 2020 survey (see Appendix C). A total of twenty-three (23) native vertebrate fauna species have also previously been recorded on the site or within the study area. Previous fauna surveys by TEC included Anabat recordings, motion sensing cameras and spotlighting. Fauna detected in the previous surveys included six (6) micro bat species and seven species of (7) birds and mammals including Swamp Wallaby (*Wallabia bicolor*), Brush-tailed Possum (*Trichosurus vulpecula*), and Sugar Gliders (*Petaurus breviceps*). Of the species previously recorded in the site and greater study area, five (5) threatened species, which are listed as Vulnerable under the BC Act 2016, were recorded. These are:

- Eastern Pygmy-possum *Cercartetus nanus*
- Square-tailed Kite *Lophoictinia isura*
- Little Bentwing-bat *Miniopterus australis*
- Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*
- Grey-headed Flying-fox *Pteropus poliocephalus* (also Vulnerable under the EPBC Act)

During the current survey three (3) Ring-tailed Possum dreys were observed and at least one (1) was observed to be in use (see Figure 3).

A number of exotic species, including rabbits, foxes and rats were also recorded. See Table 10 in Appendix C for the full fauna list from previous recent TEC surveys.

The site does not contain important breeding habitat for threatened species due the lack of suitable caves (for microbats), tree hollows (for Eastern Pygmy-possums) or nesting or colony sites (for Square-tailed Kite and Grey-headed flying foxes). Fauna habitat is mostly associated with the native plant communities on site as a foraging resource. Exposed sandstone boulders and benches in the southern portion of the bushland area can provide smaller cracks and ledges that can be used as habitat by reptiles and other small creatures. Larger caves, and older trees with large hollows are not present on site.

The abundance of Banksias on site provide important foraging habitat for various bird species and the Eastern Pygmy Possum. Formalised drainage lines provide habitat for fish, amphibians, reptiles and invertebrate species. Native and exotic trees, which are going to be cleared in the managed lawn area, may provide opportunistic nectar foraging and perching sites for visiting species.

Figure 3. Small pool on the western boundary of the site [Left] and Ring-tailed Possum drey in use [Right].

3.3 Site Constraints including Significant Environmental Features

As previously discussed the site contains moderate to good quality remnant bushland which provides habitat for several fauna species including threatened species. No threatened plants, communities or threatened species breeding habitats are to be removed by direct clearing for the proposal. The boundary of permanent clearing for the development footprint is contained to the eastern side of the artificial drainage line. Bushland adjacent to the drainage line falls into the Outer Protection Area (OPA) of the APZ for the development. Management of the APZ in proximity to the drainage line will need to consider appropriate erosion control measures.

There are rock outcrops throughout the site with exposed sandstone benches which run east to west on either side of the access road. There are some crevices within the rock outcrops although these were determined to be unsuitable for microbat species due to being accessible by predators such as goannas, foxes and cats. Rock plateaus and boulders are present throughout the site which provide potential habitat for reptiles. Refer to Map 6 for the habitat constraints and features.

3.4 Vegetation Condition and Resilience

The intact bushland is of moderate to good quality being fully structured in most areas and of good resilience. Weeds are present in high densities in areas of historic disturbance associated with the installation of the access road and the areas adjacent to the managed lawn and the two (2) eastern drainage lines. Weed species include Morning Glory (*Ipomoea indica*), dense thickets of Lantana (*Lantana camara*), Crofton Weed (*Ageratina adenophora*) and Senna (*Senna pendula* var. *glabrata*). These are encroaching on good quality bushland and need to be controlled particularly along the drainage lines to prevent their spread into the areas of resilient bushland downstream. Refer to Map 5 for the weed densities. The weed species present within the site are detailed in Table 2 and the description of the weed zones displayed in Map 5 are provided in Table 3. See Figure 4 to Figure 9 for photos of the condition of the site.

Table 2. Weed Species Inventory

Family	Scientific Name	Common Name
Agavaceae	*Yucca spp.*	
Apocynaceae	*Nerium oleander*	Oleander
Araceae	*Zantedeschia aethiopica*	Arum Lily
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern
Asteraceae	*Ageratina adenophora*	Crofton Weed
	Conyza spp.	A Fleabane
Convolvulaceae	*Ipomoea indica*	Morning Glory
Crassulaceae	*Bryophyllum delagoense*	Mother of millions
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant
Fabaceae (Caesalpinioideae)	*Senna pendula var. glabrata*	
Fabaceae (Faboideae)	*Erythrina x sykesii*	Coral tree
Musaceae	*Musa acuminata*	Edible banana
Oleaceae	*Ligustrum sinense*	Small-leaved Privet
Passifloraceae	*Passiflora suberosa*	Cork Passionfruit
Poaceae	*Paspalum quadrifarium*	Blue Paspalum
Solanaceae	*Solanum chrysotrichum*	Devil`s Fig
	Solanum mauritianum	Wild Tobacco Bush
Verbenaceae	*Lantana camara*	Lantana

Table 3. Description of Weed Zones

Weed Area	Description
A	**<5% weed cover.** This weed zone is predominantly undisturbed except for the powerline easement along the western boundary. As a result this patch is made up of good quality bushland that is highly resilient and mostly weed free. This zone is a priority to manage and monitor to prevent the encroachment or establishment of weeds from the neighbouring zones.
B	**75-100% weed cover.** This area lacks canopy species and mostly consists of dense patches of Blue Paspalum (*Paspalum quadrifarium*), Crofton Weed (*Ageratina adenophora*) and scattered Arum Lily (*Zantedeschia aethiopica*).
C	**<5% weed cover.** This area is predominantly, good quality bushland which is highly resilient and mostly weed free. This zone is a priority to manage and monitor to prevent the encroachment or establishment of weeds from the neighbouring zones.
D	**50-75% weed cover.** This weed zone follows a drainage line where there are encroachments of Crofton Weed (*Ageratina adenophora*), Small-leaved Privet (*Ligustrum sinense*) and exotic

Weed Area	Description
	ornamental garden species. This zone will be re-landscaped as part of the proposed development.
E	**<5% weed cover.** This area is predominantly, good quality bushland which is highly resilient and mostly weed free. This zone is a priority to manage and monitor to prevent the encroachment or establishment of weeds from the neighbouring zones.
F	**25-50% weed cover.** This area forms a transition between the high density weeds of Zone 4 and the moderate quality bushland. The bushland most consists of intact native strata but is subject to weed encroachment from the high density weed area of Zone G. Lantana (*Lantana camara*) continues down the edge of the track and Blue Paspalum (*Paspalum quadrifarium*) is scattered throughout the zone and along the track. Despite the weed encroachment this area has a good level of resilience.
G	**75-100% weed cover.** Previous disturbance during the construction of the access road has led to dense weed infestations in this area. This area contains dense thickets of Lantana (*Lantana camara*), a mature Coral Tree (*Erythrina × sykesii*), scattered Oleander (*Nerium oleander*), Morning Glory (*Ipomoea indica*) at the western end as well as Wild Tobacco (*Solanum mauritianum*), Giant Devil's Fig (*Solanum chrysotrichum*) and a few small shoots of Asparagus Fern (*Asparagus aethiopicus*).
H	**75-100% weed cover.** Dense patches of Blue Paspalum (*Paspalum quadrifarium*) are scattered throughout this area. Crofton Weed (*Ageratina adenophora*) follows the drainage line and the edge of bushland areas. Mature Coral Trees (*Erythrina × sykesii*) are present and juvenile Coral Trees (*Erythrina × sykesii*) are becoming scattered in this area. Lantana (*Lantana camara*) and Wild Tobacco (*Solanum mauritianum*) are also encroaching on bushland edges.

Figure 4. North-west corner of Weed Zone G.

Figure 5. Looking east over Weed Zone B.

Figure 6. Looking north over Weed Zone C.

Figure 7. Managed lawn area looking to bushland area.

Figure 8. Managed lawn area to be developed.

Figure 9. Edge of Weed Zone G and H looking west.

Title: Asset Protection Zone

Map No: 2

Site: William Charlton Village

Client: Allambie Heights Village

Date: February 2020

Project No: C11661

Author: G Teear

Legend

- Outter Protection Zone
- Subject Site
- APZ

0 15 30 60 Meters

N

Data Source:
Total Earth Care
Nearmap

total earth care

Copyright Total Earth Care Pty Ltd, 2018

Tel: 02 9913 1432 Fax: 02 9913 1434

Title: OEH 2016 Vegetation Mapping

Map No: 3

Site: William Charlton Village

Client: Allambie Heights Village

Date: February 2020

Project No: C11661

Author: G Teear

Legend

Subject Site

Plant Community Type

- S_DSF09: Coastal Sandstone Gully Forest
- S_DSF11: Sydney North Exposed Sandstone Woodland
- S_HL08: Coastal Sandstone Heath-Mallee
- Urban_E/N: Urban Exotic/Native
- Weed_Ex: Weeds and Exotics

0 15 30 60 Meters

N

Data Source:
Total Earth Care
Nearmap
OEH 2016

Copyright Total Earth Care Pty Ltd, 2018

Tel: 02 9913 1432 Fax: 02 9913 1434

total earth care

Title: Vegetation Communities TEC 2019

Map No: 4

Site: William Charlton Village

Client: Allambie Heights Village

Date: Feb 2020

Project No: C11661

Legend

- Subject site
- Study area
- Lot

Plant Community Type (PCT)

- PCT 1250: Sydney Peppermint - Smooth-barked Apple - Red Bloodwood
- PCT 1783: Red Bloodwood - Scribbly Gum / Old-man Banksia
- PCT 1824: Mallee - Banksia - Tea-tree - Hakea
- Urban Exotic/Native
- Weeds and Exotics

0 15 30 60 Meters

N

Data Source:
Total Earth Care
SIX Maps

Copyright Total Earth Care Pty Ltd, 2017

Tel: 02 9913 1432 Fax: 02 9913 1434

total earth care

Title: Weed Density

Map No: 5

Site: William Charlton Village

Client: Allambie Heights Village

Date: February 2020

Project No: C11661

Author: G Teear

Legend

Subject Site

Weed Density

- < 5%
- 5 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%

0 12.5 25 50 Meters

N

Data Source:
Total Earth Care
Nearmap

total earth care

Copyright Total Earth Care Pty Ltd, 2018

Tel: 02 9913 1432 Fax: 02 9913 1434

Title: Habitat Constraints

Map No: 6

Site: William Charlton Village

Client: Allambie Heights Village

Date: February 2020

Project No: C11661

Author: G Teear

Legend

- Subject Site
- Drainage lines and 10m buffer
- Sanstone Rock Outcrops

0 15 30 60 Meters

N

Data Source:
Total Earth Care
Nearmap

total earth care

Copyright Total Earth Care Pty Ltd, 2018

Tel: 02 9913 1432 Fax: 02 9913 1434

4 Identification of Potential Impacts to Biodiversity

4.1 Nature and Extent of Proposed Construction Activities

The proposed development includes the construction of the following:

- Two additional building containing independent living units;
- Communal building;
- Associated landscaping;
- Required APZs;
- Internal access roads; and
- Car parking.

The impact area for the construction of buildings and roads and landscaping is show on Map 1. Landscaping includes the modification and naturalization of the drainage line north of the access road to include boulders and pools.

Most of the vegetation to be cleared is within the areas of managed lawn and includes mature native and exotic tree species and small patches of vegetation predominantly made up of weeds and exotic plant species.

4.2 Nature and Extent of any Bushfire Hazard Asset Protection Zones

The area to be managed as an APZ is shown in Figure 9. The APZ will be managed as an Inner Protection Area (IPA) and an OPA(Australian Bushfire Safety & Planning 2018). The OPA is defined in Map 2 and the remainder of the APZ will form the IPA. Most of the area to be managed as an IPA is already cleared with some mature remnant and planted native trees and patches of weeds and exotic species. Sections of the OPA have a high density of weeds and will therefore benefit from the clearing required for the OPA. Some native ground cover and shrub species may require removal to meet the below requirements for the OPA. Some canopy species may also need to be removed to meet the OPA requirements.

Planning for Bushfire Protection (NSW RFS 2019) states that the following requirements apply when establishing and maintaining an IPA:

"Trees:

- *canopy cover should be less than 15% (at maturity)*
- *trees (at maturity) should not touch or overhang the building*
- *lower limbs should be removed up to a height of 2m above ground*
- *canopies should be separated by 2 to 5m*
- *preference should be given to smooth barked and evergreen trees.*

Shrubs:

- *create large discontinuities or gaps in the vegetation to slow down or break the progress of fire towards buildings*
- *shrubs should not be located under trees*
- *shrubs should not form more than 10% ground cover*
- *clumps of shrubs should be separated from exposed windows and doors by a distance of at least twice the height of the vegetation.*

Grass:

- *should be kept mown (as a guide grass should be kept to no more than 100mm in height)*
- *leaves and vegetation debris should be removed."*

Planning for Bushfire Protection (NSW RFS 2019) states that the following requirements apply when establishing and maintaining an OPA:

"Trees:

- *tree canopy cover should be less than 30%; and*
- *canopies should be separated by 2 to 5m.*

Shrubs:

- *shrubs should not form a continuous canopy; and*
- *shrubs should form no more than 20% of ground cover.*

Grass:

- *grass should be kept mown to a height of less than 100mm; and*
- *leaf and other debris should be removed.*

These APZs are to be managed in a manner that provides as much biodiversity value as possible, within the constraints required for fire protection performance. The measures taken include:

- Weeds to be completely removed and supressed;
- Tree and shrub thinning is required to reduce the canopy cover to 15% or less and the shrub layer to 20% cover or less;
- Retain some larger tree specimens as standing habitat by poisoning rather than felling,
- Retain diversity in groundcover species with grasses and forbs;
- Supplemental planting of low native grasses and ground covers at minimum of 10 per square metres; and
- Use of sandstone and erosion control measures where the APZ is in close proximity to drainage lines.

4.3 Nature and Extent of Proposed Operational Activities

The nature of the ongoing operational activities include use of the residential buildings, facilities and garden areas by senior residents and their visitors. Road use is likely to be infrequent and as it will be used as a thoroughfare. There are few ongoing impacts foreseen during the operational activities. Potential impacts included increased ongoing human presence closer to the bushland area, including some increased to noise and light.

4.4 Potential Indirect Impacts to Any Vegetation in Areas Adjoining the Development

Potential indirect impacts to vegetation include the potential encroachment of exotic plants into bushland by gardening activities. The appropriate selection of landscaping species can minimise this risk.

Increase rate of run-off from hard surfaces of the proposal may alter stream flow rates outside the subject site and lead to increases in sediment or nutrient loads and should be addressed in the Storm Water Management Plan addressing onsite detention measures.

There are potential impacts from erosion and sediment run-off which can be minimised with standard control techniques and must be addressed in the Construction Environment Management Plan (CEMP) which should be prepared prior to works as a requirement of this management plan. See 5.1 for further details.

5 Impact Mitigation Pre-clearing and During Clearing Works

5.1 Pre-clearing

The following mitigation measures are to be documented in a CEMP and implemented prior to clearing:

- All Environmental Subplans (e.g. Soil & and Water MP, Flora and Fauna MP etc.) within the CEMP must include Scope, Project Compliance Requirements, Project Targets, Control Measures Used, and Monitoring Details.
- Erosion and sediment control must be detailed in an Erosions and Sediment Management Plan, including types of control, method of installation, locations, maintenance regime, responsibilities, and stockpile storage. These may include, but are not limited to, silt fencing, vehicle shake-down, floating silt boom, and stabilisation access for machinery.
- Prior to works commencing a pre-clearance survey must be conducted by a qualified Ecologist to determine the presence of any nests, dreys or fauna using hollows. A report of findings for any required supervision of clearing works is to be submitted to Council.
- Areas determined not to be cleared must be marked and flagged off as “no-go” zones prior to construction and maintained throughout the works period.
- Any trees marked within “no-go” zones are to be retained and protected. Any impacts to these trees have not been assessed in this current report. AS 4970-2009 Protection of trees on development sites, is to be followed for all trees to be retained.
- Any trees within close proximity to the works zones must be examined by an arborist prior to works to identify the Tree Protection Zone (TPZ) and the Structural Root Zone (SRZ).
- For APZs;
    - Survey the APZ alignments (OPA, IPA and significant habitat features);
    - Delineate the alignment with bunting;
    - Identify trees for removal or pruning in consultation with fire consultant and ecologist;
    - Tag all trees which are to be protected; and
    - Protect all trees which are to remain within the APZs in close proximity to the clearing alignment.
- All environmentally sensitive areas must be permanently delineated from clearance areas with fencing and signage. Delineation must allow for passage of native fauna.
- All personnel must undertake environmental site inductions to highlight any and all environmental and ecological constraints within the site.
- Hygiene controls must be implemented for all vehicles and personnel entering the site. Phytophthora hygiene controls are provided in Appendix D.
- The bushland area must be permanently delineated from the areas managed as APZs, to assist in defining areas for ongoing fuel reduction management actions. This is to be an indicative boundary and not designed to restrict human or fauna access. A minimum specification consists of a single wire star picket fence or similar. Other posts of similar dimensions could be chosen for aesthetic consideration. Small auger or drilled post holes may be required given the shallow exposed bedrock.

5.2 During Clearing

The following mitigation measures should be implemented and maintained during clearing:

- Erosion and sediment controls should be implemented and maintained as per the Erosions and Sediment Management Plan.
- Areas which are marked and flagged off as “no-go” zones should be maintained during construction.
- Any trees marked within “no-go” zones are to be retained and protected. AS 4970-2009 Protection of trees on development sites, is to be followed.
- TPZs and the SRZs should be maintained for trees within proximity of the work zones.

- All environmentally sensitive areas must be permanently delineated from impacted areas with fencing and signage. Delineation must allow for passage of native fauna.
- All personnel should undertake environmental site inductions to highlight any and all environmental and ecological constraints within the site.
- Hygiene controls should be implemented for all vehicles and personnel entering the site. Phytophthora hygiene controls are provided in Appendix D.
- Felled trees, particularly those with hollows, are be placed within the remnant bushland within the site under the direction of an ecologist.
- Any hollows which are removed should be replaced with nest boxes at a ratio of 2:1 (two nest boxes for every hollow removed). The size of these should be determined by the size of the hollow removed. For example, large hollows should be replaced with large nest boxes at a 2:1 ratio.
- During tree clearing works, a qualified ecologist should be on present on site. If an animal is identified and at risk during construction, works should not continue until the animal has been rescued. If the animal is injured a qualified carer should be contacted by either ringing Sydney Metro Wildlife on 02 9413 4300 or WIRES on 1300 094 737.
- All weed vegetation should be removed from the site for disposal. Weedy vegetation should not be moved or stockpiled in areas of retained vegetation in order to reduce their spread. Ongoing treatment of remaining weeds outside cleared areas is covered in Section 6 of this management plan.

5.3 Construction

The following mitigation measures should be implemented and maintained during construction:

- Erosion and sediment controls should be implemented and maintained as per the Erosions and Sediment Management Plan.
- Areas which are marked and flagged off as “no-go” zones should be maintained during construction.
- Any trees marked within “no-go” zones are to be retained and protected. AS 4970-2009 Protection of trees on development sites, is to be followed.
- TPZs and the SRZs should be maintained for trees within proximity of the works zones.
- All environmentally sensitive areas must be permanently delineated from construction areas with fencing and signage. Delineation must allow for passage of native fauna.
- All personnel should undertake environmental site inductions to highlight any and all environmental and ecological constraints within the site.
- Hygiene controls should be implemented for all vehicles and personnel entering the site. Phytophthora hygiene controls are provided in Appendix D.
- The marking and flagging of the APZ boundaries should be maintained to protect the surrounding remnant intact bushland.

5.4 Post-construction

The following mitigation measures should be implemented post construction:

- Bush regeneration within the adjacent remnant bushland is recommended to increase habitat quality for native ground cover species and address the existing problem weeds at the edges which include but are not limited to: Wild Tobacco (*Solanum mauritianum*), Morning Glory (*Ipomoea indica*), dense thickets of Lantana (*Lantana camara*), Crofton Weed (*Ageratina adenophora*) and Senna (*Senna pendula* var. *glabrata*). Bush regeneration is also required to address new weed infestations that are likely to arise after construction.
- Bush regeneration and management of the retained bushland should be conducted as per the management zones detailed in Section 6 of this report.
- All environmentally sensitive areas must be permanently delineated from the residents’ area. Delineation must allow for passage of native fauna.

- Landscaping works are to be outside areas of bushland and do not include Environmental Weeds.

Title: Boundaries for Delineation

Map No: 7
Site: William Charlton Village
Client: Allambie Heights Village
Date: February 2020
Project No: C11661
Author: G Teear

Legend

Subject Site

Delineation Boundaries

Management Zones

1
2
3
4
5

0 10 20 40 Meters

N

Data Source:
Total Earth Care
Nearmap

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6 Management of Retained Vegetation and Rehabilitation Areas

The areas of vegetation to be retained and managed as an OPA following development are described in Table 4 below. The boundaries for these zones are shown in Map 8 with photo-monitoring points for each zone. Photos taken during the February field survey at these photo-monitoring points are provided in Table 5. The management actions, timing, duration and performance indicators for these zones are provided in Table 6. A Gantt Chart with the timing of works is provided in Table 7.

Table 4. Management Zones

Management Zone	Management Issues
1	This management zone is predominantly undisturbed, good quality bushland that is highly resilient and mostly weed free. This zone is a priority to manage and monitor to prevent the encroachment or establishment of weeds from the neighbouring zones. Small shoots of Asparagus Fern (*Asparagus aethiopicus*) are beginning to emerge near photo-point A at the boundary of this zone. These should be targeted as a priority to prevent further encroachment into the adjacent areas of high quality bushland.
2	This zone lacks canopy species and mostly consists of dense patches of Blue Paspalum (*Paspalum quadrifarium*), Crofton Weed (*Ageratina adenophora*) and scattered Arum Lily (*Zantedeschia aethiopica*). Management efforts in this zone must focus on preventing the spread of weeds into the good quality bush of Zone 1 to the east and west.
3	This area forms a transition between the high density weeds of Zone 4 and the moderate and good quality bushland. Lantana (*Lantana camara*) continues down the edge of the track and Blue Paspalum (*Paspalum quadrifarium*) is scattered throughout the zone and along the track. Management actions should focus on reducing the weed infestation and preventing the spread into the good quality bushland of Zone 1.
4	This zone contains dense thickets of Lantana (*Lantana camara*), a mature Coral Tree (*Erythrina × sykesii*), scattered Oleander (*Nerium oleander*), Morning Glory (*Ipomoea indica*) at the western end, as well as Wild Tobacco (*Solanum mauritianum*), Giant Devil's Fig (*Solanum chrysotrichum*) and a few small shoots of Asparagus Fern (*Asparagus aethiopicus*) in close proximity to photo-point A. Management efforts in this zone must focus on preventing the spread of weeds into the good quality bush of Zone 1. Asparagus Fern (*Asparagus aethiopicus*) should be a priority target as only a small amount of young growth was observed. This can be eradicated easily at this stage before it spreads.
5	This area forms the OPA of the APZ. There is a high density of weeds at the northern part of this zone and along the drainage line including Crofton Weed (*Ageratina adenophora*) and Wild Tobacco (*Solanum mauritianum*). Management actions should focus on the removal of weeds around the drainage line working from upstream areas to downstream areas. Weed management should also prevent the spread of weeds into the good bushland of in Zone 1 and in the western portion of Zone 5. This zone will also be managed as an OPA as per the Planning for Bushfire Protection (NSW RFS 2019) requirements discussed in Section 4.2.

Title: Management Zones

Map No: 8
Site: William Charlton Village
Client: Allambie Heights Village
Date: February 2020
Project No: C11661
Author: G Teear

Legend

Subject Site

Photo Monitoring Points

Management Zones

1
2
3
4
5

0 10 20 40 Meters

N

Data Source:
Total Earth Care
Nearmap

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Table 5. Photo-monitoring point images

Photo Point	Direction	Photo
1	North	

Photo Point	Direction	Photo
2	East	

Photo Point	Direction	Photo
3	East	

Photo Point	Direction	Photo
4	South-west	

Table 6. Schedule of Works

Management Action	Management Zones	Task	Specifications	Timing	Estimated Duration	Responsibility	Performance Indicators/ deliverables
Site Meeting, Induction and WH&S	All zones	Project meeting with client, construction contractors and bush regeneration contractor	Meeting on site with all concerned parties prior to commencement of works. Induction, including environmental inductions undertaken. Review and implementation of site specific WH&S and CEMP. Discussion, review and induction for protocols for prevention of pathogen and weed spread.	Pre-construction	Half a (0.5) day	Property Owner and Contractors	WH&S documentation Inductions, including environmental inductions completed by all staff Wash down area designated All staff inducted into work site safety and protocols
Baseline Survey	All zones	Begin establishment of baseline monitoring photo-points. Begin baseline weed mapping of all zones.	Establish baseline monitoring photo points and weed density mapping for each management zone. Conduct weed density mapping. An overall assessment of the density of weeds on site is to be conducted by an ecologist or qualified bush regenerator	Start of BMP implementation	One (1) day	Ecologist or qualified Bush Regeneration Contractorr	Baseline photo points, signs of dieback in vegetation and weed densities established, to be collated into first progress report (at 6 months from implementation of BMP)

Management Action	Management Zones	Task	Specifications	Timing	Estimated Duration	Responsibility	Performance Indicators/ deliverables
Pre-clearance survey	Construction zone and OPA	Pre-clearance survey for active nest, dreys and any fauna that could be injured.	A qualified ecologist experienced in handling fauna is required to do a pre-clearance survey before any trees or vegetation are removed. If any nests or hollows are identified an ecologist must supervise the clearing.	Prior to clearing	One (1) day	Ecologist	Pre-clearance letter report.
Fence of "no-go" zones	Zones 1 and 4	Protection of conservation areas.	Zones 1 and 4 must be fenced off as "no-go" zones prior to construction. High-vis flagging is recommended to flag off the "no-go" zones. No equipment or fill is to be stored in these areas. Machinery or construction contractors must not enter the "no-go" areas.	Pre-construction and maintained until post construction	One (1) day	Construction Constructor	Photos provided in monitoring report and flagging maintained throughout the construction period.
Permanent delineation between the OPA and bushland areas	Zone 1, 4 and 5	Delineation of conservation areas from OPA	Zones 1 and 4 must be permanently delineated from the APZ area to provide a clear management line. As a minimum, a 3 strand wire fence with post at 2-5 m intervals must be installed. Other fencing options can be used provided they are fauna friendly (no	During construction and must be maintained indefinitely.	Two (2) to three (3) days	Construction Contractor	Photos provided in monitoring report. Fence maintained and functional for the life of the BMP.

Management Action	Management Zones	Task	Specifications	Timing	Estimated Duration	Responsibility	Performance Indicators/ deliverables
			barbed wire and allow fauna to pass through).				
Sediment Fencing	Zones 1, 5 and the construction area	Installation of sediment fencing and maintenance of existing sediment fencing	Sediment fencing to be installed down slope of any earthworks and above drainage lines. Specifications included in Appendix F. Sand bags must be used in the access road gutter to prevent sediment entering drainage lines, bushland and stormwater. Fences to be maintained and functional throughout period of construction.	Before construction works begin. Must be maintained during the entire construction period until the erosion risk is eliminated.	One (1) day, two (2) staff	Construction Contractor or Bush Regeneration Contractor	No sediment flow into bushland or drainage lines. Sediment fence functional throughout the period of construction. Performance of fence noted in monitoring BMP reporting.
Identify trees for APZ Clearing	Zone 5 (OPA)	Identify trees for removal	Bushfire consultant and ecologist to determine the trees required for removal within the OPA.	Prior to APZ clearing (within two (2) weeks of clearing)	One (1) day with ecologist and fire consultant	Bush Fire consultant and Ecologist	Trees to be removed and retained clearly marked.
Initial Weed Control	Zones 1 and 2 to the north of access road	Weed Control	Weed treatment including hand removal, cut and paint and herbicide spraying where relevant. Treat woody weeds in situ. See Appendix E for species specific treatment techniques.	Prior to or during construction work	Two (2) days, team of four (4)	Bush Regeneration Contractor	Before and after monitoring photographs. Waste and weed propagules removed off-site.
Initial Weed Control	Zones 1 to 4 south of access road.	Primary Weed Control	Control weeds working outwards from the centre of Zone 1 towards other zone boundaries. Treat woody weeds in situ. See Appendix E for species specific treatment techniques.	Prior to or during construction work	Two (2) days, team of four (4)	Bush Regeneration Contractor	Before and after monitoring photographs. Waste and weed propagules removed off-site.

Management Action	Management Zones	Task	Specifications	Timing	Estimated Duration	Responsibility	Performance Indicators/ deliverables
Secondary Weed control	All zones	Secondary Weed Control	Secondary weed treatment including hand removal, cut and paint and herbicide spraying where relevant. See Appendix E for species specific treatment techniques.	Six (6) months after initial weed control	Two (2) days, team of four (4)	Bush Regeneration Contractor	Before and after monitoring photographs. Waste and weed propagules removed off-site.
Year 1 maintenance	All Zones	Weed Maintenance	Minimum four (4) visits. Maintenance works to prevent re-establishment of weeds. Weed control methods that can be undertaken include hand weeding and spraying if necessary. Maintenance of APZ following RFS specifications for an OPA as outlined in Section 4.2.	First visit six (6) months after the secondary weed control. At least two (2) visits during the spring and summer months to target the flush of annual species.	One (1) day, team of four (4) each visit	Qualified Bush Regeneration Contractor	Reduce weeds to less than 15% cover within Year 1. APZ meets RFS specifications for maintenance of an OPA.
Year 2 maintenance	All Zones	Maintenance weeding	Minimum of two (2) annual maintenance visit. Maintenance works to prevent re-establishment of weeds. Weed control methods which can be undertaken include hand weeding and spraying if necessary. Maintenance of APZ following RFS specifications for an OPA as outlined in Section 4.2.	During the spring and summer months to target the flush of annual species.	One (1) day, team of four (4) each visit	Qualified Bush Regeneration Contractor	Reduce weeds to less than 10% cover within Year 2. APZ meets RFS specifications for maintenance of an OPA.

Management Action	Management Zones	Task	Specifications	Timing	Estimated Duration	Responsibility	Performance Indicators/ deliverables
Year 3 maintenance	All Zones	Maintenance weeding	Minimum of two (2) annual maintenance visits. Maintenance works to prevent re-establishment of weeds. Weed control methods which can be undertaken include hand weeding and spraying if necessary. Maintenance of APZ following RFS specifications for an OPA as outlined in Section 4.2.	During the spring and summer months to target the flush of annual species.	One (1) day, team of four (4) each visit	Qualified Bush Regeneration Contractor	Maintain weeds to less than 5% cover within Year 3. APZ meets RFS specifications for maintenance of an OPA.
Year 4 maintenance	All Zones	Maintenance weeding	Minimum of two (2) annual maintenance visits. Maintenance works to prevent re-establishment of weeds. Weed control methods which can be undertaken include hand weeding and spraying if necessary. Maintenance of APZ following RFS specifications for an OPA as outlined in Section 4.2.	During the spring and summer months to target the flush of annual species.	One (1) day, team of four (4) each visit	Qualified Bush Regeneration Contractor	Maintain weeds to less than 5% cover within Year 4. APZ meets RFS specifications for maintenance of an OPA.
Year 5 maintenance	All Zones	Maintenance weeding	Minimum of two (2) annual maintenance visits. Maintenance works to prevent re-establishment of weeds. Weed control methods that can be undertaken include hand weeding and spraying if necessary.	During the summer months to target the flush of annual species.	One (1) day, team of four (4) each visit	Qualified Bush Regeneration Contractor	Maintain weeds to less than 5% cover within in Year 5.

Management Action	Management Zones	Task	Specifications	Timing	Estimated Duration	Responsibility	Performance Indicators/ deliverables
			Maintenance of APZ following RFS specifications for an OPA as outlined in Section 4.2.				
Monitoring and Reporting	All Zones	Conduct annual monitoring, surveys and progress reports	Assess and present progress and monitoring reports on a six-monthly basis to Council to show whether Key Performance Indicators (KPIs) have been satisfactorily met to Council guidelines.	Every six (6) months	All years	Property Owner, Ecological Consultant or qualified Bush Regeneration Contractor	Weeds are to be reduced to less than 15% cover within Year 1, less than 10% in year 2 and to less than 5% by Year 5.
Final Monitoring Report	All Zones	Conduct final monitoring, surveys and progress report.	Assess and present a final report to Council to show whether KPIs have been satisfactorily met to Council guidelines	End of Year 5 after practical completion	All years	Property Owner, Ecological Consultant or qualified Bush Regeneration Contractor	Weeds to be reduced to less than 10% cover within Year 1 less than 10% in year 2 and to less than 5% by Year 5.

Table 7. Implementation Schedule

Management Zone	ACTION	Construction Stage				OPERATION / MAINTENANCE																				Responsibility
						YEAR 1				YEAR 2				YEAR 3				YEAR 4				YEAR 5				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
All Zones	Site Meeting & Inductions - address WH&S issues																									Property Owner/Project Manager
1,4 and 5	Permanent delineation between the OPA and bushland areas																									Property Owner/Construction contractor
Zone 5	Identify trees for APZ clearing																									Fire Consultant and Ecologist
1,4 and 5	Fence of “no-go” zones																									Property Owner/Project Manager
5 and Construction area	Preclearance Survey																									Ecologist
1, 5 and Construction area	Install sediment fencing																									Property Owner/Construction contractor
All Zones	Baseline Survey																									Bush Regenerator or Ecologist
	Initial Weed Control - Zones 1 and 2 to the north of access road																									Bush Regenerator
	Initial Weed Control - Zones 1 to 4 south of access road																									Bush Regenerator
	Secondary Weed Control																									Bush Regenerator
	Year 1 Maintenance					x2			x2																	Bush Regenerator
	Year 2 Maintenance																									Bush Regenerator
	Year 3 Maintenance																									Bush Regenerator
	Year 4 Maintenance																									Bush Regenerator
	Year 5 Maintenance																									Bush Regenerator
	Monitoring Reports																									Bush Regenerator or Ecologist

7 Monitoring Guidelines

A program of monitoring and inspection is to be carried out by a qualified bushland management consultant (qualified ecologist or bush regeneration supervisor) to ensure the measures outlined in this BMP are implemented and that performance criteria have been satisfied. The monitoring programme will commence prior to any works to gather baseline data and will continue for the duration of the maintenance period.

The monitoring programme will involve:

- Assessment of weed control works and native regeneration success via permanent repeatable photographic monitoring points, and surveys of whole management zones by a suitably qualified person (ecologist or bush regeneration supervisor) to measure percentage cover of native and exotic species for each zone. Monitoring point locations are shown in Map 8;
- Mapping of weed densities per zone for the site to assess the progress of the works towards the final requirement of maximum <5% weed cover;
- Assessment of evidence of herbivory, and recommendations to counteract;
- Assessment of evidence of erosion, and recommendations to mitigate;
- Recommendations for corrective measures and/or specific vegetation management required; and,
- Provision of regular reports outlining data collected and tracking of works towards final KPIs.

Monitoring events and reporting are to follow the following schedule:

- Baseline Survey – Prior to commencement of bushland management works. No report required, but this information must be added to initial progress report;
- Surveys and Progress Report at Six (6) Monthly Intervals– following every 6 months of management activities. Report to include baseline from previous report, commencement and continuation of works, and survey results;
- Final monitoring report after five (5) years from practical completion is required which will report as to whether KPIs have been achieved, and if not, include recommendation on further works required.

All reports should be prepared by suitably qualified professionals and submitted to Council. Council defines a qualified person for supervision of on ground bush regeneration works such as weed removal, bush regeneration and revegetation as having:

- A minimum two years supervising experience of on–ground bush regeneration work and TAFE Certificate III in Conservation and Land Management - Natural Area Restoration or equivalent.

And for undertaking the bush regeneration works:

- A minimum of a TAFE Certificate II in Conservation and Land Management-Natural Area Restoration or equivalent.

8 Corrective Actions

Based on the monitoring report results corrective actions must be implemented where performance targets are not on track. Table 8 details corrective actions for potential management issues which may be identified during the monitoring stage. Corrective actions must be provided in the monitoring reports when required:

Table 8. Potential management issues and corrective actions

Management Issue	Corrective Action
Weed cover exceeding targets by 10% or more.	Increase weed control visits by a qualified bush regenerator. Frequency of visits to be determined by a qualified ecologist or bush regenerator to meet KPI's.
Ineffective sediment fencing or in disrepair	Repair existing fencing. Add additional fencing where required to ensure no sediment is entering drainage lines, bushland or stormwater.
Destabilisation after weed removal work	If the slope in management Zone 4 becomes destabilised after weed removal it should be stabilised using the following methods: - Installation of coir logs and/or jute matting depending on the extent and level of erosion potential. - Planting of local provenance tube stock plant species and watering. Plant survival rates must be maintained at 80% and in filled with additional plants if required.

9 References

Cropper, S.C. (1993) Management of Endangered Plants. CSIRO Publications Victoria.

DECC (2004). *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities. Working Draft.* NSW Department of Environment and Climate Change, Sydney.

DPIE (2013). Soil Landscapes of Central and Eastern NSW - v2, NSW Office of Environment and Heritage, Sydney. Available at: https://www.environment.nsw.gov.au/eSpade2Webapp [Accessed 9 Jan 2020].

DPIE (2020) Bionet Atlas [online]. Available at https://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx [Accessed 9 Jan 2020]

Harden GJ (ed) (1992) *Flora of New South Wales. Volume 3*. New South Wales University Press, Kensington.

Harden GJ (ed) (1993) *Flora of New South Wales. Volume 4*. New South Wales University Press, Kensington.

Harden GJ (ed) (2000) *Flora of New South Wales. Volume 1*. *Revised Edition*. University of New South Wales Press, Sydney.

Harden GJ (ed) (2002) *Flora of New South Wales. Volume 2*. *Revised Edition*. University of New South Wales Press, Sydney.

Landcom (2004) Managing Urban Stormwater: Soils and Construction

NSW Rural Fire Service (2019) Planning for Bushfire Protection - A guide for councils, planners, fire authorities and developers. November 2019

OEH (2016a) *The Native Vegetation of the Sydney Metropolitan Area. Volume 2: Vegetation Community Profiles.* Version 3.0. Office of Environment and Heritage, Department of Premier and Cabinet, Sydney.

OEH (2016b) NSW Guide to Surveying Threatened Plants. Office of Environment and Heritage, Department of Premier and Cabinet, Sydney.

Richardson, F.J., Richardson, R.G. and Shepherd, R.C.H., 2016. *Weeds of the south-east: an identification guide for Australia* (No. Ed. 3). CSIRO.

Robinson L (2003) *Field Guide to the Native Plants of Sydney*. Kangaroo Press, Sydney.

Triggs B (1984) *Mammal Tracks and Signs: A Field guide for Southeastern Australia*. Oxford University Press, Melbourne.

Appendix A. Proposed Plans

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AMENDMENTS

ISSUE	DESCRIPTION	APPROVED	DATE
1	AUTHORITY APPROVAL	MR	19/12/19

DRAWING KEY:

- SITE BOUNDARY
- PROJECT BOUNDARY
- 25m / 50m OFFSET FROM APZ LINE AS ASSESSED BY BUSHFIRE CONSULTANT, DASHED RED.
- APZ LINE AS ASSESSED BY BUSHFIRE CONSULTANT DASHED BLUE
- SITE VIEWS
- EXISTING ACCESS TO SITE
- MAIN SITE ENTRY
- EXISTING RETAINED BUILDING
- EXISTING RETAINED TREE
- TREE PROTECTION ZONE, REFER ARBORIST REPORT
- PROPOSED TREE, REFER LANDSCAPE PLAN

THIS DRAWING ISSUE HAS BEEN REVIEWED FOR

AUTHORITY APPROVAL

APPROVED BY: MR
CHECKED BY: GA

CLIENT
ALLAMBIE HEIGHTS VILLAGE

DRAWING
SITE PLAN

DATE	SCALE @ A1	DRAWN
09/03/18	1 : 500	SF

PROJECT No.	DISCP.	DRAWING No.	ISSUE
2017019	A	DA-011	1

PROJECT
2017019 - ALLAMBIE HEIGHTS

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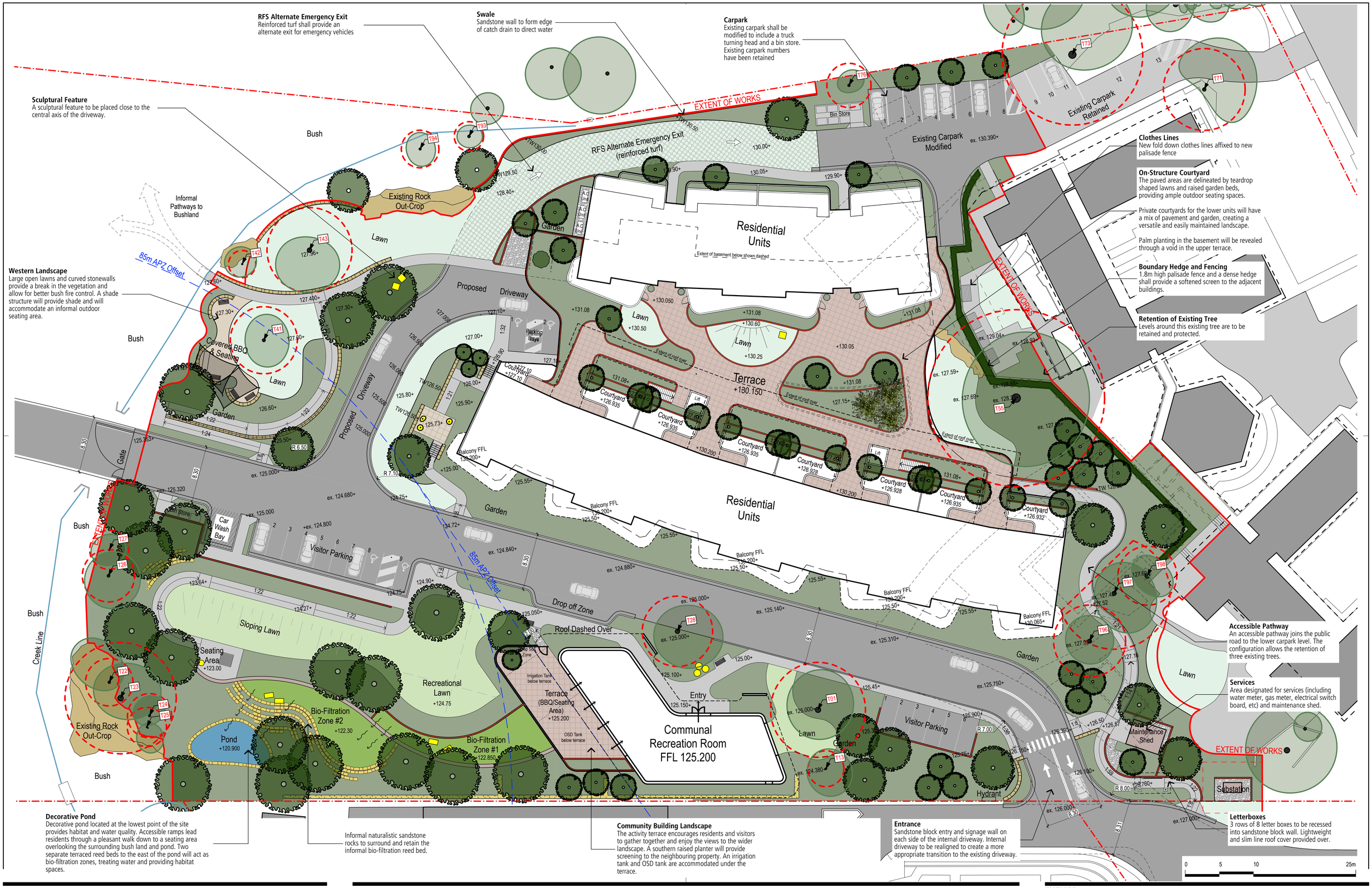
Appendix B. Landscape Plans



arterra

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Legend

- Boundary
- Building Outline
- Building Above
- Building Below
- Existing Creek Line
- Existing Tree Retained (Extent of canopy as verified by site measure)
- Nominal Tree Protection Zone (TPZ)
- T01 Tree ID Numbers (Retained)
- Proposed Tree
- Garden
- Bio-filtration Zone
- Turf
- Pavement - Standard Grey Concrete
- Pavement -Tile
- Pavement - Decomposed Granite
- Pavement - Gravel
- Retaining Wall - Blockwork
- Retaining Wall - Dry Stacked Stone Wall
- Retaining Wall - Gabion
- Informal Sandstone Boulders
- Clothesline
- Bench Seat
- Overland Flow Path
- Sculptural Features/ Planter

REVISION	DESCRIPTION	CHKD	DATE
P1	For Rural Fire Service Review	RWS	24/10/19

PROJECT & CLIENT

Allambie Heights Village - Project 2

Allambie Heights Village Ltd.

North

Project No : 18.11
Designed : CLB
Drawn : CLB
Scale : 1:250@A1/1:500@A3

DRAWING TITLE

Landscape Concept Plan

DRAWING NUMBER L-SD-01

REVISION P1

Plotted at : 5:27 pm 24/10/19

Appendix C. Fauna Species Lists

Table 9. Fauna species observed during February 2020 survey.

Family	Scientific Name	Common Name	Exotic	BC Status	EPBC Status
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra		P	
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo		P	
Corvidae	*Corvus coronoides*	Australian Raven		P	
Estrildidae	*Neochmia temporalis*	Red-browed Finch		P	
Leporidae	*Oryctolagus cuniculus*	Rabbit	*		
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill		P	
	Anthochaera chrysoptera	Little Wattlebird		P	
	Manorina melanocephala	Noisy Miner		P	
	Meliphaga lewinii	Lewin's Honeyeater		P	
	Phylidonyris niger	White-cheeked Honeyeater		P	
	Phylidonyris novaehollandiae	New Holland Honeyeater		P	
Pseudocheiridae	*Pseudocheirus peregrinus*	Common Ringtail Possum		P	
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet		P	
Psophodidae	*Psophodes olivaceus*	Eastern Whipbird		P	
Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul	*		

Table 10. Fauna species observed during previous TEC surveys.

Common name	Scientific name	BC Act status	EPBC Act status
Red Wattlebird	*Anthochaera carunculata*	P	
White-striped Free-tail Bat	*Austronomus australis*	P	
Eastern Pygmy-possum	*Cercartetus nanus*	V	
Gould's Wattled Bat	*Chalinolobus gouldii*	P	
Large-eared Pied Bat	*Chalinolobus morio*	P	
Common Eastern Froglet	*Crinia signifera*	P	
Kookaburra	*Dacelo novaeguineae*		
Australian Magpie	*Gymnorhina tibicen*	P	
Striped marsh frog	*Limnodynastes peronii*	P	
Square-tailed Kite	*Lophoictinia isura*	V	
Noisy Miner	*Manorina melanocephala*	P	
Common Dwarf Skink	*Menetia greyii*	P	
Little Bentwing-bat	*Miniopterus australis*	V	
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V	

Common name	Scientific name	BC Act status	EPBC Act status
Rabbit	*Oryctolagus cuniculus*		
Yabby (in Southern creek)	*Parastacidae* family		
Sugar Glider	*Petaurus breviceps*	P	
Common Ringtail Possum	*Pseudocheirus peregrinus*	P	
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V
Black Rat	*Rattus rattus*		
Pied Currawong	*Strepera graculina*	P	
Rainbow Lorikeet	*Trichoglossus haematodus*	P	
Common Brushtail Possum	*Trichosurus vulpecula*	P	
Large Forest Bat	*Vespadelus darlingtoni*	P	
Little Forest Bat	*Vespadelus vulturnus*	P	
Fox	*Vulpes vulpes*	U	
Swamp Wallaby	*Wallabia bicolor*	P	

Appendix D. Phytophthora Hygiene Protocols

Task	Action
Timing	When possible/practical, the development should be completed in dry soil conditions and postponed following significant rainfall. Working in dry soil conditions will reduce the need for cleaning vehicles and equipment. If it is necessary to work in wet or damp areas then greater attention will need to be spent on vehicle and equipment cleaning.
Staff	Contractors and staff involved in the development are to be made aware that fungus has / has not been recorded on site, and provided with information regarding management protocols and its threat to native vegetation.
Drainage and Water	Alterations to drainage that may result in the spread of *Phytophthora* into new areas are to be avoided as highest priority. Water used during construction should be minimised. When water is necessary, it should be from a reticulated mains system, bore supply or sterilised source. Surface water collected from infected areas should not be used. Water draining from the site should not to enter bushland areas. The use of water for dust suppression should be kept to a minimum.
Landscaping and Bush Regeneration	Plants used in landscaping should be purchased from a nursery with accreditation from the Nursery Industry Association, or from a nursery with excellent hygiene conditions. Species selected for landscaping should preferably be resistant to *Phytophthora cinnamomi*. Any gravel/sand/topsoil to be bought onto site should be purchased from a Nursery Industry Association accredited supplier, or should be certified (through testing) to be free of *Phytophthora cinnamomi*. Any infected soil/sand/gravel/vegetation moved on the site, or removed from the site should be stored at in area that is also infected with *Phytophthora cinnamomi*, or a site where the pathogen will not have any impact. Storage of gravel/sand/topsoil on site should preferably be on a dry well drained surface. Construction materials such as pipes, rocks, timber, bricks etc, should be free of mud and soil when arriving at the site. Staff should not enter infected areas unless necessary, movement within these areas should be kept to a minimum.
Vehicles and Machinery	All machinery, vehicles and equipment should arrive at the site free of uncontained mud and soil, particularly on tyres, mudflaps and the underbody. Vehicles and machinery exiting the site to be free of all uncontained mud and soil, particularly on the tyres, mudflaps and the underbody. Minimise the amount of water used. Try to remove soil and mud when it is dry (a stiff brush or stick maybe useful). Cleaning will be easier and more effective if it is completed at a depot or a permanent/designated cleaning area (it is acceptable for vehicles and machinery to be taken to a cleaning facility on sealed roads). If cleaning is to occur in the field select a site with a hard, well-drained surface (eg. a road) that is well away from remnant vegetation. If possible, wash down in an area that is close to the area you have been operating in. Wash down on ramps if possible. Do not allow mud and wash-down effluent to drain into bushland. Do not drive through wash-down effluent.
Footwear and Tools	Try to remove as much mud and soil as possible when it is dry with a stiff brush or stick. Minimise the amount of water used to initially clean footwear and tools. Footwear and tools should be scrubbed with a sterile solution (see below). All mud and soil should be collected (including in liquid) and removed in a bag or bucket. This material is to be disposed of at a site that is already infected with Cinnamon Fungus, or a site that contains no bushland.
Sterilising	Equipment can be sterilised by soaking in a disinfectant such as bleach (containing sodium hypochlorite). The bleach should be diluted (1 part bleach to 10 parts water), soak the tools for a few minutes, and then rinse. Alternatively methylated spirits can also be used for sterilising small hand tools and footwear in the field. A spray bottle containing methylated spirits can be used to cover all surfaces, allowing time for it to soak into all soil material (a couple of minutes is sufficient). A sterile water solution suitable for spraying down vehicles and machinery can be made by mixing 6mL of sodium hypochlorite (eg. pool chlorine or bleach) to every 10L of water.

Appendix E. Weed Species listed as a Biosecurity Risk

Table 11. Categories of Management under the Greater Sydney Regional Strategic Weed Management Plan 2017-2022 under the NSW Biosecurity Act 2015

Category	Management Action
Prevention (Prevent)	To prevent the weed species arriving and establishing in the Region.
Eradication (Eliminate)	To permanently remove the species and its propagules from the Region, OR to destroy infestations to reduce the extent of the weed in the region with the aim of local eradication.
Containment (Minimise)	To prevent the ongoing spread of the species in all or part of the Region.
Asset Protection (Manage)	To prevent the spread of weeds to key sites/ assets of high economic, environmental and social value, or to reduce their impact on these sites if spread.
GBD (General Biosecurity Duty)	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."
RRM (Regional Recommended Measure)	Specific details for each species included in table.
PoD (Prohibition on Dealings)	Must not be imported into the State or sold.
B Zone (Biosecurity Zone)	Specific details for each species included in table.
PM (Prohibited Matter)	A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries.

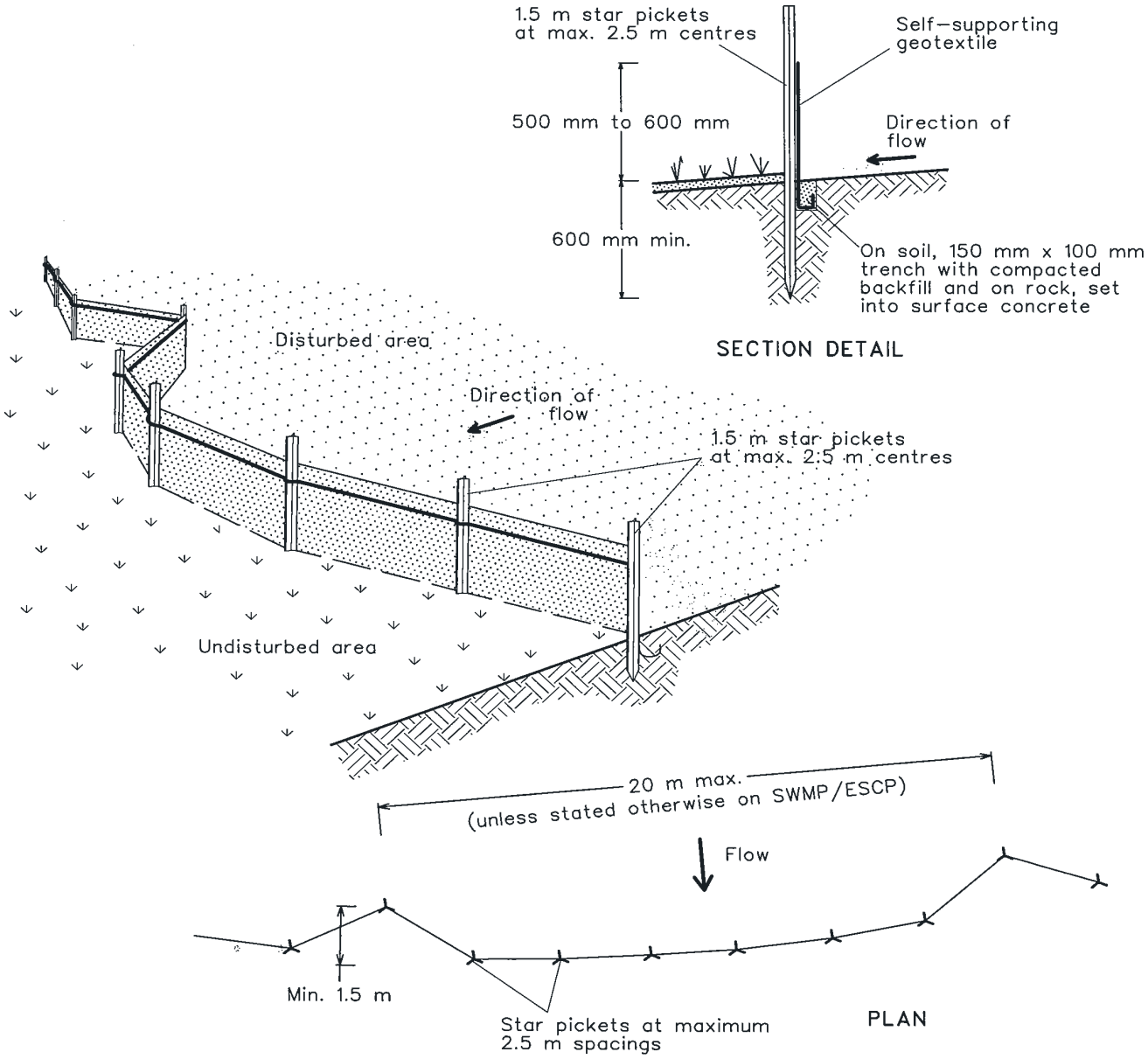
Table 12. Biosecurity Risk & Management Actions

Common Name	Botanical Name	WONS	State Priority Weed-Mgmt. Actions	Regional Priority Weeds-Mgmt. Actions	Other Regional Weeds-Asset/value at risk	Duties for Priority Weeds of Greater Sydney	Weeding Technique	Herbicide Application	Herbicide Group	Ratio
Crofton Weed	*Ageratina adenophora*				Environment, Agriculture		Hand removal, brush cut and foliar sprayed with Glyphosate	Glyphosate 360g/L	M	1/100
Asparagus Fern	*Asparagus aethiopicus*	Yes	Asset Protection			PoD	Small single specimens to be crowned or Sprayed with Glyphosate/metsulfuron methyl	Glyphosate 360g/L & Metsulfuron-Methyl 600 g/kg	M & B	1/100 & 1g/10L
Mother of Millions	*Bryophyllum delagoense*				Environment, Agriculture, Human health		Hand pulled or spot sprayed with Starane Advance	Fluroxypyr 333 g/L present as meptyl ester	I	0.36/100
Coral Tree, Common Coral Tree	*Erythrina x sykesii*				Environment		<80mm cut & painted; >80mm will be drilled/frilled with neat Glyphosate	Glyphosate 360g/L	M	Neat
Morning Glory / Blue Morning Glory	*Ipomoea indica*				Environment, Human health		Small single specimens hand pulled, skirting larger vines scraping and painting with neat Glyphosate	Glyphosate 360g/L	M	Neat
Lantana	*Lantana camara*	Yes	Asset Protection			PoD	Cut and paint, sprayed or splattered with Glyphosate	Glyphosate 360g/L	M	Neat
Small Leaf Privet	*Ligustrum sinense*				Environment, Human health		<80mm cut & painted; >80mm will be drilled/frilled with neat Glyphosate	Glyphosate 360g/L	M	Neat

Common Name	Botanical Name	WONS	State Priority Weed-Mgmt. Actions	Regional Priority Weeds-Mgmt. Actions	Other Regional Weeds-Asset/value at risk	Duties for Priority Weeds of Greater Sydney	Weeding Technique	Herbicide Application	Herbicide Group	Ratio
Tussock Paspalum, Blue Grass	*Paspalum quadrifarium*				Environment		Hand pulled or brush cut and foliar sprayed with Glyphosate	Glyphosate 360g/L	M	1/50
Corky Passionflower	*Passiflora suberosa*				Environment		Hand remove small individuals, spot spray or scrap and paint with neat Glyphosate	Glyphosate 360g/L	M	1/100 & Neat
Castor Oil Plant	*Ricinus communis*						Hand pulled and cut & painted with neat Glyphosate	Glyphosate 360g/L	M	Neat
Senna / Cassia	*Senna pendula*				Environment		Small individuals hand removed, larger plants cut and painted with neat Glyphosate	Glyphosate 360g/L	M	Neat
Giant Devil's Fig	*Solanum chrysotrichum*			Prevention		RRM: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should				

Common Name	Botanical Name	WONS	State Priority Weed-Mgmt. Actions	Regional Priority Weeds-Mgmt. Actions	Other Regional Weeds-Asset/value at risk	Duties for Priority Weeds of Greater Sydney	Weeding Technique	Herbicide Application	Herbicide Group	Ratio
						not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.				
Tobacco Bush/ Wild Tobacco	*Solanum mauritianum*				Environment, Agriculture		Cut & paint with Glyphosate	Glyphosate 360g/L	M	Neat
Arum Lily	*Zantedeschia aethiopica*				Human health, Environment		Physical removal of whole plant and rhizome or cut and paint with Neat Glyphosate	Glyphosate 360g/L	M	Neat

Appendix F. Sediment Fence Specifications (Landcom 2004)



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE

SD 6-8