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Subdivision Water Management Report

Wolfdene Placid Waters (South)

Project No: EP25-135(05)

Prepared for Wolfdene
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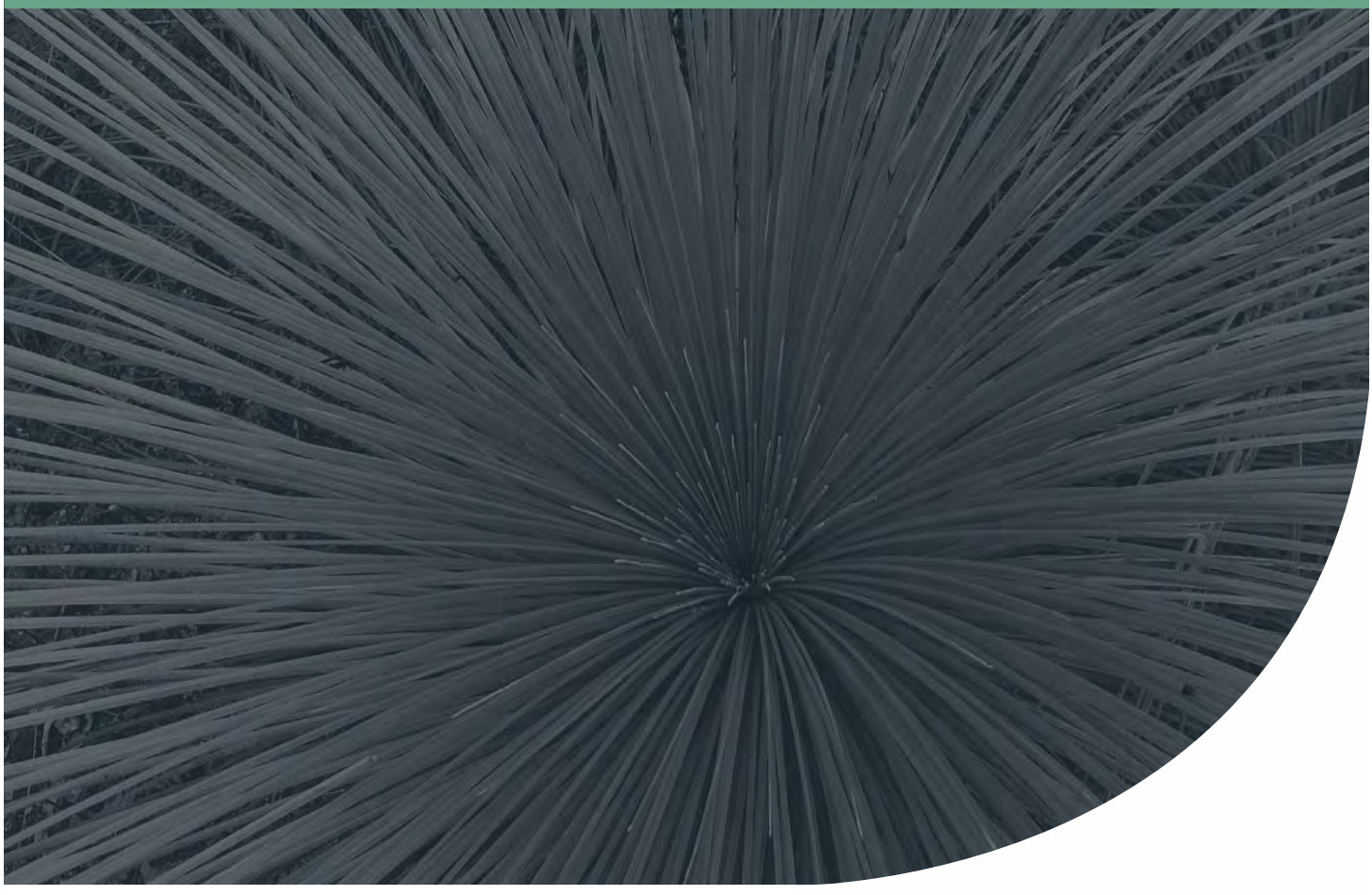

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Executive Summary

Wolfdene (the 'Proponent') are progressing with the development of Lot 9003 Placid Waters Parade, Coodanup (herein referred to as the 'site') for residential purposes. The site is situated approximately 74 km south of the Perth central business district (CBD), within the City of Mandurah (CoM). The site covers an area of 21.24 ha and is bounded by existing residential areas to the east and west, with foreshore areas and regional open spaces associated with the Serpentine River to the north and the Peel-Harvey Estuary to the south.

The site is zoned 'urban' under the Peel Region Scheme (PRS) with the northern portion reserved for 'parks and recreation.' The site is zoned 'urban development', with the northern portion reserved for 'regional open space' under the City of Mandurah Local Planning Scheme (LPS) No.12 (CoM 2022).

This Subdivision Water Management Report (SWMR) details the water management approach to support the development of the site. The SWMR is intended to satisfy the requirements of State Planning Policy 2.9 Water and the Planning for Water Guidelines SPP 2.9 (DPLH 2025a) and to address the general expectations of the Department of Water and Environmental Regulation (DWER) and adopt relevant CoM policies regarding water management to support sub-division application.

The SWMR outlines the likely water sensitive design (WSD) measures that can be adopted to provide protection to water resources and the broader environment, and which will provide an appropriate level of amenity to the future development.

The key environmental attributes and values within and adjacent to the proposed site relevant to water management are summarised below:

- The site receives 635 mm of rain on average annually with the majority of this rainfall received between May and September.
- The site levels range from approximately 0.18 mAHD to 3 mAHD. The majority of the site generally ranges between 1 mAHD and 2 mAHD.
- The majority of the site is underlain by sands derived from Tamala Limestone, while the foreshore area of the site is comprised of estuarine and lagoonal alluvium deposits associated with the Serpentine River and Peel–Harvey Estuary.
- The site is located within a 'Flood Hazard Area' under the Special Control Area as per City of Mandurah LSP No. 12, which corresponds to the 1% Annual Exceedance Probability (AEP) flood fringe within foreshore areas, identified by DWER mapping.
- The site is immediately adjacent to the Serpentine River to the north and Peel Harvey Estuary to the south; however, the area of the site proposed for development is elevated above the 1% AEP flood level and is not within the mapped floodway of the River.
- Measured MGL beneath the site are between 1.5 m BGL and 2 m BGL, indicating MGL is at approximately between 0.86 and 1.07 m AHD.
- Measured groundwater quality parameters show high concentrations of TP and TN at all monitoring bores except MW2.
- The site has a moderate to high risk of ASS occurring within 3 m of natural soil surface.
- The site is not identified as a contaminated site.

- Three multiple use wetlands (MUW) are identified within site boundary, while two conservation category wetlands (CCW) are located adjacent to the site near Serpentine River and Peel Harvey Estuary.
- The vegetation within the site is present between 'very good' to 'completely degraded' condition. The majority of the vegetation is in 'degraded' and 'completely degraded' condition (i.e. approximately 72.5% of the site).
- No threatened or priority flora species were recorded or are considered likely to occur within the site.
  A registered Aboriginal Heritage occurs over (and incorporating) the site.
- There is no bush forever site identified within the site boundary.

This document addresses water management strategy for the site which include stormwater management, groundwater management, water conservation, and the objectives for these. The existing environmental attributes of the site have guided development of design criteria which address the above aspects and aim to meet the overall development objectives for the site.

The primary water management approach for the site is to mimic the existing hydrology, which infiltrates runoff at source. To manage the surface water within the site, a WSD approach will be utilised to maintain the pre-existing hydrology, including (but not limited to):

- Soakwells and at-lot scale infiltration
- Bio-retention areas (BRAs), and vegetated swales to treat the small rainfall event (first 15 mm)
- Flood storage areas (FSAs) for the major rainfall event i.e. 1% annual exceedance probability (AEP).

This SWMR is a key supportive document for the proposed development. It has been prepared with the intention of providing a structure within which subsequent development can occur consistent with the integrated water cycle management approach, establishing water management methods that have been based on site-specific investigations, and are consistent with relevant state and CoM guidelines. It is also intended to provide guidance to the development of future water management documents.

Table E1: Water management criteria and compliance

	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	When implemented
Water Conservation	WC1	Adopt a fit for purpose water supply strategy to meet potable and non-potable needs.	A reticulated potable water supply will service the site to meet lot scale potable and non-potable needs	Proponent	Construction
			Rainwater tanks will be encouraged (for lot owners) to supplement non-potable uses.	Proponent and CoM	Building approval
	WC2	Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water.	Use of water efficient fixtures and appliances	Lot owners and residents	Construction and ongoing
			Adoption of waterwise gardening practices	Lot owners and residents	Landscaping and ongoing
	WC3	Open space areas will be designed to require no more than 6,750 kL/ha/yr for irrigation	Landscape design that follows waterwise gardening practices.	Developer	Landscape design and implementation
	WC4	Minimise the clearing of vegetation within open spaces where possible.	Landscape and civil designs will ensure to maximise tree retention within POS areas	Developer	Landscape and civil designs
Stormwater Management	SW1	Treat the first 15 mm of rainfall within lots and road reserves as close to source as possible.	Lots will retain the small rainfall event onsite within gardens and soakwells measures.	Lot owner	Lot construction
			Small rainfall event across the development will be treated by WSD measures within POS areas.	Proponent	Drainage and landscape design and implementation
	SW2	Runoff up to the 1% AEP event is to be retained on site.	Lots to retain rainfall event up to 1% AEP in soakwells and pervious gardens. Runoff above the small rainfall event up to the 1% AEP event runoff that is not retained higher in catchment will be conveyed to the downstream flood storage areas within POS	Proponent	Detailed design
	SW4	Provide minimum 500 mm clearance between finished floor levels and adjacent top water levels	The civil designs provided in **Appendix B** indicate that the finished floor levels of lots maintain a 500 mm clearance above the flood level of adjacent TWLs of flood storage areas.	Proponent	Drainage design and implementation

Table E1: Water management criteria and compliance (continue)

	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	When implemented
	SW5	Design infiltration areas to avoid creating mosquito habitat.	Due to the high infiltration rates of the sand profile, the infiltration of runoff within the co-located basin will require 2.5 to 3 hours	Proponent	Detailed design
	SW6	Apply appropriate non-structural measures to reduce nutrient loads.	Minimising fertilisers use to establish and maintain vegetation within landscaped areas and road verges	Proponent	Construction of POS and ongoing
			Use of drought tolerant turf species that require minimal water and nutrients Education of residents regarding fertiliser use and nutrient absorbing vegetation species	Proponent	Landscape design At point of sale
			Routine street sweeping and maintenance of stormwater management infrastructure	Proponent initially, then CoM following handover	Practical completion of stormwater management infrastructure and ongoing

Table E1: Water management criteria and compliance (continue)

	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	When implemented
Groundwater Management	GW1	Maintain groundwater quality leaving the site.	Treat stormwater runoff prior to infiltrating to groundwater (see **Criteria SW1**)	Proponent	Detailed design
			Provide educational literature to lot owners on appropriate fertiliser use and waterwise gardening (WWG) principles on lot gardens.	Proponent	At point of sale
			Implement WWG and appropriate fertiliser management on lots	Lot owners	After construction and ongoing
			Implement WWG and appropriate fertiliser management in landscaped areas	Proponent initially, then CoM following handover	After construction and ongoing
	GW2	Use water sensitive design approaches to recharge the superficial aquifer.	Surface water runoff will be infiltrated and recharge the superficial aquifer using soakwells on lots, swales, BRAs and FSAs.	Proponent	Detailed design
	GW3	Lots to achieve 1.2 m clearance above MGL.	The minimum lot level is 1.65 m above MGL	Proponent	Detailed design

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
ABS	Australian Bureau of Statistics
ANZECC	Australian and New Zealand Environment and Conservation Council
BoM	Bureau of Meteorology
DBCA	Department of Biodiversity, Conservation and Attractions
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
CoM	City of Mandurah
WAPC	Western Australian Planning Commission
WC	Water Corporation

Table A2: Abbreviations – General terms

General terms	
AEP	Annual exceedance probability
ASS	Acid sulfate soils
BMP	Best management practices
BRA	Bio-retention area
POS	Public open space
RWT	Rainwater tanks
TWL	Top water level
WMR	Water management report
WEFA	Water efficient fixtures and appliances
WSD	Water sensitive design
WWG	Waterwise gardens
CMP	Construction management plan

Table A3: Abbreviations –units of measurement

Units of measurement	
ha	hectare
kL	kiloliter
m	meter
m^2	square meter
m^3	cubic metre
m AHD	m in relation to the Australian height datum
m BGL	meters below ground level
mm	millimeter

1 Introduction

1.1 Background

Wolfdene (the 'Proponent') is proposing to develop Lot 9003 Placid Waters Parade, Coodanup (herein referred to as the 'site') for residential purposes. The site is situated within the City of Mandurah (CoM).

The site covers an area of 21.24 ha and is bounded by existing residential areas to the east and west, regional open spaces associated with the Serpentine River to the north and the Peel-Harvey Estuary to the south. (**Figure 1**).

The subdivision plan allows for the creation of residential lots and public open space (POS). The proposed development is discussed further in **Section 2,** and the conceptual/proposed subdivision plan is provided in **Appendix A.**

1.2 Purpose of the report

This Subdivision Water Management Report (SWMR) presents the water management approach for the proposed development and has been prepared in accordance with State Planning Policy 2.9 – Water and the Planning for Water Guidelines (DPLH 2025a). It also responds to the expectations of the Department of Water and Environmental Regulation (DWER) and relevant CoM policies to support the subdivision application.

1.3 Guiding documents

There are a number of State and Local Government policies of relevance to the site. These policies include:

- *State Water Strategy* (Government of WA 2003)
- *Planning for Water Guidelines: State Planning Policy 2.9-Water* (DPLH 2025b)
- *Statement of Planning Policy No.3: Urban Growth and Settlement* (WAPC 2006)
- *Liveable Neighbourhoods (4th Edition)* (DoP 2015)
- *Guidance Statement 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *Kep Katijin – Gabi Kaadadjan – Waterwise Action Plan* (DWER 2023)
- *Water Sensitive Urban Design Policy – (POL-RDS07): City of Mandurah* (CoM 2007)
- *City of Mandurah – Stormwater Management Plan* (CoM 2008)
- *Local Planning Policy 15 Water Sensitive Urban Design* (CoM 2009).

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding water discharge characteristics that urban developments should aim to achieve. These are key inputs that relate either directly or indirectly to the site and include:

- *Australian Rainfall and Runoff* (Ball 2019)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2018)

- *Stormwater Management Manual for Western Australia* (DWER 2022)
- *Decision Process for Stormwater Management in Western Australia* (DWER 2017).

1.4 Planning context

The site is zoned 'urban' under the Peel Region Scheme (PRS) with the northern portion reserved for 'parks and recreation.' The site is zoned 'urban development', with the northern portion zoned 'regional open space' under the City of Mandurah Local Planning Scheme (LPS) No. 12 (CoM 2022).

The site is situated within a designated 'Special Control Area' under the City of Mandurah LPS No.12. Special control areas set out provisions which may apply in addition to standard zoning requirements.

1.5 Previous studies

1.5.1 Murray drainage and water management plan (GHD 2011)

The Murray Drainage and Water Management Plan (GHD 2011) provides direction to facilitate implementation of WSD best-management practices for the Serpentine River and Peel-Harvey Estuary. Key aspects of water management outlined in the Murray drainage and water management plan are summarised below.

- **Water conservation**
  - Optimise water use through efficiency, reuse, stormwater harvesting, aquifer recharge, and groundwater utilisation.
  - Maintain environmental values and water regimes while minimising development impacts on water resources.
- **Stormwater management**
  - Manage flood risk and runoff through application of water sensitive design (WSD) principles.
- **Groundwater**
  - Assess and manage groundwater responses to development, including level control where required.
  - Protect water quality by managing acid sulfate soils (ASS) and minimising pollutant loads from all sources.
  - Mitigate water quality risks from on-site systems and incorporate opportunities for wastewater reuse.

2 Proposed Development

The proposed development of the site area is 21.24 ha and will include:

- 10.6 ha of residential lots
- Internal road network
- 6.43 ha of POS (which includes 4.1 ha of Regional Open Space and 2.32 ha of Local Open Space).

The guiding principle for water management is to adopt a water sensitive design approach to stormwater treatment, conveyance, and groundwater management. The key aspects of the site relevant to water management are the proximity to the Serpentine River, Peel-Harvey Estuary and the relatively high permeability of soils beneath the site. These are described further in **Section 3**.

Given the above, the primary objectives of the water management approach will be to protect the values of the adjacent waterways, and to adopt an at-source approach to both water quality treatment and flood mitigation.

Small rainfall events (i.e. the first 15 mm of rainfall) will be retained and treated on-site, as close to the source as practicable, through an appropriate combination of WSD measures. These may include rainwater tanks, lot soakwells and soakage structures, vegetated swales, and/or bio-retention areas (BRAs). All of these are being designed to maximise tree retention, and this will involve retaining some existing site levels.

Stormwater runoff generated by events up to the 1% average exceedance probability (AEP) will be retained within lots by combination of soakwells and pervious garden beds. Runoff from road surfaces during minor and major events (20% and 1% AEP) will be conveyed to downstream flood storage areas (FSAs) within POS via a combination of pit and pipe drainage systems and overland flow paths (discussed further in **Section 7**). These have selectively been located outside/away from foreshore areas to facilitate a design response which is appropriate to the adjacent environment.

The proposed subdivision concept for the site is provided in **Appendix A**, civil design concepts are provided in **Appendix B** and landscape design concepts are provided in **Appendix C.**

3 Existing Environment

3.1 Climate

The site experiences a Mediterranean climate which is characterised by warm dry summers and cold wet winters. The nearest weather station (Mandurah Station #009977) recorded an annual average rainfall of 635 mm between 2004 and 2025 (BoM 2026). Most rainfall occurs between May and September, with average monthly totals typically exceeding 100 mm in June and July.

3.2 Topography

The majority of the site is between 0.18 m and 3 m Australian height datum (m AHD). The topography of the site is generally flat with some low rises. The exception is the northwestern corner which fronts the Serpentine River and has slopes >3% as shown on **Figure 2**. The areas with slopes exceeding 3.5% assist in defining the likely extent of the waterway/foreshore area, up to an elevation of 2.1 mAHD (which is the 1% AEP flood height, as described in **Section 3.7**).

3.3 Geotechnical conditions

3.3.1 Regional geology and soils

A review of the 1:50,000 Geological Map Series – Mandurah 2032 IV (DMIRS 2022) describes anticipated surface soil types expected within the site. These are described in **Table 1** and regional soil mapping is shown in **Figure 3**.

Table 1: Geology and landforms within site

Map Unit	Description	Equivalent unit on geological maps
Qts	Quaternary TAMALA (Coastal) Limestone: cemented aeolian (wind-blown) calcarenite and quartz (predominantly) sand	Tamala Limestone (Qpck)
Qhg	Estuarine and lagoonal deposits: Holocene-aged organic clays, silts, and sands, often underlain by Tamala Limestone and covered by Safety Bay Sand, particularly around the Serpentine River.	Estuarine and lagoonal deposits (Qhg)

Geology and soil types beneath the site have been investigated in geotechnical investigations (Structerre 2025) and during bore installation by Emerge Associates (in 2023) . The subsurface soil profile exhibits spatial variability across the site and can be summarised as follows:

- Topsoil – up to 0.2 m thickness, comprising sand and some silty clay
- Silty sand/clayey sand – at 0.1 m to 0.45 m below ground level (BGL)
- Fill sand – at around 0.3 mBGL. Medium dense to dense yellow sand.
- Sandy clay – from 1.4 m depth
- Silty clay – at depths > 2.3 mBGL.

Soil permeability measurement has not been undertaken, however based on similar soil types are commended design permeability of 0.5 x 10^{-4}m/s is appropriate (Douglas Partners 2015) indicating

that the site can adopt infiltrate at source water management approaches where free draining sand or fill sand is present.

3.3.2 Acid sulfate soils

ASS risk mapping (DWER 2025) shows that the site is expected to have a moderate to high risk of encountering ASS within 3 m of the natural surface. The high risk is primarily associated with estuarine and lagoonal sediments related to the Serpentine River and Peel–Harvey Estuary.

Management of potential ASS can be addressed as a separate process to the SWMR, and this is typically assessed in further detail by site specific studies and then managed during the construction process via standard measures.

3.4 Contaminated sites

A review of the DWER *Contaminated Sites Database* (DWER 2026a) indicates that there are no registered contaminated sites within the site.

3.5 Natural assets

3.5.1 Bush forever areas

There are no Bush Forever (BF) sites located within the site.

3.5.2 Flora and vegetation

An assessment was undertaken by Emerge Associates (2023) which involved a desktop analysis of the site environmental setting, focusing on the potential presence of threatened and priority flora and ecological communities. Field investigations were carried out in October and November 2023, during which vegetation composition and condition were documented. The flora and vegetation attributes were assessed to a detailed survey standard, in line with (EPA 2016) guidelines. The results of the study indicate:

- No threatened or priority flora species were recorded or are considered likely to occur.
- Vegetation was classified into eight units:
  - Closed low woodland of Casuarina obesa, Eucalyptus rudis and Melaleuca spp (CoErM),
  - Open woodland of Eucalyptus marginata or Eucalyptus gomphocephala €,
  - Woodland of *Eucalyptus rudis* over sparse sedgeland of *Juncus* spp. and *Lepidosperma longitudinale* (Er),
  - Low woodland to open woodland of *Eucalyptus rudis* and *Casuarina obesa, Salicornia quinqueflora*, *Tecticornia* spp. and *Suaeda australis* and sedgeland of *Lepidosperma longitudinale* and *Juncus* spp (ErCoTS),
  - Woodland of *Eucalyptus rudis* and *Melaleuca rhaphiophylla, Machaerina juncea*, *Lepidosperma longitudinale* and *Juncus* spp *(*ErMr),
  - Shrubland of *Kunzea glabrescens* over grassland of weeds on sandy soils (Kg),
  - *Salicornia quinqueflora*, *Tecticornia* spp., *Suaeda australis* and *Frankenia pauciflora*, *Triglochin mucronata*, **Cotula turbinata* (TS)

  - and cleared.
- Vegetation condition ranged from very good to completely degraded, with approximately 72.5% of the site assessed as degraded or completely degraded.
- The site contains approximately 1.87 ha of the threatened ecological community (TEC) / priority ecological community (PEC) subtropical and temperate coastal saltmarsh, listed as vulnerable under the EPBC Act 1999 and as a Priority 3 PEC in Western Australia.
- All areas mapped as vegetation unit TS, and a small portion of the ErCoTS unit, represent this ecological community.

For water management, a key outcome of the surveys is the presence of the subtropical and temperate coastal saltmarsh TEC/PEC. This TEC/PEC is often associated with waterways/riverine and fringing environments where contiguous with other values and should be considered when establishing land that may be required to protect the values of the waterway. Similarly, the presence of plant community CoErM where contiguous with other waterway values are considered to be riparian vegetation and should also be considered. The presence of these communities/vegetation types of themselves is not a clear indicator of the extent of a waterway and therefore they are only relevant to a foreshore area/management approach where continuous with other values.

The location of TEC/PEC and CoErM communities (i.e. which are considered to be riparian vegetation associated with the waterway) within the site is shown in **Figure 4.**

3.6 Sensitive water resource areas

Sensitive water resource areas (SWRA) are identified in SPP 2.9-Water (DPLH 2025a) to protect groundwater and surface water systems. A review of the SWRA dataset (DPLH 2021) shows that the site is situated within Serpentine River and Peel Estuary catchments on the Swan and Scott Coastal Plains and therefore the majority of the site is located within a SWRA.

3.7 Hydrology

3.7.1 Surface water features and wetlands

There are no existing natural surface water features located therein. However, the site contains multiple use wetlands (MUWs) (UFI #3257, UFI #14576 and UFI #14572) which are located at northern and southern boundaries (**Figure 4**). Whilst they do not occur within the site, there are two conservation category wetlands (CCWs) (UFI #3255 and UFI #14573) that occur beyond the northern and southern extents of the site, associated with the Serpentine River and the Peel Harvey Estuary respectively.

3.7.2 Riverine and Estuarine flooding

The DWER Floodplain mapping tool (DWER 2026c) indicates that the floodway of the Serpentine River intrudes slightly into the northern boundary of the site. The floodway of the waterway should not be impeded by development in any way. The flood elevation in a 1% AEP event adjacent to the site for both the Serpentine River and the Peel-Harvey Estuary is 2.1 m AHD (DWER 2026c), and finished floor levels should achieve an appropriate clearance above this.

The floodplain/flood fringe extends further into the site from both the Serpentine River and Peel-Harvey Estuary sides (i.e. from both north and south), however the presence of a flood fringe/floodplain is typically not considered to be an impediment to development that cannot be overcome by an engineered response (i.e. imported fill).

Further, parts of the proposed development areas may be at risk of flooding from extreme tidal conditions and storm surges from the estuary. A peak storm surge level at the boundary with the estuary during 1% AEP event is anticipated to be between 1.8 and 2.0 m AHD, (GHD 2011; CZM, 2010), which are generally consistent with DWER 1% AEP flood levels in the Serpentine River.

The extent of floodway and flood fringe/floodplain is shown in **Figure 5**.

3.7.3 Local drainage

There is no existing drainage infrastructure within the site. An existing local pit and pipe network exists at William Road adjacent to the eastern boundary of the site.

3.7.4 Hydrological and hydraulic modelling

A 1D hydrological and hydraulic model of the site was developed in order to predict the extent of flooding under various rainfall scenarios. A 1D model has been prepared using XPSWMM software to provide a representation of the existing environment. This same tool can be used to simulate future development of Lot 9003 to determine a future treatment storage volumes and peak discharge rates from the site. This is discussed further in **Section 7.**

Catchments within the site are defined by the existing topography, and these are shown on **Figure 6**. These show that catchments direct runoff either toward the Serpentine River or toward Peel Parade. However, the sandy soils and relatively flat slope are likely to result in the majority of runoff infiltrating at source. Runoff which exceeds local soil infiltration capacity would be localised, occur as sheet flow and would likely re-infiltrate within the site without discharging beyond the site boundary. This is further evidenced by a lack of flow pathways from the site to either the Serpentine River or the Peel-Harvey Estuary and suggests that an infiltrate at source approach will be the most appropriate response to mimic the existing site processes.

3.8 Groundwater

3.8.1 Groundwater resources

The Water Register (DWER 2026b) indicates that the site is within the City of Mandurah sub-area of the Southwest Coastal Groundwater Management Area. This sub-area is comprised of:

- Superficial Swan Aquifer (unconfined)
- Leederville Aquifer (confined)
- Cattamarra Coal Measures Aquifer (confined).

The Water Register (DWER 2026b) indicates that the Leederville Aquifer fully allocated but that there may be some limited availability within the Superficial Swan Aquifer.

The Superficial Swan aquifer is therefore considered to be the primary aquifer of interest for the development, noting that it may potentially be impacted by water quality in the Peel-Harvey Estuary, and that it is also the most likely to be accessed for local use by others.

3.8.1.1 Groundwater levels

There are no DWER long term/regional monitoring bores within the site, however recent bore installation and monitoring of six bores by Emerge Associates (in 2023) onsite indicates that the maximum recorded groundwater level (MGL) within the site ranges from between 1.5 m and 2 m below ground level (BGL), as shown on **Figure 2**. This indicates that the site measured MGL is at approximately between 0.86 and 1.07 mAHD and suggests that some portions of the site immediately adjacent to the Serpentine River and Peel Harvey Estuary may intersect seasonal groundwater.

Given that the site will need to be filled to >2.1 m AHD to achieve clearance above the river and estuary flood levels, groundwater is unlikely to pose a spatial constraint to the development of the site.

Further monitoring is underway in 2026 and the MGL will be reviewed as necessary following collection of additional data.

3.8.1.2 Groundwater quality

Groundwater quality monitoring across the six onsite bores was undertaken in November 2023. The groundwater quality results are shown in **Table 2** and the location of monitoring bores is shown in **Figure 2.**

The guidelines for fresh and marine water quality are also provided in **Table 2** for reference, though it is noted that the default trigger values indicated are intended to be for surface water and for slightly disturbed ecosystems, not highly modified environments (ANZECC and NWQMS 2000).

Table 2: Groundwater quality November 2023

Bore	pH	EC (mS/cm)	TP (mg/L)	TN (mg/L)	NO_X (mg/L)	NH_3 (mg/L)	TKN (mg/L)
NWQMS (ANZECC 2000)	**6.8-8.0**	**0.3**	**0.065**	**1.2**	**0.15**	**0.08**	**-**
MW1	6.23	0.299	0.38	4.2	0.02	0.04	1.5
MW2	6.88	7.956	0.08	1.2	<0.01	0.46	1.2
MW3	6.31	0.240	0.45	1.9	<0.01	0.20	1.9
MW4	5.60	0.448	0.07	1.8	<0.01	0.22	1.8
MW5	5.95	0.366	0.16	2.6	<0.01	0.26	2.6
MW6	7.10	0.014	0.41	4.6	<0.01	0.45	4.6

The results indicate acidic-brackish conditions, with mean TN and TP concentrations at all bores exceeded all relevant guidelines values across the site, with the except of bore MW2.

3.9 Aboriginal heritage

A review of the Aboriginal Heritage Inquiry System (DPLH 2026) indicates that the site is within a registered heritage site 3582. The registered Aboriginal heritage site covers an extensive area and is not considered to be a constraint to development of the site.

3.10 Summary of existing environment

In summary, the existing environmental investigations conducted to date indicate that.

- The site receives 635 mm of rain on average annually with the majority of this rainfall received between May and September.
- The site levels range from approximately 0.18 mAHD to 3 mAHD. The majority of the site generally ranges between 1 mAHD and 2 mAHD.
- The majority of the site is underlain by sands derived from Tamala Limestone, while the areas adjacent to the Serpentine River and Peel-Harvey Estuary is mapped as estuarine and lagoonal.
- The site is immediately adjacent to the Serpentine River to the north and Peel Harvey Estuary to the south. The 1% AEP flood height predicted by DWER mapping is 2.1 mAHD.
- The site is located within a 'Flood Hazard Area' under the Special Control Area as per City of Mandurah LSP No. 12, which corresponds to the 1% AEP flood fringe identified by DWER mapping.
- Measured MGL beneath the site are between 1.5 m BGL and 2 m BGL, indicating MGL is at approximately between 0.86 and 1.07 m AHD.
- Measured groundwater quality parameters show high concentrations of TP and TN at all bores except MW2.
- The site has a moderate to high risk of ASS occurring within 3 m of natural soil surface.
- The site is not identified as a contaminated site.
- Three MUWs are identified within site boundary, while two CCW are located adjacent to the site – associated with the Serpentine River and Peel-Harvey Estuary.
- The vegetation within the site is present between 'very good' to 'completely degraded' condition. The majority of the vegetation is in 'degraded' and 'completely degraded' condition (i.e. approximately 72.5% of the site).
- No threatened or priority flora species were recorded or are considered likely to occur within the site.
- A TEC/PEC (subtropical and temperate coastal saltmarsh) is located within the site adjacent to the Serpentine River. This TEC/PEC is often associated with waterways/riverine and fringing environments where contiguous with other waterway values.
- A registered Aboriginal heritage site covers an extensive area which includes the site and should be acknowledged when considering the value of waterways adjacent to the site. Notwithstanding the presence of the mythological site, this is not considered to be a constraint to development within the site.
- There is no BF sites identified within the site boundary.

4 Biophysical Assessment

4.1 Policy framework

Government policy and guidance relating to waterways is primarily administered by DWER. A number of guidance documents assist with the determining what is required to protect the value of waterways including:

- *Operation Policy 4.3: Identifying and establishing waterways foreshore areas* (DoW 2012)
- *Guidance Note 6: Identifying and establishing waterways foreshore areas* (DoW 2013)
- *Water Note 23: Determining foreshore reserves* (WRC 2001).

In order to provide clarity as to the recommended approach to protecting a waterway (i.e. the area and design approach required to protect the values of the waterway from the impact of potential development), a biophysical assessment has been undertaken. The location and extent of a foreshore area should be considered during spatial planning of the site and any design response or management approach within and adjacent to these areas. The following biophysical factors require consideration when identifying a foreshore area (WRC 2001):

- Vegetation - the extent of the riparian vegetation
- Hydrology - extent of the floodway/floodplain
- Soil type - soil types that typically support riparian vegetation
- Erosion - soil types that are prone to erosion
- Topography - landscape features
- Function - foreshore function
- Habitat - valuable habitat areas
- Land use - areas that might be harmed by adjacent land use pressures.

4.2 Biophysical assessment

The elements of a biophysical assessment have been considered in the review of the existing environment (see **Section 3** which includes observations and data from on-site assessments recently undertaken. These features and their assessment have been summarised in **Table 3.**

Table 3: Biophysical characteristics and assessment

Biophysical factor	Assessment of biophysical factor	Spatial implications of biophysical factor
Vegetation	TEC/PEC and vegetation communities are present which directly connect to or are immediately adjacent to the Serpentine River floodway a waterway.	TEC/PEC vegetation that is 'good' condition and CoErM communities contiguous with other waterway values should be retained within the waterway or a foreshore area.
Hydrology	The DWER 1% AEP floodway extends slightly into the site on the northern boundary.	The mapped floodway should be included in a foreshore area. Areas of flood fringe do not necessarily need to be retained within a foreshore area.
Topography	Some of the northern portion of the site is low lying and below the 1% AEP TWL. The portions below 2.1 m AHD may provide infrequent	Those portions of the northern boundary site below 2.1 m AHD and where fringing vegetation exists may provide some hydraulic

Biophysical factor	Assessment of biophysical factor	Spatial implications of biophysical factor
	conveyance of large floods through the site. A northwestern portion of the site has slope >3.5% which may assist in defining the edge of the waterway	connectivity in larger less frequent storm events, however this does not define the waterway given that the vegetation is not riparian. Areas adjacent to the waterway and ~ 3.5% slope and up to 2.1m AHD could assist to define the extent of the waterway in some parts of the site (e.g. northwestern corner), however it is noted that there are some areas which appear to meet the slope criteria but which do not provide an indication of waterway extents. Slope > 3.5% of itself is therefore not a clear indicator of the foreshore boundary.
Soil Type	Vasse system soil landscape units exist along the northern and southern boundaries, and these are likely reflective of the adjacent waterway and estuary.	Vasse soil landscape types by themselves do not provide an indication of potential extent of foreshore area. However, their presence provides additional justification where other factors also exist.
Erosion	The southern boundary of the site (Peel Estuary side) includes an existing road and limestone armoured shores. The northern boundary of the site may be subject to minor erosion due to physical processes in the future.	A setback (from the current river edge) of 20 m should be allowed to account for the present-day physical processes. Alternative engineered approaches could be considered where spatial constraints exist as long as these are outside the floodway.
Function	The southern boundary of land adjacent to the site provides an existing function of access and protection from erosion. The function of the northern boundary of the site is limited to some relatively minor amounts of fringing vegetation, and it is not readily accessible.	The southern boundary of the site does not require any additional measures to protect the adjacent Peel-Harvey Estuary or existing uses. The low-lying portions in the northwestern portion of the site where land is below 1 m AHD may be subject to more frequent inundation and will be largely retained in Regional Open Space. The area will require management access and the Local Open spaces within the site will require public access. Maintenance and public access should be considered in the design response for POS areas.
Habitat	Mudflat the coastal saltmarsh TEC/PEC areas within the site are likely to provide foraging habitat for any number of the species that frequent the Peel Inlet, and the saltmarsh/wetland vegetation may provide roosting habitat.	Mudflat and the coastal saltmarsh TEC/PEC areas provide habitat that would be associated with the waterway and where contiguous with other values should be retained to protect the values of the waterway.
Heritage	The presence of the Serpentine River heritage site does not specifically preclude development or provide a defined spatial constraint however it does reiterate the cultural importance of the waterway.	No defined spatial considerations.
Land Use	The land is currently unused with the exception of possible informal pedestrian or vehicular access.	There are no specific requirements or influences on a foreshore area resulting from current land uses.

4.3 Foreshore area and proposed design response

The objectives of the foreshore area, design response and management approach combined is to protect the values of the waterway, to protect life and property from flooding and to provide appropriate amenity to the future and surrounding residents. The proposed subdivision concept, civil design concept and landscape design concept provides an appropriate spatial and design response to the constraints identified.

They key values/aspects to be protected/considered and which drive the final outcome include:

- Retention and protection of coastal saltmarsh Subtropical and Temperate Coastal Saltmarsh areas contiguous with adjacent waterway values.
- Retention of existing riparian vegetation.
- Provision of sufficient land area to accommodate changes in land elevation associated with development.
- Provision of natural area and fire management access within the waterway corridor.
- Ensuring the development footprint is located outside the 1% AEP floodway extent.
- Development interface with the floodway to consider erosion and safety.

The foreshore area should apply a setback or other response from the outermost of the above constraints to allow for integration with development within the site. If a spatial setback is adopted this could be varied in width as long as the design can provide:

- Accommodation of the above listed values/constraints
- Management access and fire emergency services access along the entire waterway interface.
- Earthwork/side slope integration along the entire foreshore interface. This should allow for up to 2 m of level change.

Whatever width is adopted for the foreshore, it should achieve the objectives outline above. This will likely adopting a combination of battered side slope and an engineered (retained) interface where it will allow for greater tree retention, avoid any changes to the floodway form and capacity and provide the required management access.

The proposed approach predominantly adopts a traditional foreshore setback and spatial buffer arrangement, with limited use of retaining walls typically 1.5 m in height (however noting they will vary from 0.3 m in the west and up to 2 m in the east - to accommodate sewer requirements). In most locations, however, the effective wall height will be reduced through integration of batters and side slopes within the adjoining foreshore area. This approach will protect the primary foreshore values (retains TEC/PEC and riparian vegetation and provides for 1% AEP flood conveyance) while allowing for an orderly planned outcome which presents regularly shaped lots, development cells, road reserves and open spaces which also consider other requirements, such as bushfire planning/setbacks and connectivity between adjacent developed areas.

Based on the above considerations, the proposed foreshore area varies in width and is up to approximately 30 m from the outermost constraint, however with some narrower sections which adopt a combination of setback and engineered response, as shown in **Figure 6**. The manner in which the foreshore area is proposed to be treated is also demonstrated in the landscape concept contained in **Appendix C**.

The ongoing management of the foreshore area is further detailed in the Foreshore and Wetland Management Plan (Emerge Associates 2026).

5 Design Criteria and Objectives

5.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003) and SPP 2.9-*Water* (DPLH 2025a) endorse the adoption of integrated water cycle management and application of WSD principles to provide improvements in the management of stormwater, groundwater and water resources, and to increase the efficient use of existing water supplies.

The key principles of integrated water cycle management include:

- Considering all water sources, including wastewater, stormwater and groundwater
- Integrating water and land use planning
- Allocating and using water sustainably and equitably
- Integrating water use with natural water processes
- Adopting a whole of catchment integration of natural resource use and management.

Integrated water cycle management addresses not only physical and environmental aspects of water resource use and planning but also integrates other social and economic concerns. Water management design objectives at Placid Waters should therefore seek to deliver best practice outcomes in terms of:

- Foreshore protection
- Water supply and conservation
- Stormwater management
- Groundwater management.

The first step in applying integrated water cycle management is to establish agreed environmental values for receiving environments. The existing environmental context of the site has been discussed in **Section 3.** Guidance regarding environmental values and criteria is provided by National, State and CoM policies and guidelines, as detailed in **Section 1.3**.

5.2 Water supply and conservation

The design criteria for water conservation management are:

Criteria WC1 Adopt a fit for purpose water supply strategy to meet potable and non-potable needs.

Criteria WC2 Consumption target for water of 100 kL/person/year, including not more than 40 - 60 kL/person/year scheme water.

Criteria WC3 Maximum irrigation rate of 6,750 kL/ha/year in open space areas.

Criteria WC4 Minimise the clearing of vegetation within open spaces wherever possible.

The manner in which this objective will be achieved is further detailed in **Section 6.**

5.3 Stormwater management

The principle behind stormwater management at the site is to mimic the pre-development hydrological conditions, described in **Section 3.7**. This SWMR proposes the following stormwater management criteria:

Criteria SW1 Manage and treat the frequent rainfall event (first 15 mm) as close to source as practicable.

Criteria SW2 Manage runoff up to 1% AEP rainfall event within the site.

Criteria SW4 Provide minimum 500 mm clearance between finished floor levels and adjacent top water levels.

Criteria SW5 Design infiltration areas to avoid creating mosquito habitat.

Criteria SW6 Apply appropriate non-structural measures to reduce nutrients and other pollutants.

The manner in which these objectives will be achieved is further detailed in **Section 7**.

5.4 Groundwater management

The principle behind the groundwater management strategy is to maintain the existing groundwater recharge regime. This SWMR proposes the following groundwater management criteria:

Criteria GW1 Groundwater quality beneath the site to be maintained or improved.

Criteria GW2 Use water sensitive design approaches to recharge the superficial aquifer.

Criteria GW3 Lots to achieve 1.2 m clearance above the MGL.

The manner in which these objectives will be achieved is further detailed in **Section 8.**

6 Water Conservation Strategy

6.1 Fit-for-purpose water use sources

Conservation of water through fit-for-purpose use and best management practices (BMPs) is encouraged so that water is not wasted. Fit for purpose principles have been utilised in the water conservation strategy for the site is summarised in the following sections and will achieve **Criteria WC1**.

6.1.1 Scheme water

Scheme water will be supplied by the Water Corporation's Integrated Water Supply System (IWSS), via an existing 200P-12 water main located within Placid Waters and Peel Parade. Scheme water is proposed to be used for all potable internal house uses. Scheme water will also serve external household uses (including irrigation of outside garden areas) where fit-for-purpose alternatives are not available.

The use of scheme water for irrigation will be minimised and avoided where practicable, particularly for POS, consistent with water efficiency and demand management objectives.

6.1.2 Wastewater

All lots within the site will be connected to the reticulated sewer system which is transported to the Halls Head wastewater treatment plant.

6.1.3 Groundwater

Currently, there are no groundwater licenses exists within the site. Whilst the finish treatments for most POS areas will be based around retention of native vegetation (and will not require irrigation, there may be some portions of POS that require limited irrigation. If this is the case irrigation will be limited to 6750 KL/ha/yr. Given the very minor nature/size of irrigated areas this does not warrant groundwater extraction infrastructure and could be achieved by scheme water. The irrigation requirements and demand will be confirmed once the landscape designs are finalised and after consultation with CoM.

6.1.4 Harvested rainwater

Collection and storage of runoff from roof surfaces can be undertaken using rainwater tanks (RWTs). Stored rainwater may be used for some irrigation requirements however this will need to be supplemented with scheme water during the lower rainfall months. During the higher rainfall months, most of the stored rainwater can be used to supplement lot scale internal building non-potable uses and lot scale irrigation.

RWTs will not be mandated but will be promoted at the point of sale by providing educational literature regarding their benefits and will assist in achieving **Criteria WC1** and **Criteria GW1**.

6.2 Water conservation measures

The water conservation strategy for the site includes:

- Water efficient fixtures and appliances (WEFA) to minimise potable water use.
- RWTs to supply non-potable uses within private lots (where adopted).
- Waterwise garden (WWG) approaches in lot scale gardens and within estate landscaping.

These are summarised in the following sections.

6.2.1 Water efficient fixtures and appliances

The water conservation strategy for the site proposes the use of WEFA. Water efficient fittings will be mandated through the building licence, while the uptake of water efficient appliances can be encouraged by State and Local Government rebates in addition to the education from the proponent at the point of sale. It is assumed that water efficient appliances will be implemented by 40% of households, based on data obtained from the Australian Bureau of Statistics (ABS) (ABS 2023).

The use of WEFA will assist in achieving **Criteria WC1**.

6.2.2 Rainwater tanks

The use of RWTs will not be mandated, and the stormwater quantity management strategy does not rely on their use; they are therefore only considered to be a water conservation measure. Given that RWTs will not be mandated or supplied by the proponent, it has been assumed that these would only be implemented by 7.5% of households, based on data obtained by the ABS (ABS 2023).

The use of RWTs to harvest roof runoff will assist in achieving Criteria **WC1, WC2** and Criteria **GW1**.

6.2.3 Waterwise gardens

Reduction in irrigation requirements will be achieved by promoting WWG principles at the point of sale. It has been assumed that 7% of households will implement WWG within lots (ABS 2013). WWG principles adopted across the development include:

- Retain remnant native trees where possible.
- Irrigation will be avoided during winter months or where sufficient rainfall occurs.
- The irrigation system to be designed and installed according to best water efficient practices:
  - Where required, soil shall be improved with soil conditioner certified to Australian Standards AS4454 to a minimum depth of 150 mm where turf is to be planted and a minimum depth of 300 mm for garden beds.
  - Mulch garden beds to 75 mm with a product certified to Australian Standards AS4454.
- The adoption of xeriscaped gardens (garden beds are landscaped using ‘waterwise plants’).
- Minimise use of fertiliser and/or utilise slow-release fertilisers.

WWG principles will be used within POS, road reserve verges and where relevant within lots. Permanent irrigation within the site will occur within the downstream POS areas.

The adoption of WEFA and WWG principles will assist in achieving **Criteria WC1**, **WC2**, **WC4** and **Criteria GW1**.

7 Stormwater Management

The principle behind the stormwater management strategy for the site is to infiltrate stormwater runoff at source where possible, and to retain up to the 1% AEP event within WSD measures located within the site.

WSD measures that will be utilised include:

- Soakwells and at-lot infiltration
- Gross pollutant trap (GPT)
- BRAs
- Vegetated roadside swales
- Flood storage areas (FSAs).

7.1 Lot drainage

Lots will be required to retain the 1% AEP rainfall event runoff onsite, and this will typically be achieved using soakwells and via infiltration into pervious areas within lots. The runoff will infiltrate directly at-source into the highly permeable underlying soils described in **Section 3.3**, thereby mimicking the existing hydrological regime.

Where adopted, RWTs may also provide some measure of at-source stormwater retention, however this has not been considered in the stormwater modelling undertaken for the site.

Lot storage is the responsibility of the lot owner and should be assessed as part of the building approval process prior to construction.

The use of soakwells and/or pervious garden areas at a lot level will assist in achieving **Criteria SW1**, **SW2** and **GW1**.

7.2 Development drainage

All stormwater runoff from events up to and including the major storm event (1% AEP) will be treated and retained within the site.

Drainage from the road network will first be treated to manage water quality. This will occur within a vegetated swale or to a BRA via a GPT, which will collectively be sized to manage the first 15 mm of rainfall. Runoff above the first 15 mm rainfall and up to the 1% AEP event will be discharged into the downstream FSAs within POS areas within the site.

7.2.1 Gross pollutant traps

Surface flow via flush kerbs/kerb breaks will be adopted where possible for road pavement immediately adjacent to swales. However, for the majority of the site a system of pits and pipes will be required to maintain road trafficability at intersections, and these will be sized to cater for a 20% AEP rainfall event. GPTs will be used as part of the pit and pipe network prior to discharge to BRAs to provide an additional level of treatment.

Flush kerbing/kerb breaks and adoption of GPTs will assist in achieving **Criteria SW7**.

7.2.2 Bio-retention areas and swales

Surface runoff from the small rainfall event (i.e. first 15 mm) from road reserves will be managed by a vegetated swale and/or in vegetated BRAs.

BRAs and the swales will predominantly be vegetated using plant species with high nutrient update capacity and low water requirements, consistent with the *Vegetation guidelines for stormwater biofilters in the South West of Western Australia* (Monash University 2014). BRAs may be underlain with an amended soil media (with PRI > 10 or equivalent) to facilitate nutrient removal from runoff.

The BRAs will be designed with a maximum inundation depth of up to 500 mm, while the swales will have a maximum depth of 300 mm. Both will have maximum side slopes of 1:3. A design infiltration rate of 4.32 m/day has been used for the design of BRAs. This is based on the permeability of existing site soils (Douglas Partners 2015), however it is also noted that these will be constructed into either imported or engineered soil media. The use of BRAs and swale will assist in achieving **Criteria SW1**, **SW4**, **SW5**, **GW1** and **GW2**.

7.2.3 Flood storage areas

Stormwater runoff in excess of the capacity of the BRA and up to the critical duration 1% AEP event will spill via weir overflow or bubble down pit and be retained in an immediately adjacent FSA. A design infiltration rate of 4.32 m/day has been applied to the FSAs within the POS. The FSAs have been designed with a maximum water depth of 500mm; side slopes up to 1:6. The location of the FSAs is shown on **Figure 7** and the design parameters are presented in **Appendix C**

The design of FSAs varies across individual POS areas to facilitate maximum retention of existing trees/vegetation and detailed design is described in **section 7.3**. The modelling methodology and key assumptions are summarised in the modelling assumptions report (MAR) is provided in **Appendix D.**

The implementation of FSAs will assist in achieving **Criteria SW2**, **SW4**, **SW5** and **Criteria GW2**.

7.3 Demonstration of compliance

Criteria SW1 Manage and treat runoff from the small rainfall event (i.e. first 15 mm) as close to source as possible.

Residential lots will retain first 15 mm AEP event runoff using soakwells, and up to the 1% AEP within the lot boundary with a combination of permeable site area and soakwells. Stormwater runoff from road reserves will be retained in the BRAs and swale within POS.

BRAs for Catchments A and B are proposed within the north-eastern and south-western POS areas (**Figure 7**). These BRAs are designed with inundation depths of 0.3 m and 0.5 m respectively, with side slopes no steeper than 1:3 to cater frequent rainfall event.

To maximise retention of existing vegetation within the POS area associated with Catchments C and A, vegetated swales are proposed immediately adjacent to the road reserve. The swales will be designed with side slopes of 1:3 and a depth of up to 0.3 m to accommodate runoff from the first 15

mm rainfall event. Vegetated swale for catchment A will provide added storage and treatment for first 15mm in addition to the downstream BRA.

Surface runoff modelling has been undertaken using XPSWMM to inform the design of drainage infrastructure. The modelling methodology and assumptions are summarised in the Modelling Assumptions Report (see **Appendix D**). The modelled storage volumes required to manage small rainfall events are detailed in **Table 4** and the locations are shown on **Figure 7.**

Table 4: Treatment area (15 mm) rainfall event

Catchments	WSD feature	Depth (m)	TWL surface area (m^2)	Volume (m^3)
CT-A	BRA	0.3	360	100
	Swale	0.3	450	75
CT-B	BRA	0.5	290	120
CT-C	Swale	0.3	640	96

Ct-A: Swale = 225m long, and top width will be 2m

Ct-C: Swale = 320m long, and top width will be 2m

On this basis, Criteria **SW1** is considered to have been achieved.

Criteria SW2 Runoff up to the 1% AEP event is to be retained on site.

Runoff from lots in a 1% AEP event will be managed/retained by using lot soakwells and pervious garden areas. Runoff from roof areas may also be directed to RWTs (where installed) with excess runoff to soakwells, or entirely to soakwells which will infiltrate into sandy fill to be imported to site.

Runoff generated from road reserves for events up to and including the 1% AEP rainfall event will be conveyed firstly to either a swale or a BRA within POS. Once the capacity of the swale/BRA is exceeded it will overtop via weir or bubble down pit/gully to discharge into the adjacent FSA.

The flood storage requirements for major (1% AEP) and minor (20% AEP) events are provided in **Table 5** and location of the FSAs is shown in **Figure 7.**

Table 5: Minor and Major rainfall event retention requirements

Catchments	WSD feature	Minor event (20% AEP)			Major event (1% AEP)		
		Depth (m)	TWL surface area (m^2)	Volume (m^3)	Depth (m)	TWL surface area (m^2)	Volume (m^3)
CT-A	FSA	0.16	554	81	0.5	765	305
CT-B		0.21	235	41		560	215
CT-C		0.19	319	52		470	175

Criteria SW4 Provide minimum 500 mm clearance between finished floor levels and adjacent top water levels

The maximum TWL within the FSAs will be 1.07 mAHD. The detailed civil designs demonstrate that the minimum adjacent lot levels are 2.6 mAHD, thereby providing significantly greater than 500 mm clearance above the TWLs within FSAs.

The 1 %AEP flood height in the adjacent Serpentine River and Peel Harvey Estuary is 2.1 mAHD. The minimum lot height has been set to achieve 500 mm clearance above this at 2.6 m AHD as shown in the civil design concepts contained in **Appendix B**.

Criteria SW4 is therefore considered to be achieved.

Criteria SW5 Design infiltration areas to avoid creating mosquito habitat.

Infiltration structures are designed to dry out within 96 hours following rainfall events to mitigate mosquito breeding risk. Surface runoff modelling undertaken in XPSWMM indicates that the basins will dry out between 2.5 and 4 hours following cessation of the design storm event.

Given that the above measures will be implemented, Criteria **SW5** will be achieved.

Criteria SW6 Apply appropriate non-structural measures to reduce nutrient loads.

A number of non-structural measures will be implemented to help reduce nutrient loads. These measures include:

- Minimising fertilisers use to establish and maintain vegetation within road verges.
- Use of drought tolerant plant species that require minimal water and nutrients.
- Street sweeping to remove sediments and gross pollutants.
- Maintenance of BRAs and the pipe network to remove sediments and other pollutants.
- Education of residents regarding fertiliser use and nutrient absorbing vegetation species within lots.

Given that the above measures will be implemented, Criteria **SW6** will be achieved.

8 Groundwater Management

The main principle behind groundwater management is to maintain the existing hydrology across the site (which infiltrates the stormwater at source or close to source) and to maintain/improve the existing groundwater quality.

It is noted that there is no proposed design criteria regarding inverts of BRAs/FSAs in relation to MGL. This is because native vegetation retention is the primary aim, and the BRAs/FSAs are located in areas that would either achieve almost no clearance, or in the case of the central POS the existing site levels are less than MGL, and a clearance above MGL criteria would not be achievable, or would result in loss of additional native vegetation.

The manner in which the civil designs for the site will comply with design criteria are described in the following sections.

8.1 Demonstration of compliance

Criteria GW1 Maintain groundwater quality leaving the site

Groundwater quality will be maintained by reducing the total nutrient load to groundwater from sources within the site via treatment of surface runoff prior to infiltrating to groundwater. Stormwater runoff will be treated as discussed in response to **Criteria SW1** and **SW2** (discussed in **Sections 7.3**).

Ongoing maintenance of surface water treatment areas will be carried out in accordance with the management objectives and maintenance plans detailed in **Section 0.**

On this basis **Criteria GW1** will be achieved.

Criteria GW2 Use water sensitive design approaches to recharge the superficial aquifer.

Surface water runoff will be infiltrated and recharge the superficial aquifer via on lot soakwells, swales, BRAs and FSAs within the POS. The locations of these structures are shown in **Figure 7**.

The above measures will assist in achieving **Criteria GW2**.

Criteria GW3 Lots to achieve 1.2 m clearance to MGL.

MGL has been measured to be at approximately 0.95 mAHD beneath most of the site. The minimum lot levels are 2.6 mAHD, and this is driven by the regional 1 %AEP flood height of 2.1 mAHD + 500 mm. Most lots are higher than 2.6m AHD. Given that the minimum lot level is 1.65 m above MGL **Criteria GW3** will be readily achieved. Lot elevations are shown on the civil design concepts provided in **Appendix B**.

9 Management and Maintenance Plan

9.1 Management objectives

The design of stormwater management features has been undertaken in a manner that promotes the long-term health of the structural measures and facilitates effective management of the site. Active ongoing management is often required, particularly in the first years after construction.

Ongoing management incorporates a monitoring regime to provide guidance to the management actions which will ensure that the overall objectives are met. The management objectives include:

- Maintain functions of the stormwater management features.
- Minimise potential environmental impacts and disturbance to residents.
- Ensure that the system remains in an appropriate and sustainable condition.

The management objectives will be achieved through the implementation of a number of actions that will be carried out at regular intervals. The key areas that will be addressed through the implementation of these objectives include:

- Construction
- Nutrients and water quality
- Gross pollutants and sediments
- Vegetation management
- Nuisance pests.

9.2 Construction

Prior to earthworks being approved, a site evaluation may be required to be completed in accordance with *A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities* (DEC 2011).

The above guidelines consider the proximity and type of surrounding land uses, the nuisance potential of soil when disturbed, the area and type of works, the existing topography as well as the prevailing winds on the site. Results of the site evaluation will determine the requirement for wind fencing at the site, in addition to any dust suppression and stabilisation measures.

The final construction management plan (CMP) should be prepared which provides direction for dealing with public queries and complaints. Issues that should be addressed in the CMP include:

- Sediment control – temporary sediment control structures and their proposed locations.
- Vegetation – controls to ensure that clearing is minimised to that which is required.
- Noise – operation hours to minimise disturbances to the amenity of the area.
- Preventative measures – control stormwater runoff during construction works.
- Contingency measures – measures to address water quality issues that may arise during construction.

9.3 Nutrients and water quality

Nutrient inputs will be managed to ensure that groundwater quality does not decline. Ongoing measures that will be utilised to control nutrient inputs and therefore groundwater quality include:

- At time of landscape backfilling, apply slow-release fertiliser at the base of planted native species.
- Ongoing application of fertilisers shall be only as required and not exceeding manufacturer's recommended rates of application.

These actions and the manner in which they should be implemented are detailed in **Table 6**.

Table 6: Nutrients and water quality ongoing management and maintenance

Action	Timing	Location	Responsibility
Fertilise native species with slow-release low phosphorous fertiliser	When planted	Around base of planted native species	Landscape contractor
Apply fertiliser at rates not exceeding manufacturer specifications	As required, not exceeding manufacturer specifications	FSA and POS	Maintenance contractor
Provide information to residents	At point of sale	Entire development	Proponent

9.4 Gross pollutants and sediments

Gross pollutants can potentially introduce health risks and reduce the overall visual amenity of an area. The ongoing management and maintenance of gross pollutants will include:

- Periodic visual inspection of the site
- Removal of gross pollutants to an offsite disposal facility in response to observations
- Removal of sediments from BRAs/FSAs within POS areas
- Street sweeping.

These actions and the manner in which they should be implemented are detailed in **Table 7**Table 7.

Table 7: Gross pollutants ongoing management and maintenance

Action	Timing	Location	Responsibility
Inspect for gross pollutants and sediments	Minimum three-monthly	Swale, GPT, BRAs and FSA	Maintenance contractor
Remove gross pollutants and sediments	In response to observations	Swale, GPT, BRAs and FSA	Maintenance contractor
Dispose of waste to an approved facility	Following removal of gross pollutants	Offsite disposal facility	Maintenance contractor
Street sweeping and manual litter collection	After construction and then as required	Road network	Maintenance contractor

9.5 Vegetation management

9.5.1 Weeds

Heavy growth of terrestrial weeds can impair the aesthetic value and hydrological functioning of the swale, BRAs and FSAs. The primary means of monitoring and detecting weed growth will be regular visual inspections by maintenance contractors. Management of weeds will therefore include:

- Visual monitoring for presence of weeds. The information gained will then be used to direct the need for any remedial actions.
- Manual removal of weeds as deemed necessary.
- Application of approved herbicides to terrestrial weeds.

These actions and the manner in which they should be implemented are detailed in **Table 8.**

9.5.2 Infill planting

Some plants can be subject to theft and vandalism. Additionally, there is the potential for young plants to perish prior to establishing deeper root systems. To manage this potential issue, infill planting will be conducted to maintain the required plant densities according to the landscape designs provided in **Appendix C**. If required, management of infill planting will include:

- Visual inspections for infill planting requirements. Information gained during inspections will be used to guide the need for infill planting.
- Conduct infill planting as required.
- Planting densities will be maintained by the proponent until the time of handover to the CoM.

These actions and the manner in which they should be implemented are detailed in **Table 8.**

Table 8: Vegetation ongoing management and maintenance

Action	Timing	Location	Responsibility
Visually monitor for terrestrial weeds	Three-monthly basis	Swale, BRAs and FSAs	Landscape contractor
Manually remove weeds	In response to visual inspections	Swale, BRAs and FSAs	Landscape contractor
Apply herbicide to weeds at manufacturer's recommended rates	In response to visual inspections	Swale, BRAs and FSA	Landscape contractor
Visually monitor for infill planting requirements	Three-monthly basis	Swale, BRAs and FSAs	Landscape contractor
Conduct infill planting	In response to visual inspections	Swale, BRAs and FSAs	Maintenance contractor

9.6 Nuisance pests

An important objective of the stormwater drainage system design is to avoid creating mosquito habitat, as determined in the *Guidance Statement for Management of Mosquitoes for Land*

Proponents (EPA 2003). This is achieved by minimising changes to the existing hydrological regime and ensuring that infiltration throughout the site is maximised such that runoff is infiltrated in less than 96 hours, the critical time for utilisation of surface water for mosquito breeding. Due to the high infiltration rate of the parental sands observed across the site, infiltration across the drainage infrastructure is expected to occur within 4 hours.

Direct intervention methods, such as chemical treatment, are the responsibility of CoM and should be a part of a regional integrated approach to mosquito management. The proponent will work with CoM in such cases where the potential mosquito problem is likely to affect the development.

10 Monitoring Program

10.1 Condition monitoring

In addition to the maintenance and management plan outlined in **Section 9**, it is proposed that the overall condition of the development will be monitored on a bi-annual basis. This monitoring will be implemented after the completion of the civil and landscaping works and will continue for a period of two years or until handover of POS areas.

A visual assessment will be undertaken to monitor the overall condition of the development, with the aim to ascertain that the maintenance activities (as detailed in **Section 9**) are achieving the objectives of the management plan. The parameters that will be monitored and remedial actions that will be implemented if required are detailed in **Table 9**.

Table 9: Condition monitoring parameters and remedial actions

Parameter	Trigger for remedial action	Remedial action
Gross pollutants	If present	Remove gross pollutants and dispose of at approved facility
Sediments	If present	Remove sediments
Terrestrial weeds	Excessive weed growth	Manually remove weeds
		Apply herbicide at manufacturer's recommended rate
Vegetation density	If significant number of plant deaths/thefts occur	Remove dead plants
		Conduct infill planting to maintain species densities

11 Implementation Plan

11.1 Roles and responsibilities

This SWMR provides a framework to implement stormwater management methods that are based upon site specific investigations, and which is consistent with guiding documents and relevant policies.

The responsibility for working within the framework rests with the proponent and their contractors, although it is anticipated the future management actions beyond the proposed management timeframes will be the responsibility of CoM. These responsibilities are outlined in **Section 9.**

11.2 Completion criteria

The overall criteria for the successful completion of the development will be to comply with this SWMR. If the objectives and criteria highlighted within this document are satisfied, the POS will be considered to be in a suitable condition for management handover to the CoM.

If the objectives and criteria of this document have not been fulfilled or other issues are identified, the proponent will work with CoM to determine appropriate contingency measures to achieve a mutually satisfactory outcome.

11.3 Funding

As the subdivision area constitutes a single land holding, the management strategies outlined within this SWMR will be implemented and funded by the proponent. Lot scale measures will be the responsibility of the future lot owners to implement.

11.4 Review

It is not intended that this document will be reviewed unless there are significant changes to the subdivision layout and/or approach to the civil designs.

12 References

12.1 General references

The references listed below have been considered as part of preparing this document.

Australian Bureau of Statistics (ABS) 2013, *4602.0.55.003 - Environmental Issues: Water use and Conservation, Mar 2013*, Canberra <https://www.abs.gov.au/ausstats/abs@.nsf/mf/4602.0.55.003>.

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Department of Water and Environmental Regulation (DWER) 2025, *Acid Sulfate Soil Risk Map, Albany-Torbay (DWER-054)*, <https://catalogue.data.wa.gov.au/dataset/acid-sulphate-soil-risk-map-albany-torbay-dwer-054>.

Department of Water and Environmental Regulation (DWER) 2026a, *Contaminated Sites Database*, <https://dow.maps.arcgis.com/apps/webappviewer/index.html?id=c2ecb74291ae4da2ac32c441819c6d47>.

Department of Water and Environmental Regulation (DWER) 2026b, *Water Register*, Perth, WA, <https://maps.water.wa.gov.au/#/webmap/register>.

Department of Water and Environmental Regulation (DWER) 2026c, *Western Australia Floodplain Mapping*.

Environmental Protection Authority (EPA) 2008, *Guidance Statement No. 33. Environmental Guidance for Planning and Development*, Perth.

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Water and Rivers Commission (WRC) 2001, *Water Note 23: Determining Foreshore Reserves*, East Perth.

12.2 Online references

The online resources that have been utilised in the preparation of this report are referenced in **Section 12.1**, with access date information provided in **Table R 1**.

Table R 1 Access dates for online references

Reference	Date accessed	Website or dataset name
(DWER 2025a)	2 September 2025	Acid Sulfate Soil mapping
(DWER 2025b)	2 September 2025	Contaminated Sites database
(DPLH 2021)	2 September 2025	Government Sewerage Policy database
(DWER 2025c)	8 September 2025	Water Register
(BoM 2025)	11 September 2025	Climate data online
(DBCA 2025)	12 September 2025	Geomorphic Wetlands – Swan Coastal Plain database
(DMIRS 2018)	12 September 2025	1:50,000 Geological Series Map
(DWER 2025d)	12 September 2025	Western Australia floodplain mapping

Figures

Figure 1: Site Location

Project:	Subdivision Water Management Report Placid Waters South Planning Support
Client:	Wolfdene

Plan Number:
EP25-135(05)--F28a

Drawn:	LAM
Date:	22/04/2026
Checked:	UH
Approved:	DPC
Date:	08/05/2026

N

0 50 100 150
Metres

Scale: 1:4,500@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2025). Nearmap Imagery date: 21/01/2026

Figure 2: Topographic Contours

Project:	Subdivision Water Management Report Placid Waters South Planning Support
Client:	Wolfdene

Plan Number:
EP25-135(05)--F29a

Drawn:	LAM
Date:	15/05/2026
Checked:	UH
Approved:	DPC
Date:	15/05/2026

N

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Metres

Scale: 1:4,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2025). Nearmap Imagery date: 21/01/2026

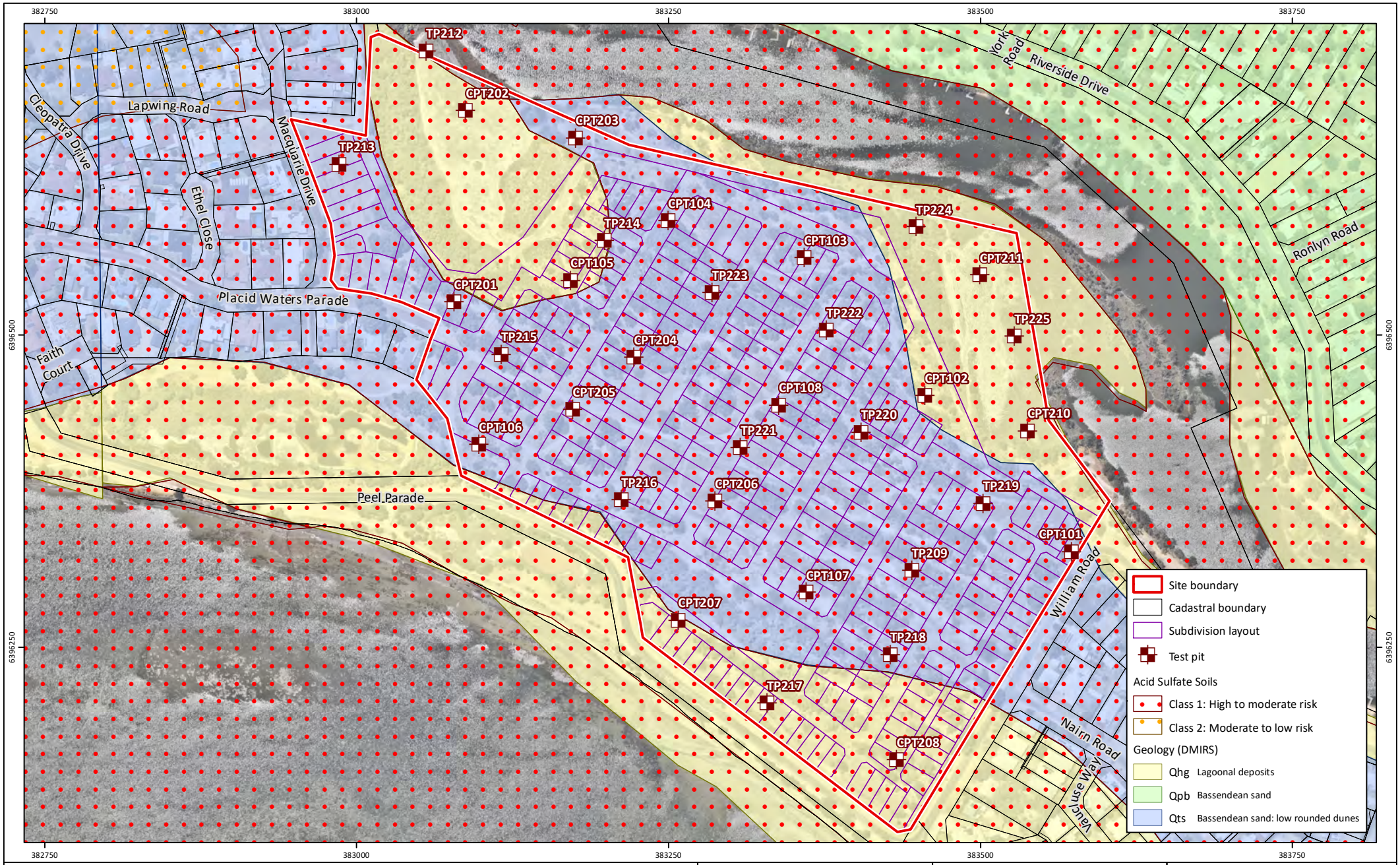

Figure 3: Geology and Soils

Project:	Subdivision Water Management Report Placid Waters South Planning Support
Client:	Wolfdene

Plan Number:
EP25-135(05)--F30

Drawn:	LAM
Date:	22/04/2026
Checked:	UH
Approved:	DPC
Date:	08/05/2026

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Metres

Scale: 1:4,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2025). Nearmap Imagery date: 21/01/2026

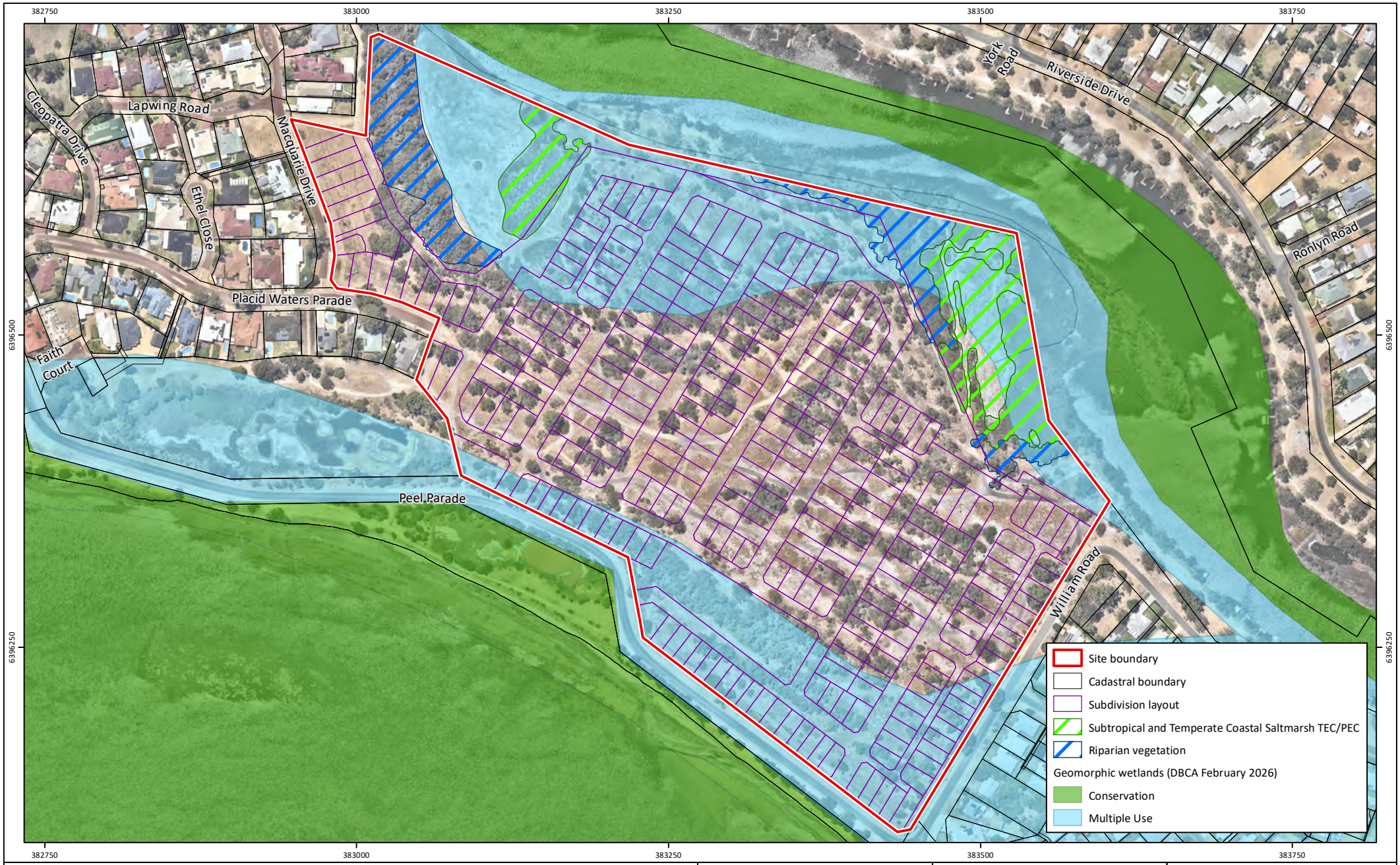

Figure 4: Vegetation and Wetlands

Project:	Subdivision Water Management Report Placid Waters South Planning Support
Client:	Wolfdene

Plan Number:
EP25-135(05)--F31

Drawn:	LAM
Date:	22/04/2026
Checked:	UH
Approved:	DPC
Date:	08/05/2026

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Metres

Scale: 1:4,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

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Figure 5: Biophysical Considerations

Project:	Subdivision Water Management Report Placid Waters South Planning Support
Client:	Wolfdene

Plan Number:
EP25-135(05)--F59a

Drawn:	LAM
Date:	22/04/2026
Checked:	UH
Approved:	DPC
Date:	11/05/2026

N

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Metres
Scale: 1:4,000@A4
GDA2020 MGA Zone 50

emerge ASSOCIATES

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©Landgate (2025). Nearmap Imagery date: 21/01/2026

Figure 6: Foreshore Boundary and Setbacks

Project:	Subdivision Water Management Report Placid Waters South Planning Support
Client:	Wolfdene

Plan Number:
EP25-135(05)--F32

Drawn:	LAM
Date:	08/05/2026
Checked:	UH
Approved:	DPC
Date:	08/05/2026

N

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Metres

Scale: 1:4,000@A4

GDA2020 MGA Zone 50

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Catchment	Small Event Treatment (First 15mm)				Minor and Major Event Flood Storage						
					Minor 20% AEP				Major 1% AEP		
	Side Slope	Depth (m)	TWL surface area (m^2)	Volume (m^3)	Side Slope	Depth (m)	TWL surface area (m^2)	Volume (m^3)	Depth (m)	TWL surface area (m^2)	Volume (m^3)
CT-A	1 / 3	0.3 BRA	360	100	1 / 6	0.16	554	81	0.5	765	305
		0.3 Swale	450	75							
CT-B	1 / 3	0.5	290	120	1 / 6	0.21	235	41	0.5	560	215
CT-C (Swale)	1 / 3	0.3 Swale	640*	96	1 / 6	0.19	319	52	0.5	470	175
CT-C *Swale = 320m long, and top width will be 2m											
CT-A *Swale = 225m long, and top width will be 2m											

Figure 7: Stormwater Management

Project: Subdivision Water Management Report
Placid Waters South Planning Support

Client: Wolfdene

Plan Number:
EP25-135(05)--F33b

Drawn:	LAM
Date:	15/05/2026
Checked:	UH
Approved:	DPC
Date:	15/05/2026

N

0 50 100 150
Metres

Scale: 1:4,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
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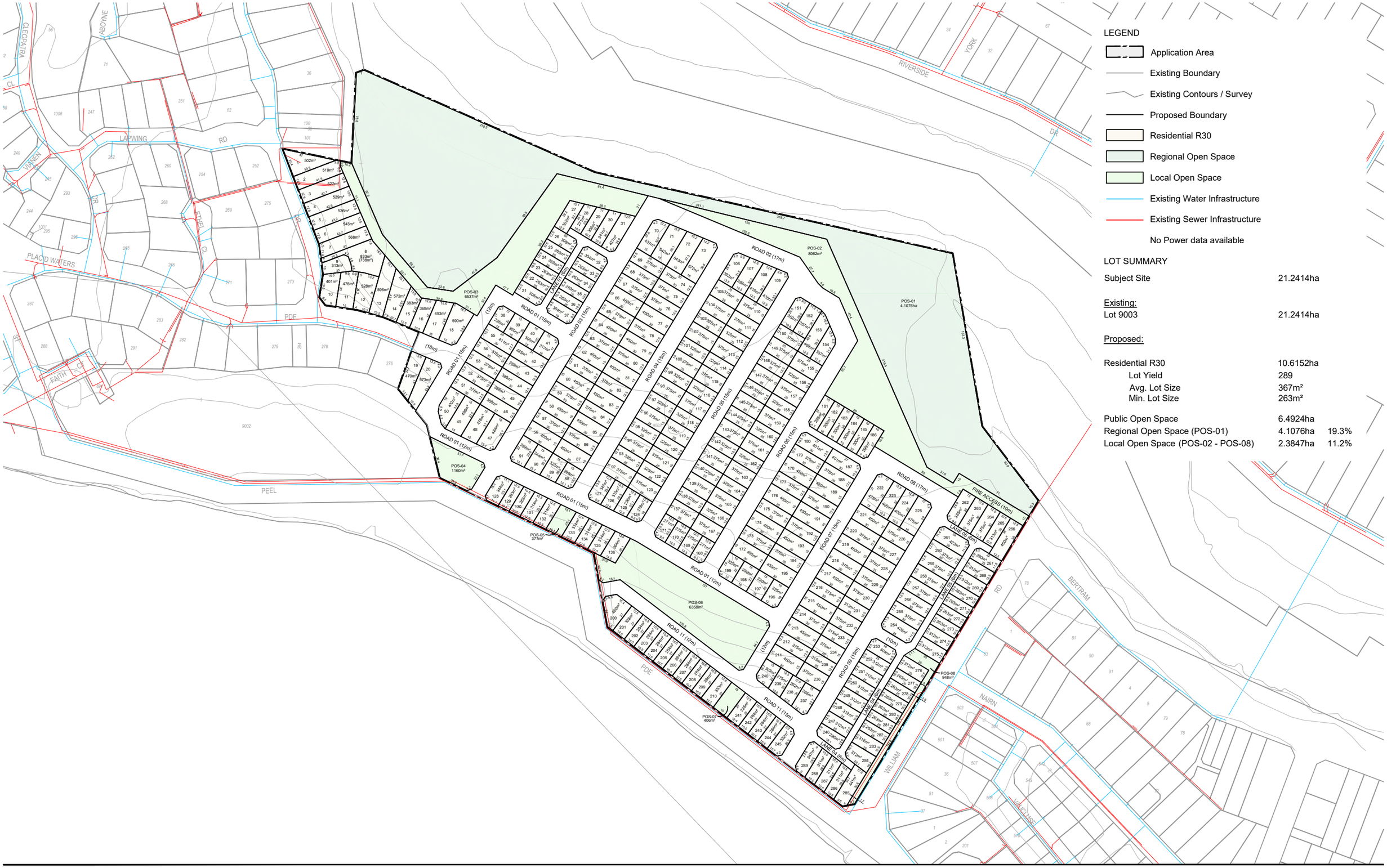
Appendix A

Sub-division Plan, (SLR 2026)



Subdivision Plan

Lot 9003 (28) Placid Waters Parade, Coodanup

0 60m

Date: 22 Apr 2026 Scale: 1:3000 @ A3 1:1500 @ A1 File: **25-234 SU1** Staff: DL MS GW JK Checked: DL

element. | PART OF SLR
Level 1, 500 Hay Street, Subiaco, Western Australia 6008. **T.** +61 8 9289 8300 | **E.** hello@elementwa.com.au **elementwa.com.au**

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Appendix B

Civil Designs (Colliers 2026)

PLAN

SCALE 1:2000 0m 40m 80m

NOTES

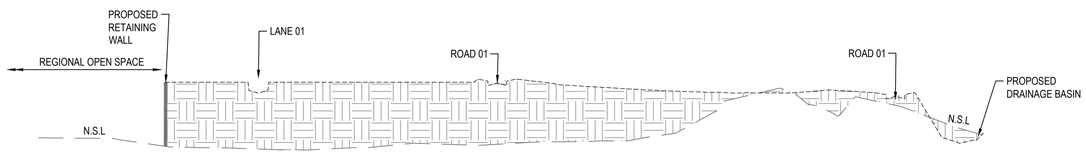
1. ALL DIMENSIONS SHOWN ARE IN METRES U.S.O.
2. ALL CO-ORDINATES AND LEVELS SHOWN ON THIS DRAWING SHALL BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS. ANY DISCREPANCIES SHALL BE REPORTED TO THE SUPERINTENDENT WITH IN SEVEN DAYS.
3. SURVEY INFORMATION SUPPLIED BY McMULLEN NOLAN GROUP (MNG) - REFERENCE 107313 DATE: 16 AUGUST 2025
4. ALL HEIGHTS ARE TO AUSTRALIAN HEIGHT DATUM (AHD) AND ALL LEVELS SHALL BE DERIVED FROM ESTABLISHED BENCHMARKS.
5. FINISHED CONTOURS AND VOLUMES ARE TO FINISHED GROUND LEVEL.
6. MINOR AMENDMENTS TO THE EXTENT OF EARTHWORKS MAY OCCUR TO PRESERVE IDENTIFIED TREES.
7. ALL BATTERS TO BE NOMINALLY 1 IN 6, OR FLATTER, UNLESS SHOWN OTHERWISE (U.S.O.).

LEGEND

- EARTHWORKS BOUNDARY
- CUT EXTENTS
- FILL EXTENTS
- LOCAL OPEN SPACE
- PROPOSED EARTHWORKS CONTOURS (0.25m) — 15.00
- PROPOSED ROAD CENTERLINE
- EXISTING SURFACE CONTOUR — 15.0
- PROPOSED RETAINING WALL
- PROPOSED FINISHED GROUND LEVEL
- PROPOSED FLOOD LEVEL (2.10 AHD)
- EXISTING NATURAL SURFACE LEVEL
- EXISTING TREES
- RL 3.10 — DESIGN ROAD CL LEVEL
- 3.00 — INDICATIVE PAD / LOT LEVEL

QUANTITY TABLE		NOTES
CUT (m³)	-1,138	TO FGL
FILL (m³)	+212,639	TO FGL
BALANCE (m³)	+211,501	IMPORT

EW NOTES:
NO ALLOWANCE FOR TOP SOIL STRIP, ROAD BOXOUT, LEVEL LOT PADS, COMPACTION OR MATERIAL LOSS IS FACTORED INTO THESE QUANTITIES



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VER. SCALE 1:10 0m 200mm 400mm
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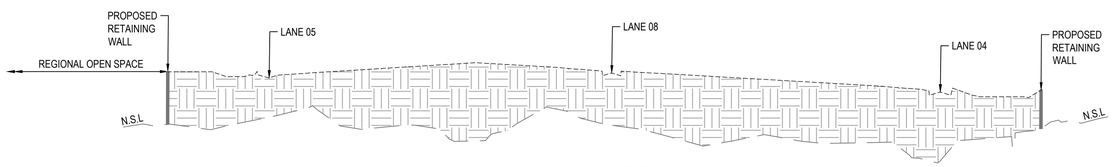

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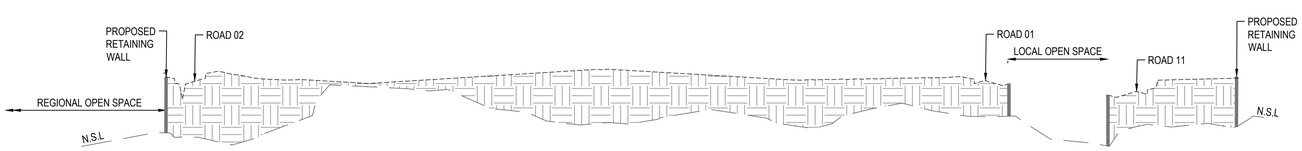

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VER. SCALE 1:10 0m 200mm 400mm
-

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Zero damage - Zero harm - Zero disruption

REV	DATE	DESCRIPTION	BY	CHKR
E	07/05/26	DESIGN LAYOUT AND LEVELS AMENDED	JS	JVV
D	30/04/26	DESIGN LAYOUT AND LEVELS AMENDED	JS	JVV
C	09/04/26	DESIGN LAYOUT AND LEVELS AMENDED	JS	JVV
B	02/04/26	RE-ISSUE FOR INFORMATION	RG	JVV
A	19/02/26	INITIAL ISSUE	RG	JVV

Wolfdene

Colliers

DRAWING STATUS: NOT FOR CONSTRUCTION

CLIENT & JOB: WOLFDENE WATERWAYS SOUTH

DATE: FEB / 2026 | GRID: PCG94 | DATUM: AHD

DESIGNED: R.G | DRAWN: R.G | CHECKED: J.V.V | APPROVED: XXX

TITLE: EARTHWORKS SKETCH

W.A.P.C.: N/A | SCALE U.N.O.: 1:500 @ | SHEET SIZE: A1 | DRG No.: 25249-C9-SK-01 | REVISION: E

FILE PATH: C:\12DS_WORKSPACE\DATA\AUMELSQL01\25-249_PLACID WATERS SOUTH_60664\CIV\70 DRG\C9 SK\25249-C9-SK-01

NORTH

SERPENTINE RIVER

REGIONAL OPEN SPACE

REGIONAL OPEN SPACE

CATCHMENT 'CT-A'
AREA: 17,662m²
15mm EVENT: 160m³ REQ'D
20% AEP EVENT: 87m³ REQ'D
1% AEP EVENT: 315m³ REQ'D

CATCHMENT 'CT-A' BASIN
TWL: 0.90
BASE: VARIES (NSL). LOWEST: 0.49
1:6 SLOPES
VOL: 325.0m³

CATCHMENT 'CT-B'
AREA: 12,276m²
15mm EVENT: 120m³ REQ'D
20% AEP EVENT: 69m³ REQ'D
1% AEP EVENT: 215m³ REQ'D

CATCHMENT 'CT-B' BASIN
TWL: 1.45
BASE: 1.10
1:6 SLOPES
VOL: 230.1m³

CATCHMENT 'CT-C' BASIN
TWL: 0.50
BASE: VARIES (NSL)
VOL: 213.0m³

CATCHMENT 'CT-C'
AREA: 11,245m²
15mm EVENT: 96m³ REQ'D
20% AEP EVENT: 52m³ REQ'D
1% AEP EVENT: 175m³ REQ'D

ROAD 01 ROAD 02 ROAD 03 ROAD 04 ROAD 05 ROAD 06 ROAD 07 ROAD 08 ROAD 09 ROAD 10 ROAD 11

PLACID WATER PARADE

NAIRN ROAD

WILLIAM ROAD

PEEL PARADE

BERTRAM

PLAN
SCALE 1:1000 0m 20m 40m

NOTES

1. ALL DIMENSIONS SHOWN ARE IN METRES U.S.O.
2. SURVEY INFORMATION SUPPLIED BY McMULLEN NOLAN GROUP (MNG) - REFERENCE 107313 DATE: 16 AUGUST 2025
3. ALL HEIGHTS ARE TO AUSTRALIAN HEIGHT DATUM (AHD) AND ALL LEVELS SHALL BE DERIVED FROM ESTABLISHED BENCHMARKS.

LEGEND

- SITE BOUNDARY
- LOCAL OPEN SPACE
- DRAINAGE CATCHMENT BOUNDARY
- EXISTING WETLAND LEVEL
- EXISTING TREES
- PROPOSED ROAD CONTOURS (0.10m)
- PROPOSED RETAINING WALL
- PROPOSED FLOOD LEVEL
- STORMWATER FLOW ARROWS
- HIGH POINT
- LOW POINT
- BASIN T.W.L. EXTENTS
- PROPOSED STORMWATER DRAINAGE PIPE
- PROPOSED STORMWATER DRAINAGE PITS

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REV	DATE	DESCRIPTION	BY	CHKR
C	07/05/26	CATCHMENTS AMENDED	JS	JVV
B	30/04/26	CATCHMENTS AMENDED	JS	JVV
A	02/04/26	INITIAL ISSUE	RG	JVV

Wolfdene

Colliers

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE: APR / 2026 | GRID: PCG94 | DATUM: AHD

DESIGNED: R.G | DRAWN: R.G | CHECKED: J.V.V | APPROVED: XXX .... / ....

W.A.P.C.: N/A | SCALE U.N.O.: 1:1000 @ A1

CLIENT & JOB: WOLFDENE WATERWAYS SOUTH

TITLE: STORMWATER DRAINAGE CATCHMENTS SKETCH

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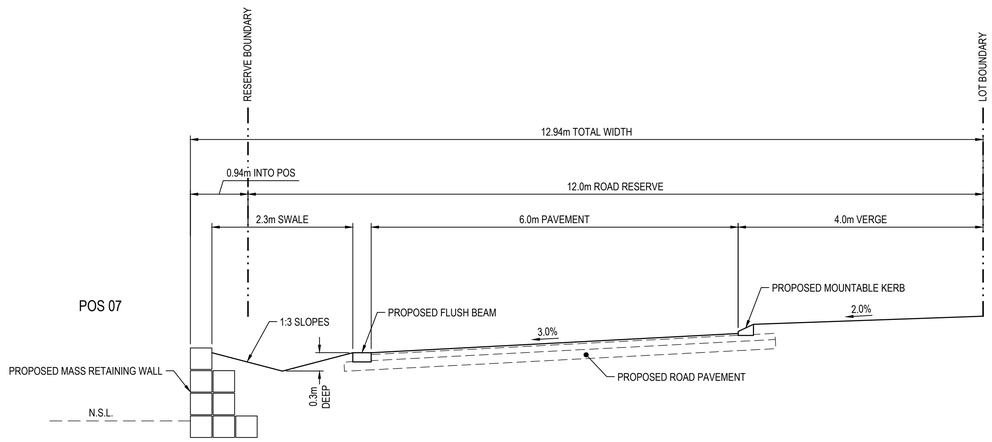

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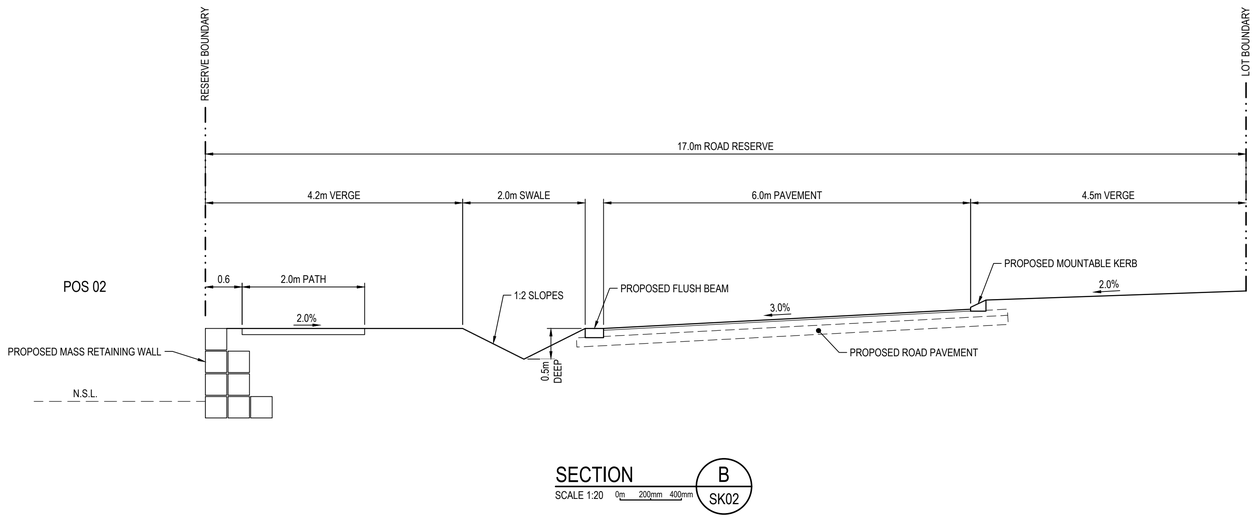
SK02



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SK02

BEFORE YOU DIG byda.com.au
Look up and Live
Zero damage - Zero harm - Zero disruption

REV	DATE	DESCRIPTION	BY	CHKR
A	07/05/26	INITIAL ISSUE	JS	JVV

Wolfdene

Colliers

DRAWING STATUS: NOT FOR CONSTRUCTION
DATE: MAY 20206 | GRID: PCG94 | DATUM: AHD
DESIGNED: JS | DRAWN: JS | CHECKED: JVV | APPROVED: JVV .... / ....
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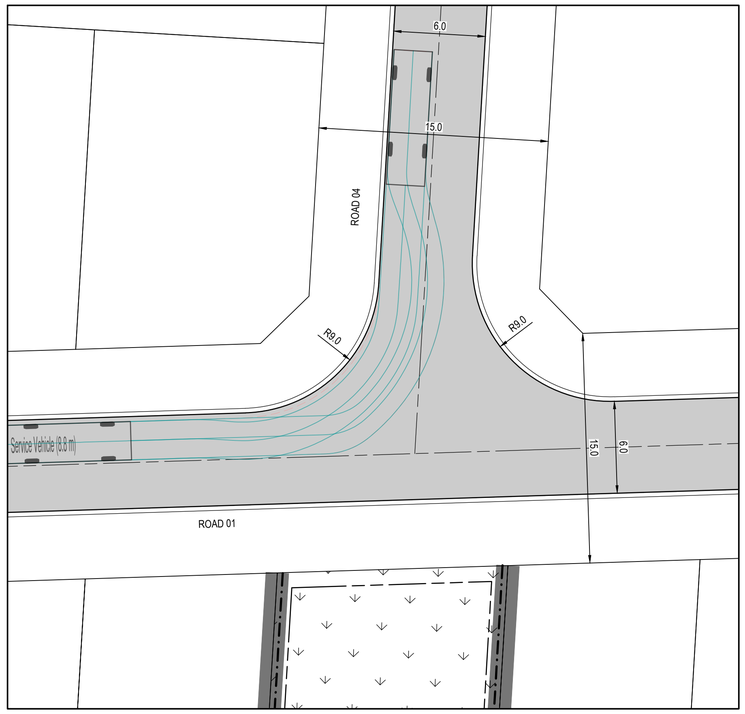
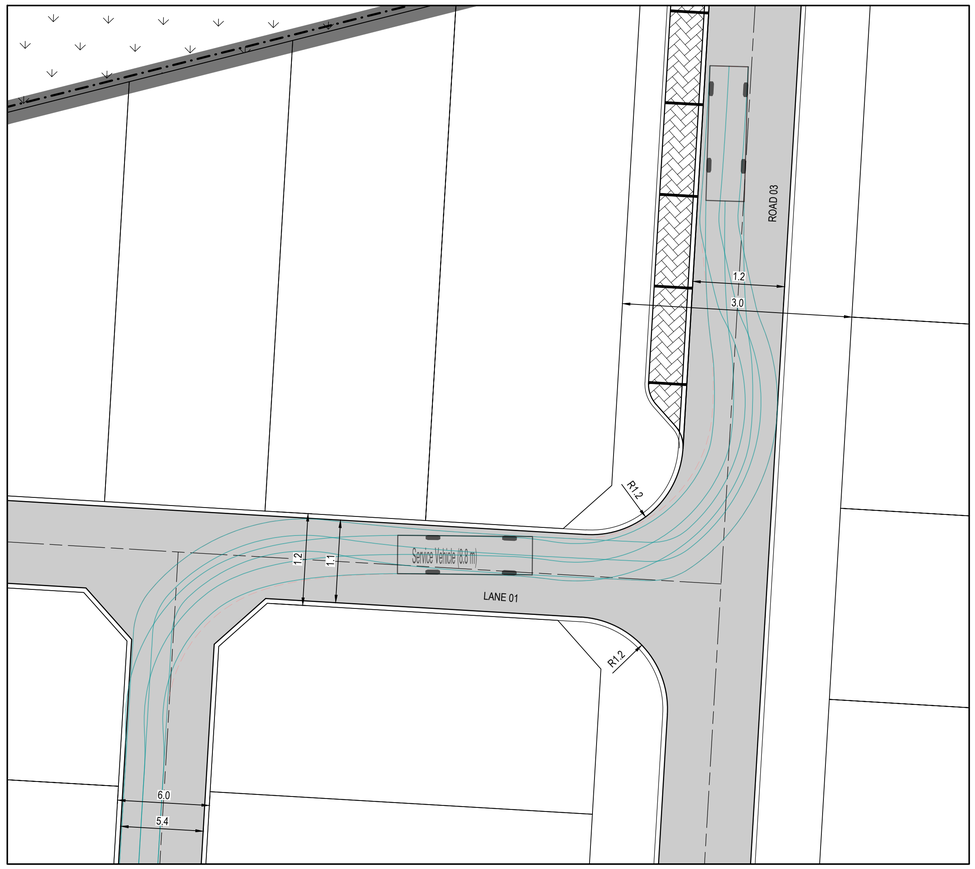


PLAN

SCALE 1:200 0m 4m 8m



PLAN

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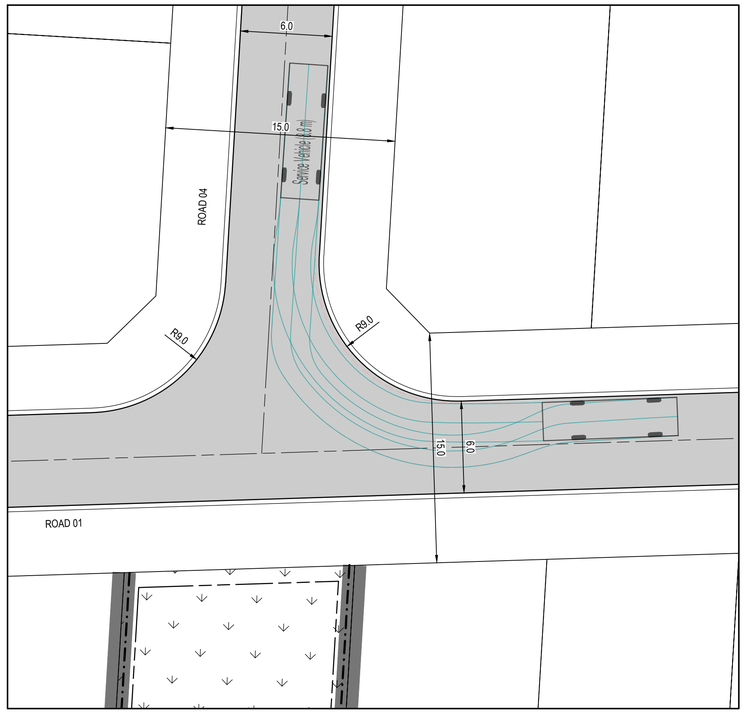

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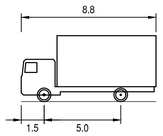
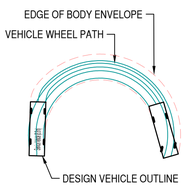


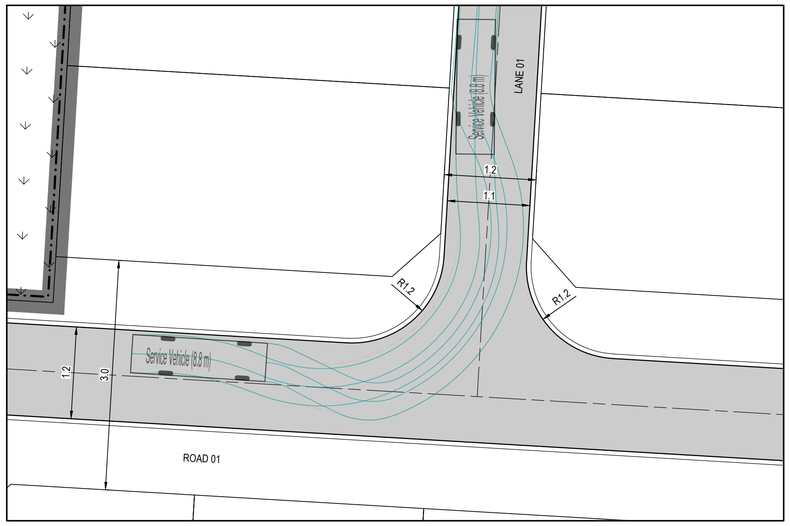
AUSTROADS SERVICE VEHICLE (8.8 m)

Overall Length	8.800m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.427m
Track Width	2.500m
Lock-to-lock time	4.00s
Curb to Curb Turning Radius	12.500m



TURNING TEMPLATE DIAGRAM

PRODUCED BY VEHICLE TRACKER



PLAN

SCALE 1:200 0m 4m 8m

REV	DATE	DESCRIPTION	BY	CHKR
A	07/05/26	INITIAL ISSUE	JS	JVV

Wolfdene

Colliers

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE: MAY 2026 | GRID: PCG94 | DATUM: AHD

DESIGNED: JS | DRAWN: JS | CHECKED: JVV | APPROVED: JVV .... / ....

W.A.P.C.: N/A | SCALE U.N.O.: 1:200 @

CLIENT & JOB: WOLFDENE WATERWAYS SOUTH

TITLE: 8.8m SERVICE VEHICLE MOVEMENTS SKETCH

SHEET SIZE: A1 | DRG No.: 25249-C9-SK-04 | REVISION: A

FILE PATH: C:\12DS_WORKSPACE\DATA\AUMELSQL01\25-249_PLACID WATERS SOUTH_606\4\CIV\70 DRG\C9 SK\25249-C9-SK-04

PLAN

SCALE 1:1000 0m 20m 40m

REV	DATE	DESCRIPTION	BY	CHKR
B	21/05/26	ROUNDABOUT REMOVED	JS	JVV
A	11/05/26	INITIAL ISSUE	JS	JVV

Wolfdene

Colliers

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE: MAY 2026 | GRID: PCG94 | DATUM: AHD

DESIGNED: JS | DRAWN: JS | CHECKED: JVV | APPROVED: JVV ..../....

W.A.P.C.: N/A | SCALE U.N.O.: 1:1000 @ | SHEET SIZE: A1

CLIENT & JOB: WOLFDENE WATERWAYS SOUTH

TITLE: SITE ROAD LAYOUT SKETCH

DRG No.: 25249-C9-SK-05 | REVISION: B

FILE PATH: C:\12DS_WORKSPACE\DATA\AUMELSQL01\25-249 PLACID WATERS SOUTH_6984\CIV\70 DRG\C9 SK\25249-C9-SK-05

Appendix C

Landscape Designs

Waterways

PRIVATE ESTATE

LANDSCAPE CONCEPT REPORT

MAY 2026

emerge ASSOCIATES

LEGEND

- EXTENT OF WORKS
- STREET TREES
- NATIVE PLANTING
- TURF
- BASIN
- DRAINAGE SWALE
- RETAINED VEGETATION
- FEATURE HARDSTAND
- PROPOSED ENTRY SIGNAGE LOCATION

WATERWAYS PRIVATE ESTATE

LANDSCAPE MASTERPLAN

DWG **PWN-02-2**
REV **C**
DATE **15-05-26**

0 25 50 75 mm

SCALE **1 : 3,000 @ A3**

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LEGEND

- EXTENT OF WORK
- EXISTING TREES/VEGETATION
- OPEN TURF
- BASIN & SWALES
- BENCH SEAT
- DUAL USE PATH
- BIN
- PLAYGROUND
- PARK SHELTER
- BBQ
- PICNIC SETTING
- BIKE RACK
- DRINK FOUNTAIN
- FITNESS NODE

WATERWAYS PRIVATE ESTATE

SPACIAL AMENITIES PLAN

DWG **PWN-02-3**
REV **C**
DATE **15-05-26**

0 25 50 75 mm

SCALE **1 : 3,000 @ A3**

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WATERWAYS PRIVATE ESTATE

DRAINAGE STRATEGY

DWG **PWN-02-4**
REV **C**
DATE **15-05-26**

0 25 50 75 mm

SCALE **1 : 3,000 @ A3**

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STREET TREE LEGEND

Eucalyptus gomphocephala
Tuart

Agonis flexuosa
WA Peppermint

Cupaniopsis anacardioides
Tuckeroo

Melaleuca viminalis
Weeping bottlebrush

Eucalyptus leucoxylon rosea
Yellow Gum

WATERWAYS PRIVATE ESTATE
STREET TREE MASTERPLAN

DWG **PWN-02-5**
REV **C**
DATE **15-05-26**

0 25 50 75 mm

SCALE **1 : 3,000 @ A3**

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OPTION 1

SIGNAGE DETAIL:

LIMESTONE RETAINING WALL BY CIVIL

ALUMINIUM BLADE (75mm X 25mm) FENCING, EQUAL OR EQUIVALENT TO BROADWATER FENCING

LASERCUT STEEL ESTATE BRANDING FIXED TO WALL

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM” WALL

NATIVE VERGE PLANTING

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM” PIER

OPTION 2

SIGNAGE DETAIL:

LIMESTONE RETAINING WALL BY CIVIL

ALUMINIUM BLADE (75mm X 25mm) FENCING, EQUAL OR EQUIVALENT TO BROADWATER FENCING

LASERCUT STEEL ESTATE BRANDING FIXED TO WALL

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM” WALL

NATIVE VERGE PLANTING

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM” PIER

ALUMINIUM BLADE (75mm X 25mm) FENCING, EQUAL OR EQUIVALENT TO BROADWATER FENCING

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM”

WATERWAYS PRIVATE ESTATE

OPEN FENCING CONCEPT DESIGN

DWG **PWN-02-6**
REV **C**
DATE **15-05-26**

0 0.25 0.5 0.75 1.0 1.25 m

SCALE **1 : 50 @ A3**

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OPTION 3

SIGNAGE DETAIL:

LIMESTONE RETAINING WALL BY CIVIL

ALUMINIUM BLADE (75mm X 25mm) FENCING, EQUAL OR EQUIVALENT TO BROADWATER FENCING

LASERCUT STEEL ESTATE BRANDING FIXED TO WALL

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM” WALL

NATIVE VERGE PLANTING

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM” PIER

OPTION 4

SIGNAGE DETAIL:

LIMESTONE RETAINING WALL BY CIVIL

ALUMINIUM BLADE (75mm X 25mm) FENCING, EQUAL OR EQUIVALENT TO BROADWATER FENCING

LASERCUT STEEL ESTATE BRANDING FIXED TO WALL

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM” WALL

NATIVE VERGE PLANTING

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM” PIER

ALUMINIUM BLADE (75mm X 25mm) FENCING, EQUAL OR EQUIVALENT TO BROADWATER FENCING

ECO OUTDOOR RANDOM ASHLAR CLADDING “COOLUM”

WATERWAYS PRIVATE ESTATE

OPEN FENCING CONCEPT DESIGN

DWG **PWN-02-7**
REV **C**
DATE **15-05-26**

0 0.25 0.5 0.75 1.0 1.25 m

SCALE **1 : 50 @ A3**

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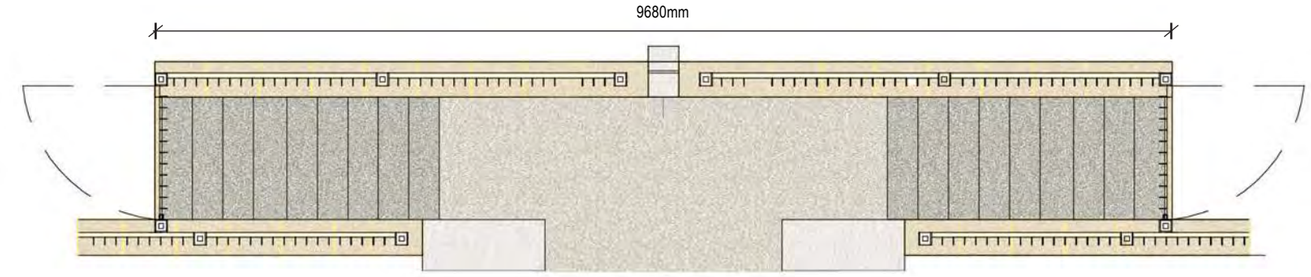
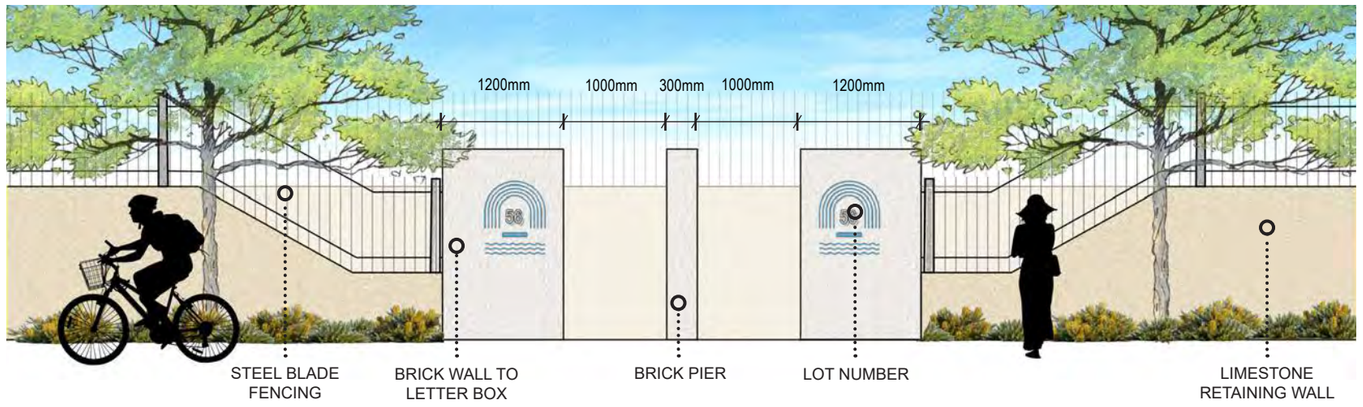


OPTION 1

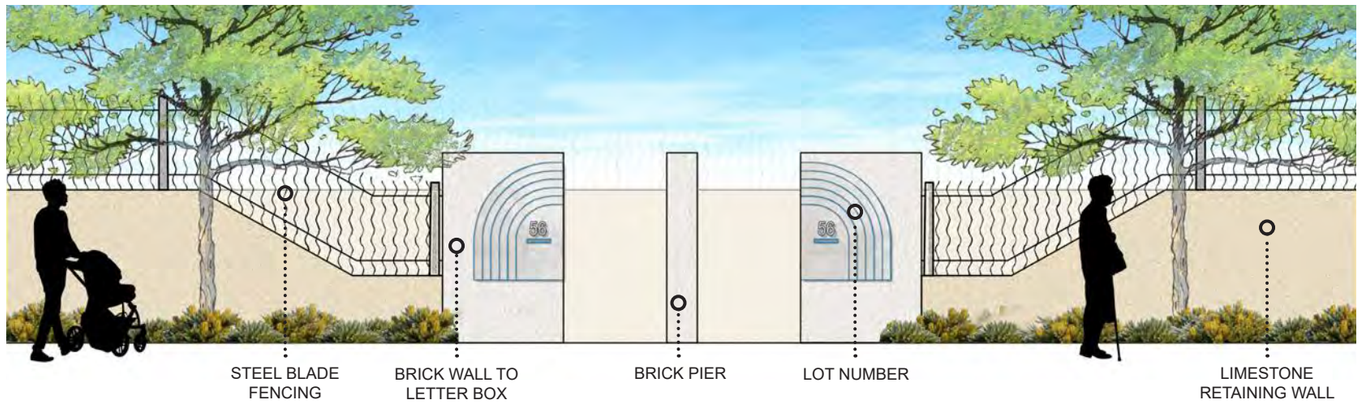
LOT NUMBERS INSIDE OF LASER CUT ALUMINIUM SHAPED DESIGN



OPTION 2

LOT NUMBERS ON TOP OF ALUMINIUM PLATE WITH ENGRAVED AND POWDER COATED LOGO PATTERN

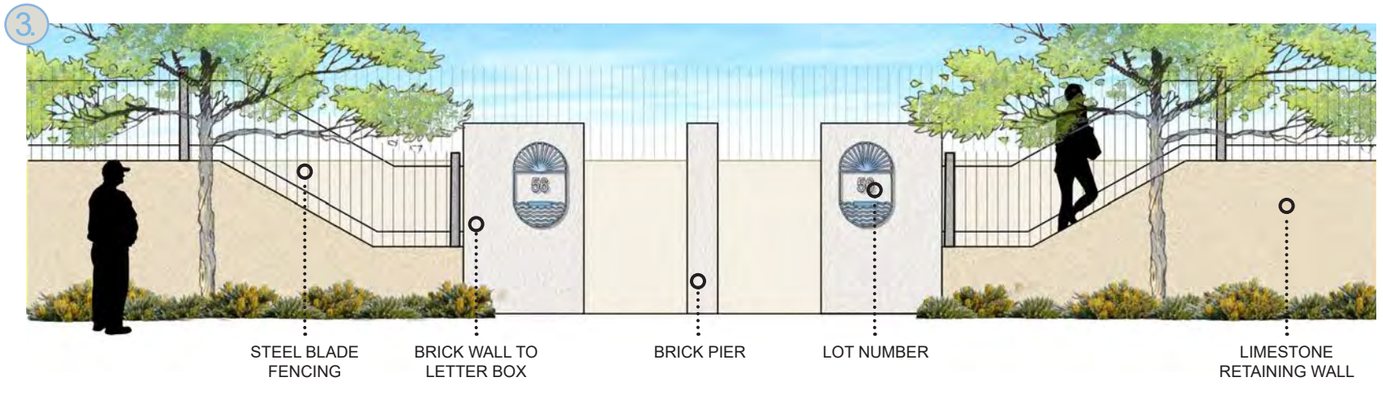
+ FEATURE FENCING SHAPED TO REFLECT DESIGN LANGUAGE



OPTION 3

LOT NUMBERS INSIDE OF LASER CUT ALUMINIUM SHAPED DESIGN

3.



TWO BRICK WALL MATERIAL OPTIONS:

1.

WHITE SAND RENDER

2.

ECO OUTDOOR RANDOM ASHLAR CLADDING "COOLUM"

WATERWAYS PRIVATE ESTATE

LOT WALL CONCEPT DESIGN

DWG **PWN-02-8**
REV **C**
DATE **15-05-26**

0 0.25 0.5 0.75 1.0 1.25 m

SCALE **1 : 50 @ A3**

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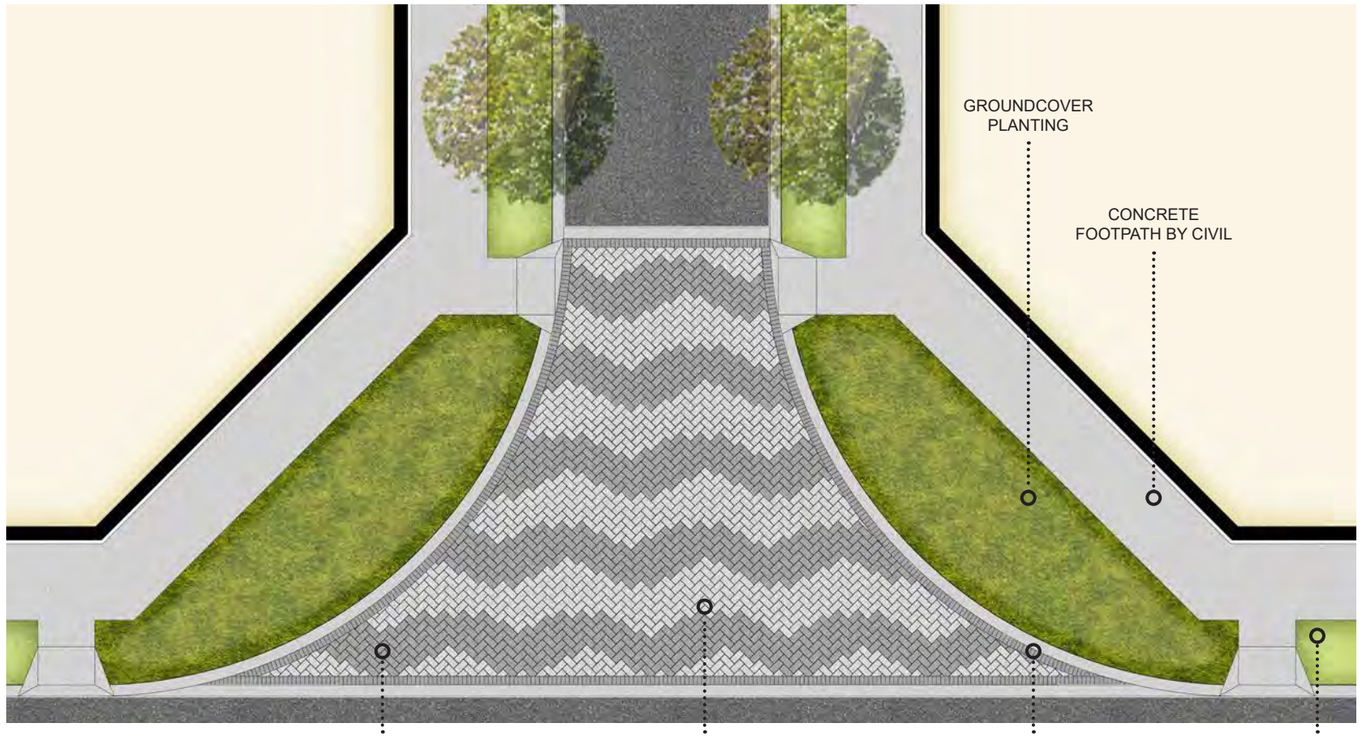
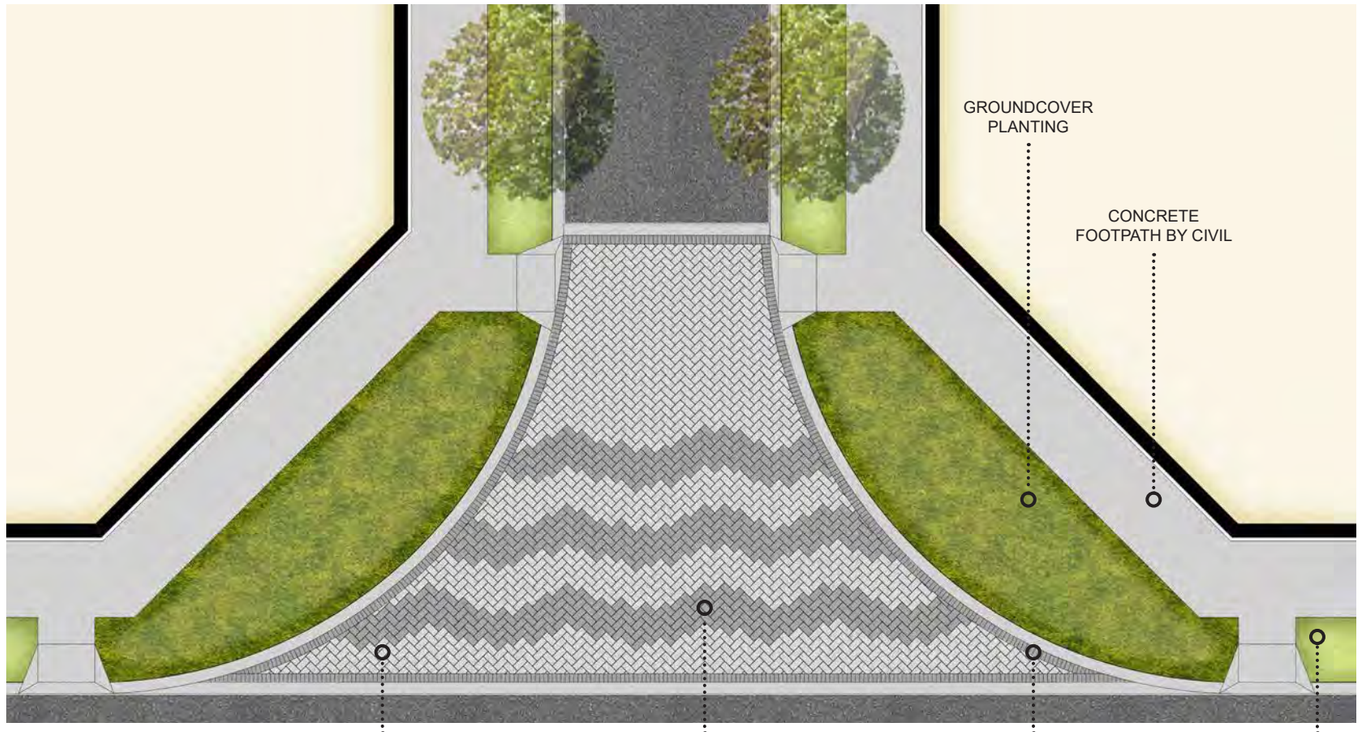
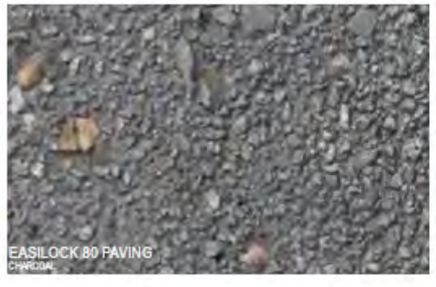
OPTION 1



OPTION 2



MATERIALS



WATERWAYS PRIVATE ESTATE
ROAD PAVING CONCEPT DESIGN

DWG **PWN-02-9**
REV **C**
DATE **15-05-26**
0 0.25 0.5 0.75 1.0 1.25 m
SCALE **1 : 50 @ A3**

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PRIMARY BRAND COLOURS

RIVULET

DULUX
BLUE LOBELIA
RGB: 40 50 77

SUBSTITUTE COLOUR FOR WATERWAYS COLOR PALETTE.

RIVERSAND

DULUX
FEATHER SOFT
RGB: 214 210 200

SUBSTITUTE COLOUR FOR WATERWAYS COLOR PALETTE.

RIPPLE

DULUX
MYSTIFICATION
RGB: 42 66 112

SUBSTITUTE COLOUR FOR WATERWAYS COLOR PALETTE.

SKY

DULUX
SKY DIVER
RGB: 131 174 210

SUBSTITUTE COLOUR FOR WATERWAYS COLOR PALETTE.

SECONDARY BRAND COLOURS

WETLANDS

DULUX
ADRIFT
RGB: 78 147 152

SUBSTITUTE COLOUR FOR WATERWAYS COLOR PALETTE.

WATTLE

DULUX
BRIGHT DELIGHT
RGB: 204 84 38

SUBSTITUTE COLOUR FOR WATERWAYS COLOR PALETTE.

GALAH

DULUX
WATERMELON PINK
RGB: 198 117 147

SUBSTITUTE COLOUR FOR WATERWAYS COLOR PALETTE.

WATERWAYS PRIVATE ESTATE
COLOUR PALETTE

DWG **PWN-02-10**
REV **C**
DATE **15-05-26**

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Banksia blechnifolia
Groundcover Banskia

Banksia ashbyi
Ashby's Banksia (Dwarf)

Calothamnus quadrifidus
Clean & Green

Hemiandra pungens
Snakebush

Grevillea crithmifolia prostrate
Grevillea

Eremophila maculata
Spotted Emu Bush

Banksia nivea
Honeypot Dryandra

Anigozanthos viridis 'Green machine'
Kangaroo paw

Conostylis aculeata
Cottonhead

Olearia lanuginosa Ghost Town
Ghost Town

Eremophila glabra dawes
Smooth emu bush

Calothamnus quadrifidus
One-Sided Bottlebrush

Grevillea obtusifolia Gin Gin Gem
Gin Gin Gem Grevillea

Anigozanthos manglesii
Kangaroo paw

Chrysocepalum silver sunburst
Yellow buttons

Lepidosperma gladiatum
Coast sword sedge

Scaevola aemula
Fan Flower

Grevillea scarlet moon
Kings park grevillea

Westringia 'Low horizon'
Coastal rosemary

Leucophyta brownii
Cushion Bush

WATERWAYS PRIVATE ESTATE
INDICATIVE PLANTING PALETTE

DWG **PWN-02-11**
REV **C**
DATE **15-05-26**

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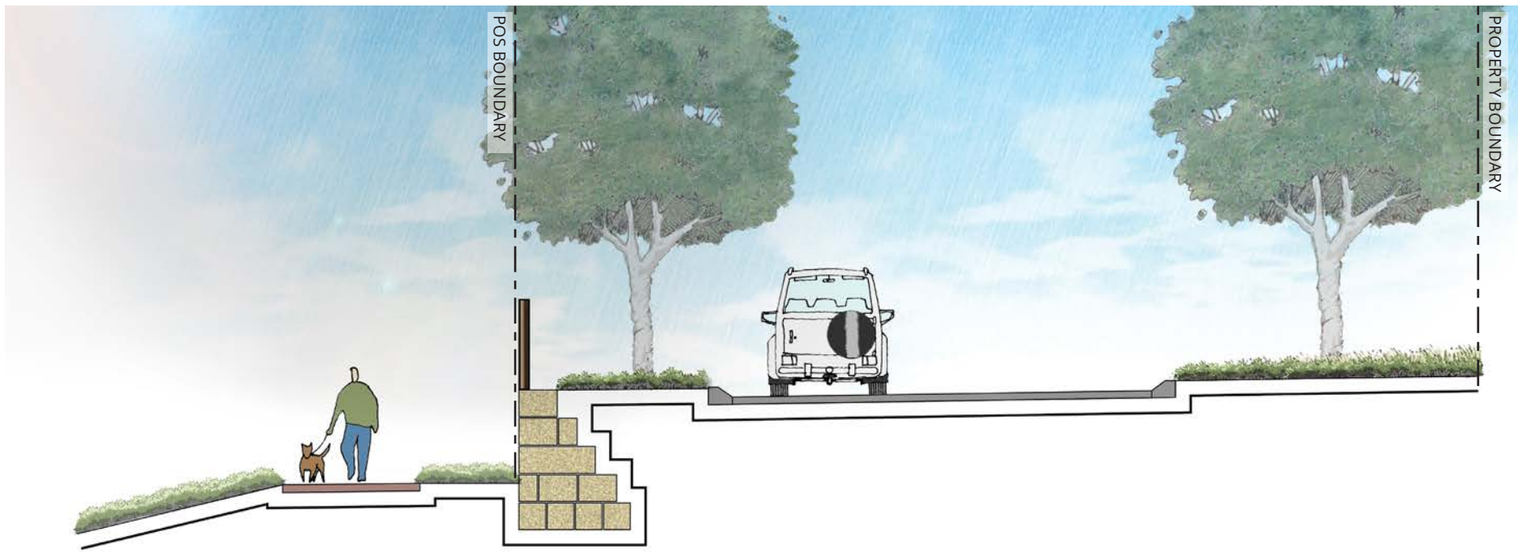
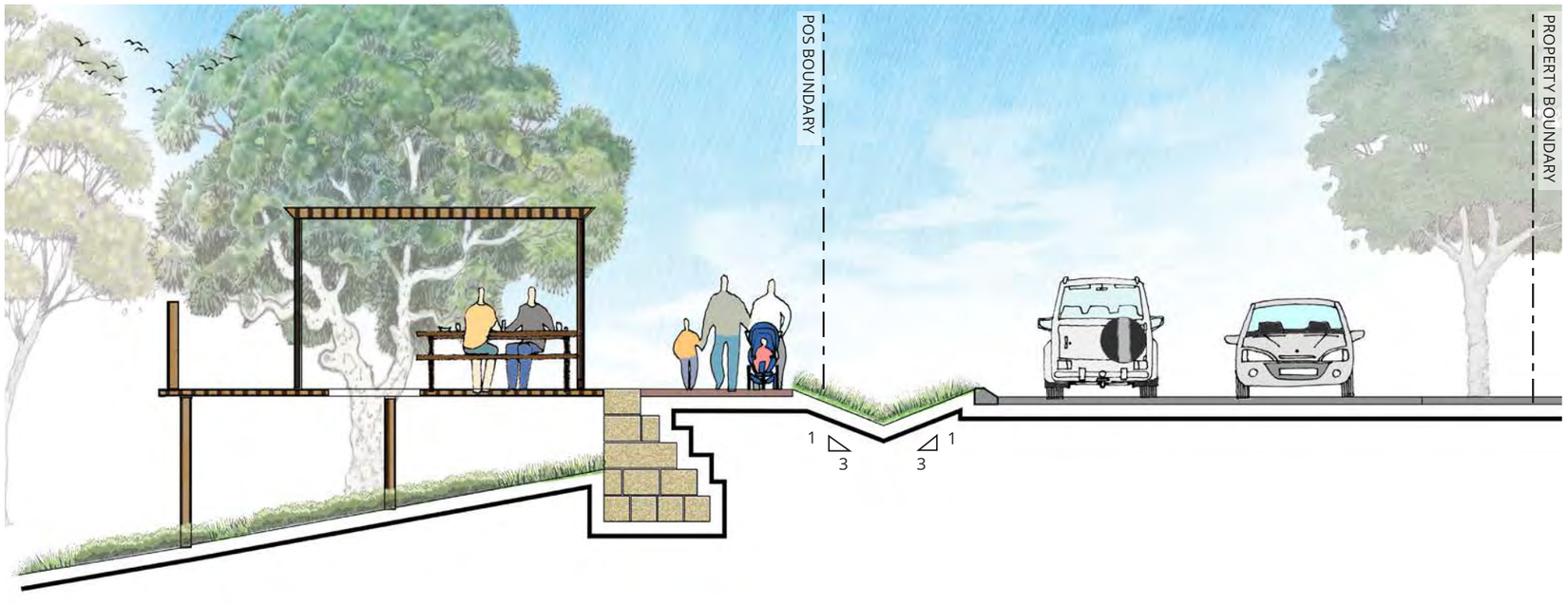


SECTION A-A
SCALE 1:100/A3

2.1m PEDESTRIAN WALKWAY | 2.1m PEDESTRIAN WALKWAY & RETAINING WALL WITH BALUSTRADE | 6.0m ROAD | VERGE



SECTION B1-B1
SCALE 1:100/A3

POS BASIN AREA | OPEN GATHERING SPACE WITH SHADE STRUCTURE, PICNIC SETTING & TREE HOLE FOR RETAINED EXISTING TREE | 2.1m PEDESTRIAN WALKWAY | SWALE DRAIN | 6.0m WIDE ROAD

WATERWAYS PRIVATE ESTATE
TYPICAL STREET CROSS SECTIONS

DWG **PWN-02-12**
REV **C**
DATE **15-05-26**
0 0.25 0.5 0.75 1.0 1.25 m
SCALE **1 : 50 @ A3**

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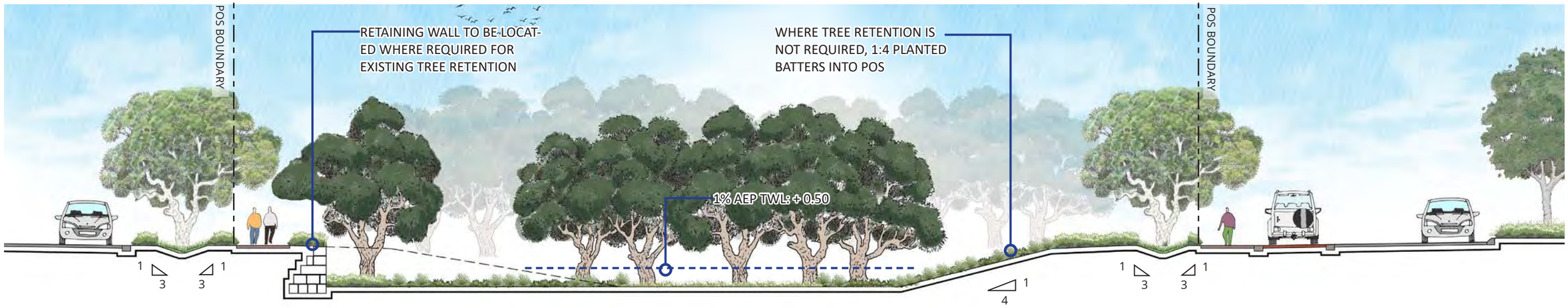

SECTION B2-B2
SCALE 1:200/A3

6.0m ROAD | SWALE DRAIN | 2.1m PEDESTRIAN WALKWAY | DRAINAGE BASIN WITH RETAINED VEGETATION | SHRUB PLANTING | SWALE DRAIN | 2.1m PEDESTRIAN WALKWAY | 2.5m PARKING | 6.0m ROAD | VERGE

SECTION C-C
SCALE 1:100/A3

2.1m PEDESTRIAN WALKWAY & RETAINING WALL WITH BALUSTRADE | SWALE DRAIN | 6.0m ROAD | VERGE

LANDSCAPED SWALES & DRAINAGE BASINS
INDICATIVE IMAGERY

WATERWAYS PRIVATE ESTATE
TYPICAL STREET CROSS SECTIONS

DWG **PWN-02-13**
REV **C**
DATE **15-05-26**
0 0.25 0.5 0.75 1.0 1.25 m
SCALE **1 : 50 @ A3**

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Appendix D

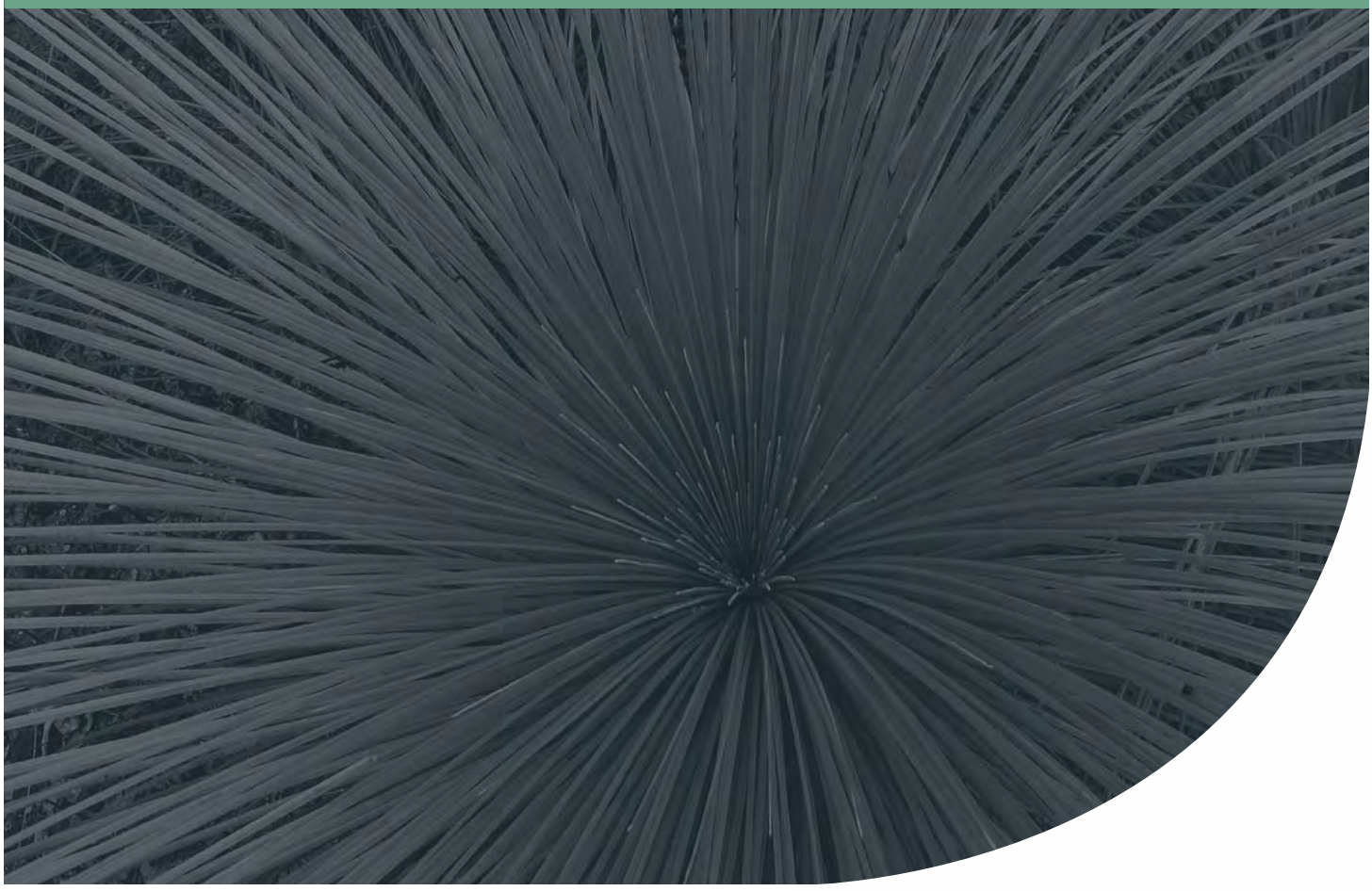
Modelling Assumptions Report

Wolfdene Placid Waters (South) Structure Plan Support

Modelling Assumptions Report

Project No: EP25-135(05)

Prepared for Wolfdene
May 2026



Document Control

Doc name:	Wolfdene Placid Waters (South) Structure Plan Support Modelling Assumptions Report				
Doc no.:	**EP25-135(05)**				
Version	**Date**	**Author**		**Reviewer**	
1	May 2026	Umer Habib	UH	David Coremans	DPC
	Submission to CoM				

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Table of Contents

List of Tables

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
AR& R	Australian Rainfall and Runoff
BOM	Bureau of Meteorology

Table A2: Abbreviations – General terms

General terms	
AEP	Annual exceedance probability
AHD	Australian height datum
ARI	Average recurrence interval
CL	Continuing loss
GIS	Geographical information systems
IFD	Intensity, frequency and duration
IL	Initial loss
WMR	Water Management Report

Table A3: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
km	Kilometre
m	Metre
m AHD	Metres in relation to the Australian height datum
m/day	Metres per day
m^2	Square metre
m^3	Cubic metre
m^3/s	Cubic metre per second
mm	Millimetre
mm/hr	Millimetres per hour
%	Percentage

Table A4: Terminology - design rainfall

Equivalent average recurrence interval (ARI) terminology	Average exceedance probability (AEP) terminology utilised
1 in 1 year ARI event	63.2% AEP event
1 in 1.5 year ARI event	50% AEP event
1 in 5 year ARI event	20% AEP event
1 in 10 year ARI event	10% AEP event
1 in 20 ARI event	5% AEP event
1 in 50 ARI event	2% AEP event
1 in 100 ARI event	1% AEP event
1 in 200 ARI event	1 in 200 AEP event
1 in 500 ARI event	1 in 500 AEP event

1 Purpose of this report

Wolfdene (the 'Proponent') are proposing the development of Lot 9003 Coodanup (the 'site') for residential purposes. Site is located in the suburb of Coodanup within the City of Mandurah (CoM). This document includes information relevant to the modelling that was undertaken for the Placid Waters (South) structure plan support since stormwater will be managed in a holistic way across the development.

2 Methodology

XPSWMM hydrologic and hydraulic modelling software (v23.1) was used to calculate the surface water runoff volumes within the road reserves and lots associated with the development of Placid Waters South. The catchment areas are shown in Figure 6 of the Local Water Management Report (LWMR)

The hydrologic component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrologic model include:

- Runoff is proportional to slope, area, infiltration and percentage of imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPSWMM. Generally, assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given the length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a ‘storage’ node, a ‘dummy intermediate’ node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a 1% annual exceedance probability (AEP)). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 5 m, roughness of 0.014 (Manning’s n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Where relevant median swales, bio-retention areas (BRAs) and flood storage areas (FSAs) are modelled as nodal-reservoirs with infiltration depth-rating curves to account for differential infiltration rates with changing depth.

3 Predevelopment model

A pre-development model has not been developed as part of the current LWMR, and no previous modelling is available to establish pre-development flow or storage conditions.

4 Post-development model

An initial loss continuing loss model was adopted to account for post-development catchment losses. The post-development catchment area, land types and loss values were based on the structure plan design, typical infiltration rates for the soils which occur onsite and based on project team experience. Post-development catchment areas and land types within the site were informed by sub-division plan provided by SLR surveyors. **Table 1** summarises the loss parameters used within the post-development model.

Table 1: Post-development parameters

Land type	Initial loss (mm)	Continual loss (mm)	Roughness
Road Surface	1	0.1	0.02
Road Verge	9	1.5	0.05
Roof	1	0.1	0.02
Lot impervious	1	0.1	0.02
Gardens	25	3.5	0.05
POS	20	2.5	0.05

A summary of post-development catchment information is provided in **Table 2** with the catchment plan and basin location shown in **Figure 7** of the WMR.

Table 2: Post-development catchment areas (ha)

Sub-catchment	Slope	Road Reserve (area in ha)
CT-A	0.010	1.77
CT-B	0.010	1.22
CT-C	0.010	1.12

The following assumptions were incorporated into the model:

- Lots
  - Pervious areas on lots will retain up to 1% AEP of runoff.
  - Residential lots will have little slope (i.e. will be flat) and pockets of storage are likely. This will effectively increase the initial loss (storage) and overall infiltration rate (continual loss).
  - Garden areas in lots will have high infiltration rates as it is likely that sand-based landscape mix or mulch will be used
- Road reserve
  - There will be no infiltration on roads, pavements and driveways. There will however be some minor absorption storage loss which is accounted for in the initial and continuing loss values.
  - Road reserve contains 80% pervious verge and 20% impervious bitumen areas. This equates to a runoff coefficient of 0.8 from road reserves for the design of downstream storages (i.e. BRAs).

  - Laneways and alleys are assumed 100% impervious and will retain the 20% AEP event on site.
- POS assumptions
  - POS is assumed to be 100% pervious and fully retains runoff up to the 1% AEP event.
  - Similar to lot gardens, POS areas will likely contain dense vegetation or turf over a sand-based landscape mix or mulch. However, turf areas will become compacted over time, which is accounted for in the loss values provided in **Table 1.**

Storage
  - BRAs retain runoff from events up to and including the frequent event (i.e. first 15 mm).
  - BRAs and swales will have 1/3 side slopes and maximum depth of 500 mm within POS areas
- Infiltration
  - An infiltration rate of 4.32 m/day is assumed from soakwells in Lane- and Alleyways, and regional carparks.
  - Infiltration rates within the BRA basin section are modelled as 4.32 m/day
  - Infiltration rates within the BRA section of each basin were taken from historic in-situ infiltration testing conducted at the location of each POS area (Douglas Partners 2015)
- Evapotranspiration
  - Volumes leaving the system through evapotranspiration were assumed to be negligible when compared to the total runoff volume and since the duration of the model run was comparatively short. XPSWMM default evapotranspiration assumptions are therefore used.

5 References

5.1 General references

The references listed below have been considered as part of preparing this document.

Douglas Partners 2015, *Geotechnical Investigations, Proposed Residential Development, Placid Waters South, Coodanup, WA*, 1.

5.2 Online references

Australian Rainfall and Runoff (AR&R) 2021, ARR Data Hub, viewed 1 December 2021, Available from: <https://data.arr-software.org/>.

Bureau of Meteorology (BoM) 2021a, Climate Data Online, viewed 1 December 2021, Available from, <http://www.bom.gov.au/water/designRainfalls/revised-ifd/>.

Bureau of Meteorology (BoM) 2021b, Design Rainfall Data System (2016), viewed 1 December 2021, Available from, <http://www.bom.gov.au/water/designRainfalls/revised-ifd/>.

(Douglas Partners 2015)