

NOTE: This Chapter should not be read in isolation. You may need to consider other chapters of this DCP when preparing your application.



DRAFT CHAPTER NB4: MOSS VALE ROAD NORTH URBAN RELEASE AREA

Draft Chapter NB4: Moss Vale Road North Urban Release Area

Contents

1	Purpose	4
2	Application	4
3	Context	5
4	Objectives	5
5	Vision	5
6	Key Development Outcomes for Moss Vale Road North URA	5
7	Subdivision Controls	7
7.1	Indicative Layout Plan	7
7.2	Staging	9
7.3	Subdivision Design	10
7.4	Street Network and Hierarchy	16
7.5	Laneways	28
7.6	Shared Driveways	29
7.7	Shared Use Pathway Network	31
7.8	Open Space System	33
7.9	Landscape Strategy	34
7.10	Aboriginal Cultural Heritage, Environment and Environmental Risk Management	36
7.11	Bushfire Considerations	39
8	Development in the Vicinity of the Eastern Gas Pipeline	41
	Mandatory Controls	43
9	Desired Future Character Controls – Colours and Materials	43
10	Village Centre Key Design Principles and Controls	44
10.1	Key Design Principle - Land Use	47
10.2	Key Design Principle - Built Form	48
10.3	Key Design Principle - Movement and Access	51
10.4	Key Design Principle - Public Domain	52
10.5	Key Design Principle - Staging	53
11	Low Density Residential Development Controls	54
12	Medium Density Residential Development Controls	62
13	Fencing Controls	68

14	Advisory Information	70
14.1	Information required with subdivision applications	70
14.2	Satisfactory Arrangements for Local Infrastructure	70
14.3	Other legislation you may need to check	73

Figures

Figure 1:	Subject Land	4
Figure 2:	Indicative Layout Plan	8
Figure 3:	Indicative Staging Plan	10
Figure 4:	Indicative Subdivision Patterns	13
Figure 5:	Location of Zero Lot Lines	14
Figure 6:	Significant Views and Vistas	15
Figure 7:	Street Hierarchy and Network Plan	17
Figure 8:	Indicative Interim and Ultimate Public Transport Route	19
Figure 9:	Underground Service Allocation (verge width 3-3.6m)	20
Figure 10:	Typical Plan and Section – Collector Road – Tier 1	21
Figure 11:	Typical Plan and Section – Collector Road – Tier 2	22
Figure 12:	Typical Plan and Section – Local and Retail Streets	23
Figure 13:	Typical Plan and Section – Access Street – Tier 1	24
Figure 14:	Typical Plan and Section – Access Street – Tier 2	25
Figure 15:	Typical Plan and Section – Riparian Street	26
Figure 16:	Typical Plan and Section – Rear Laneway	27
Figure 17:	Shared Driveway Configuration	30
Figure 18:	Shared Use Pathway Network	32
Figure 19:	Vegetated Buffer Typical Section	39
Figure 20:	Bushfire Consideration – APZs	40
Figure 21:	Key Gas Pipeline Elements	42
Figure 22:	The Village Centre	46
Figure 23:	Village Centre Ground Floor Land Uses	48
Figure 24:	Active Frontages	50
Figure 25:	Ground Floor Setbacks	50
Figure 26:	Village Centre Pedestrian Connections	52
Figure 27:	Garage Location Principles	57
Figure 28:	Dwelling Configuration Based on Orientation	58
Figure 29:	Location of Setbacks (Standard and Corner Lots)	59
Figure 30:	Front Setbacks for Medium Density Development	66
Figure 31:	Building Envelope	67
Figure 32:	Location of Fencing “Areas”	69
Figure 33:	Example of Good Fence Design	69
Figure 34:	Required Satisfactory Arrangements for Infrastructure	72

Tables

Table 1:	Lot Width Requirements	12
Table 2:	Minimum Cross-section Width – Collector Road – Tier 1	21
Table 3:	Minimum Cross-Section Widths – Collector Road – Tier 2	22

Table 4: Minimum Cross-section Widths – Local and Retail Streets.....	23
Table 5: Minimum Cross-section Widths – Access Street – Tier 1	24
Table 6: Minimum Cross-section Widths – Access Street – Tier 2	25
Table 7: Minimum Cross-section Widths – Riparian Street.....	26
Table 8: Minimum Cross-section Widths – Riparian Street.....	27
Table 9: Key Development Controls for Low Density Residential Development.....	59
Table 10: Key Development Controls for Medium Density Development	65

Amendment history

Version Number	Date Adopted by Council	Commencement Date	Amendment Type
1			Draft

1 Purpose

The purpose of this Chapter is to guide the **development** of land in the Moss Vale Road North **Urban Release Area** (URA) in accordance with the provisions of Part 6 of Shoalhaven Local Environmental Plan 2014 (**SLEP 2014**).

Advisory Note: In addition to the provisions outlined in this Chapter, you must also refer to:

- Supporting Document 1: Integrated Water Cycle Assessment.
- Supporting Document 2: Landscape Specifications.
- Supporting Document 3: Vegetation Management Plan Requirements.
- Moss Vale Road North Species List [[link](#)].

In the event of an inconsistency between a provision in this Chapter and a provision in a generic Chapter in this **Development Control Plan**, the provision in this Chapter will prevail to the extent of the inconsistency.

2 Application

This Chapter applies to the Moss Vale Road North URA, as shown on the Subject Land Map (**Figure 1**). The area is approximately 5 km north-west of the Nowra CBD and is north of the Moss Vale Road South URA.

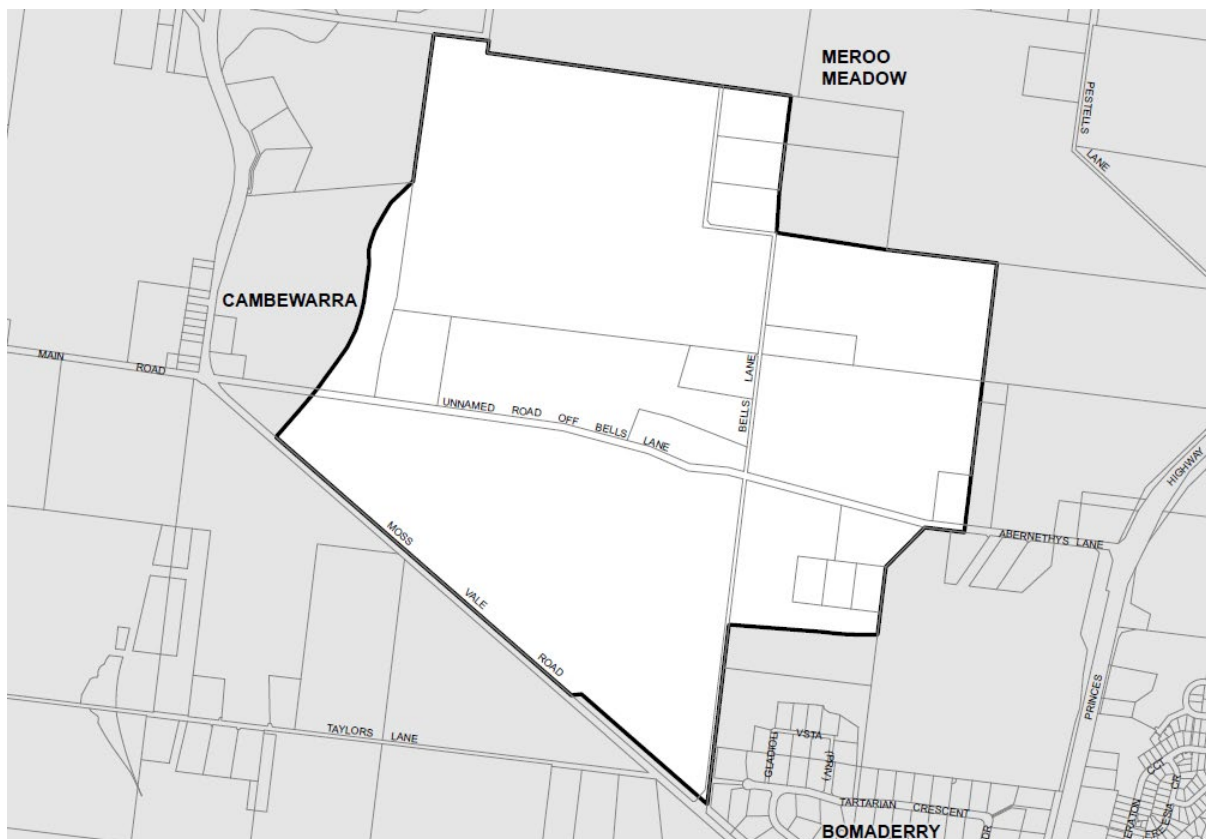


Figure 1: Subject Land

3 Context

The Moss Vale Road North URA is part of a pastoral landscape of high scenic value. The pastoral landscape offers a visually appealing transition in land use and topography from the heavily forested Cambewarra Range and the urban settlement of Nowra-Bomaderry. Located on the lower southern slopes of the Cambewarra Range, the area is highly visible from the Moss Vale Road tourist drive, the Cambewarra Mountain Lookout and the Princes Highway.

4 Objectives

The **objectives** of this Chapter are to:

- i. Provide sound **objectives** and controls that build on sustainable living, economic vitality and community wellbeing principles.
- ii. Promote neighbourhood design that achieves healthy, active and high-quality urban design outcomes.
- iii. Ensure that the environmentally sensitive development of the Moss Vale Road North URA occurs in an integrated and efficient manner.

5 Vision

The Moss Vale Road North URA will become a highly desirable urban area with a variety of residential types, styles and densities with a mix of **lot** sizes and housing products at different price points. Housing choice in this URA will appeal to a broad future community, including first-home buyers and households wishing to downsize; and everyone in between. Increased densities will be located in high amenity areas that can be easily serviced by public transport and **public open space**, with lower housing density appropriately transitioning into the rural landscape on the edges of the URA.

The URA will complement its natural environment by building on significant assets, including riparian corridors and elaborate **views** of natural features including creeks, wooded backdrops and pastoral landscapes. The URA will incorporate a large environmental conservation area that enables environmental management of riparian corridors whilst integrating areas of significant and **remnant vegetation** and **water sensitive urban design**. Emphasis will be placed on the conservation of existing **vegetation** in riparian corridors and open space areas as far as possible.

The URA incorporates a passive open space network that provides a variety of recreational opportunities and also features an integrated movement network for pedestrians and cyclists.

6 Key Development Outcomes for Moss Vale Road North URA

The Moss Vale Road North URA will be designed to incorporate the following key development outcomes which are to be responded to in the Design Verification Statement that is to be submitted at the subdivision Development Application (DA) stage.

- i. The URA will provide housing diversity by enabling the development of various housing types to meet the needs for the future community.

- a. Medium density development within the URA is primarily concentrated in areas within 400m of the Village Centre (including the Village Centre Activation Precinct), areas of high amenity adjacent to the riparian corridors/open space areas and areas adjacent to certain **collector roads**.
- b. Where small **lots** (**lots** under 500m²) are provided (refer to the ILP at **Figure 2**), they:
 - i. Engage with the street and open space areas by minimising the dominance of garages and vehicular **parking spaces**.
 - ii. Maximise access to open space areas.
- ii. The defined street hierarchy is determined by the placement and design of **road** types and achievement of the intended function. The street hierarchy is important to enable an accessible and well connected movement network that integrates shared use pathways and public transport routes that are safe and convenient. The street types include:
 - a. **Collector Roads (Tier 1 and Tier 2)** – provide an attractive entry and circulation network through the URA which will facilitate future public transport routes. All **dwelling**s within the URA are approximately 400m walking distance from the **Collector Road** network. **Collector Roads** are characterised by **tree** lined verges and shaded footpaths.
 - b. **Local and Retail Streets** – provide access from the **Collector Roads** and circulation within residential areas and the Village Centre. Local streets are important components of the street network as they facilitate permeability within the URA.
 - c. **Access Streets (Tier 1 and Tier 2)** - provide lower tier access and circulation within residential areas.
 - d. **Riparian Streets** – provide access to the high amenity riparian areas and a connection to the wider URA.
 - e. **Rear Laneways** – provide rear access and **waste** collection to small **lots**. They are designed to be short in length to optimise passive surveillance and minimise the visual impact of the laneways. They are functional and include a level of amenity with planting along one verge.
- iii. Open space areas will meet environmental sustainability **objectives** and be adaptable spaces. They will function to protect and enhance riparian corridors and significant and **remnant vegetation**, incorporate **water sensitive urban design** elements and create opportunities for passive recreation.
- iv. Adequate good quality infrastructure, essential to meet the demands of development in the URA and support the orderly and economic development of land in the URA, must exist, or satisfactory arrangements for the provision of such infrastructure must exist, to enable land in the URA to be developed. The specific infrastructure considered to be essential in this regard is set out in **Section 14.2** of this Chapter. New development should not occur in the absence of the provision, or satisfactory arrangements for the provision, of such essential infrastructure.

7 Subdivision Controls

7.1 Indicative Layout Plan

The Indicative Layout Plan (ILP) at **Figure 2** illustrates the key development outcomes for the Moss Vale Road North URA.

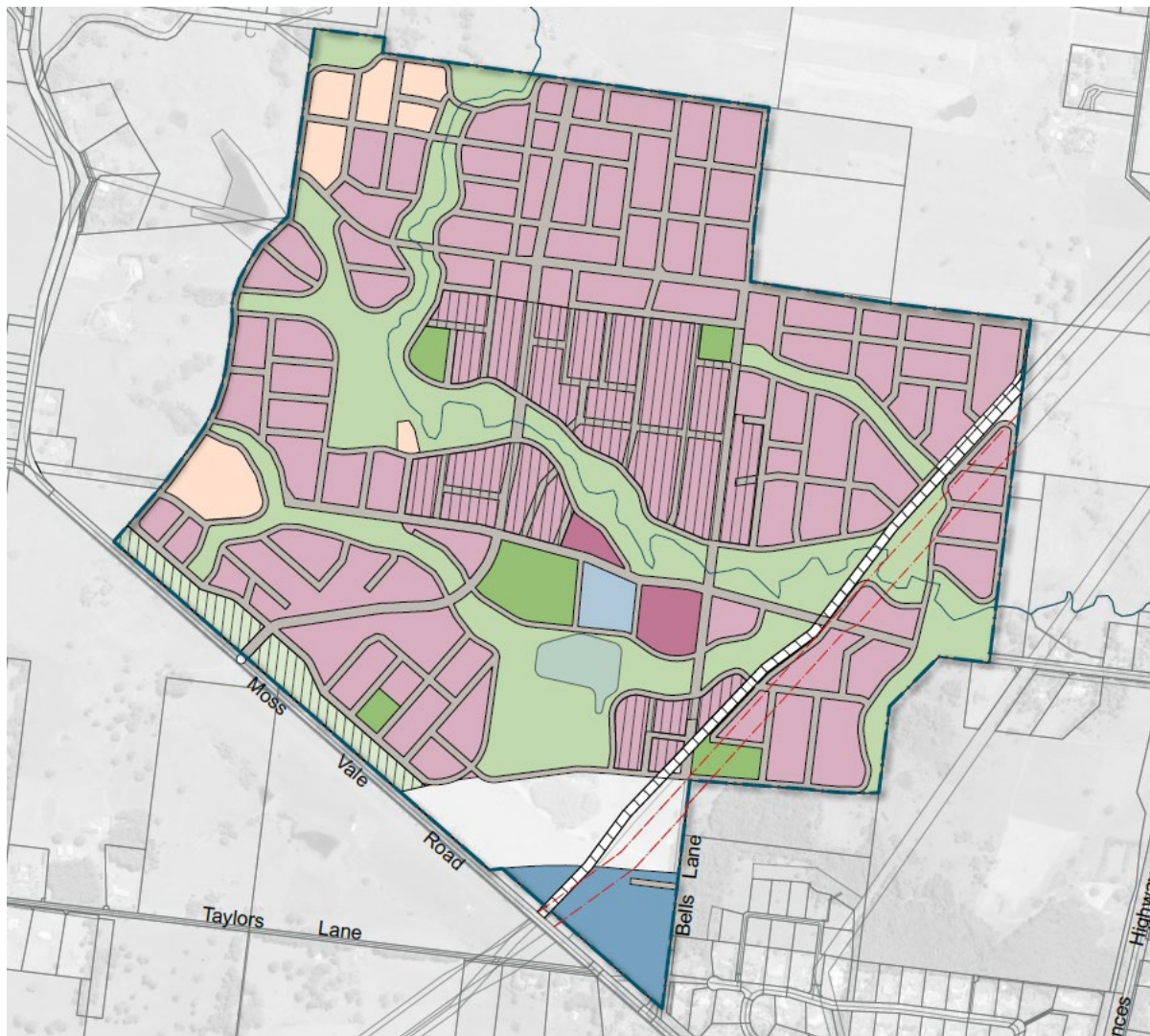
The specific **objectives** are to:

- i. To ensure development is undertaken in a coordinated manner which responds to the topography, **views** and the natural environment.
- ii. To provide a variety of **lot** sizes that will facilitate a range of housing types in appropriate locations.
- iii. To provide a vibrant mixed use neighbourhood centre to service the needs of the Moss Vale Road North and Moss Vale Road South URAs.
- iv. To ensure well connected and legible movement network that will provide a variety of routes for vehicles, pedestrians and cyclists both within the neighbourhood and to surrounding areas.
- v. To provide **public open space** that enhances existing landscape values, protects significant and **remnant vegetation**, provides opportunities for **stormwater** management and improves the amenity for future residents.

Performance Criteria	Acceptable Solutions
P1 Development is undertaken in a coordinated manner that is consistent with the ILP.	A1.1 Development within the URA is in accordance with the ILP (Figure 2). Note: The ILP is to be read in conjunction with the provisions in this Chapter, broader Development Control Plan, the SLEP 2014 and other relevant policy documentation and legislation. Variations to the ILP may be considered where the applicant provides sound justification and can demonstrate that the proposal meets the intent of the relevant objectives and provisions in this Chapter. Refer to Section 14 regarding Design Verification Statement requirements. A1.2 Subdivisions must demonstrate consistency with the following residential density targets in relation to the ILP: • Large Lot Residential (1,000m²+ lots): less than or equal to 10 dwellings per hectare. • Standard Lot Residential (500-999m² lots): 11-20 dwellings per hectare.

- Small **Lot** Residential and Medium Density / Integrated Housing (300-499m² **lots**): 21-33 **dwelling**s per hectare.

Note: Density is measured exclusive of **roads**.



Legend

	URA Boundary		Village Centre Activation Precinct		Vegetated Buffer
	Large Lot Residential		Business Park		Lake
	Standard Lot Residential		Natural Open Space		Eastern Gas Pipeline Easement
	Small Lot Residential		Public Open Space Area		Electrical Easement
	Village Centre Core				

Figure 2: Indicative Layout Plan

Note: Development under the high voltage power line easement is restricted. Early discussions with Endeavour Energy regarding underground trenching and alternative infrastructure/ easement arrangements is encouraged.

7.2 Staging

The specific **objectives** are to:

- i. To ensure the development of the URA enables efficient release of residential land, business land and essential infrastructure.

Performance Criteria	Acceptable Solutions
P2 Development is staged to enable orderly development and provision of necessary infrastructure.	A2.1 The staging of the URA is undertaken in accordance with Figure 3. Sub-stages within the stages identified in Figure 3 is acceptable where: • Infrastructure delivery has not been compromised. • Waste vehicles can safely and efficiently service each substage. Note: Early coordination with adjacent sub-stages/ owners regarding infrastructure delivery is encouraged. Temporary turning heads may be required to facilitate waste collection.

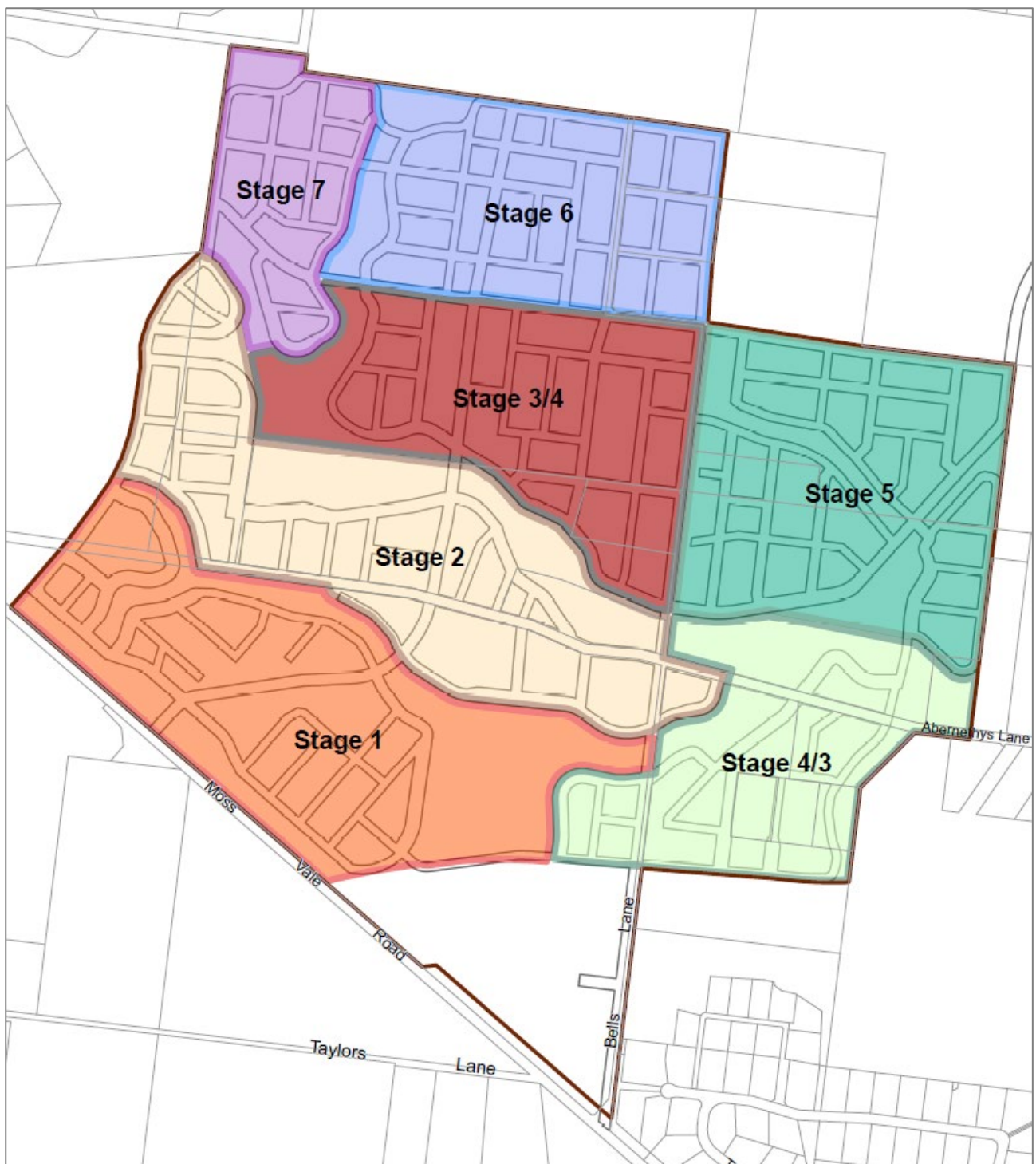


Figure 3: Indicative Staging Plan

7.3 Subdivision Design

The specific **objectives** are to:

- i. To create an attractive urban environment that meets the changing needs of the community and offers a wide choice in good quality housing.

- ii. To create a mix of **lot** sizes that provide a range of **dwelling** types to suit the needs of the community.
- iii. To ensure that all residential **lots** are able to have a high level of amenity in terms of **solar access**, **views** and proximity to **public open space**.
- iv. To ensure that subdivision layouts respond to the natural environment, topography, the escarpment and rural **vistas**.
- v. To create a subdivision pattern that facilitates the efficient provision of infrastructure.
- vi. To enhance community interaction and outdoor activity through the provision of public space.

Mandatory Controls

Note: Refer to Clause 4.1H of **SLEP 2014** which sets out certain requirements for the subdivision of small **lots**.

- 1) Subdivision applications are to be accompanied by a Design Verification Statement in support of the application.

Note: **Section 14.1.4** of this Chapter provides guidance for preparing a Design Verification Statement.

- 2) Subdivision applications are to be accompanied by an Aboriginal Cultural Heritage Assessment in support of the application.

Note: Refer to the following guidelines by Heritage NSW as the relevant authority under the *National Parks and Wildlife Act 1974*:

- [Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW](#).
- [Code of practice for archaeological investigation of Aboriginal objects in New South Wales](#).
- [Aboriginal cultural heritage consultation requirements for proponents 2010](#).

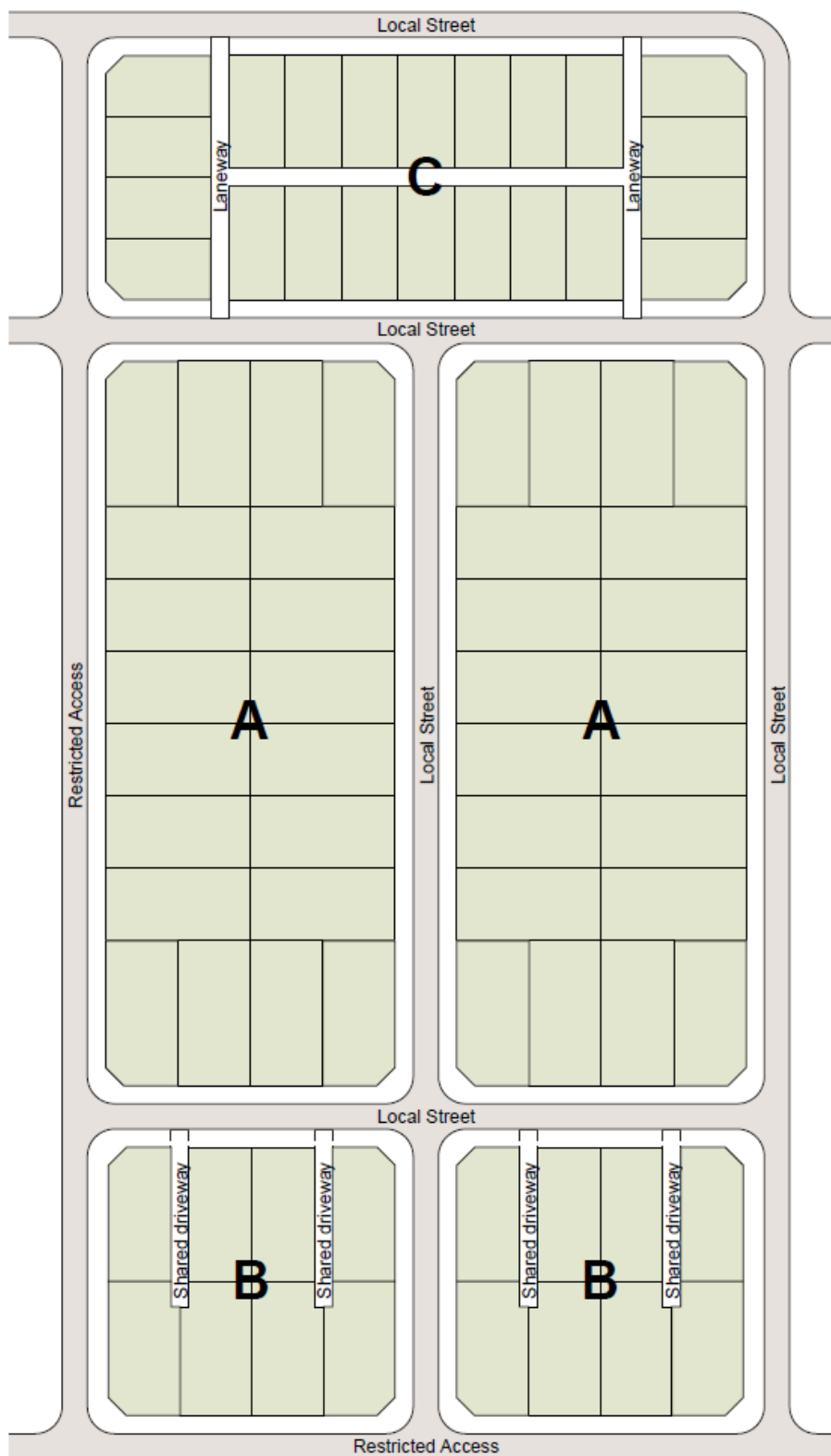
- 3) **Lot** widths are to be relative to the **lot** area as per **Table 1** below:

Table 1: Lot Width Requirements

Lot Type	Lot size (m ²)	Minimum Width (m)
Small	300 - 399	>8 and <12
	400 - 499	Equal to or >12 and <15
Standard	500-999	In accordance with Chapter G11: Subdivision of Land
Large	1000+	

- 4) Small **lots** must have varying **lot** widths. No more than three consecutive **lots** shall have the same **lot** width. A minimum variation of 10% of the adjacent **lot** width is required.
- 5) Street blocks are designed to enable permeability. The length and width of street blocks (excluding **road** verges) are as follows:
 - Small and standard **lot** areas are a maximum of 160m x 70m, particularly where rear lane access or shared driveways are located.
 - Large **lot** areas may have larger block sizes to accommodate specific topographic circumstances or rural transitions.
- 6) The subdivision layout is designed to optimise **solar access** to **dwellings** as per the indicative subdivision patterns demonstrated in **Figure 4**. In the case of certain forms of medium density housing and **zero lot line allotments**, preference will be given to an east-west **dwelling** orientation in order to maximise **solar access** along the longest **dwelling** elevation.
- 7) **Lots** less than 400m² must include a restriction as to user on a Section 88B instrument that restricts vehicular access from the primary **road** frontage.
- 8) **Battle-axe lots** are avoided unless the access handle provides rear access to small **lots**.
- 9) Subdivision applications are to be accompanied by a detailed Landscape Strategy.

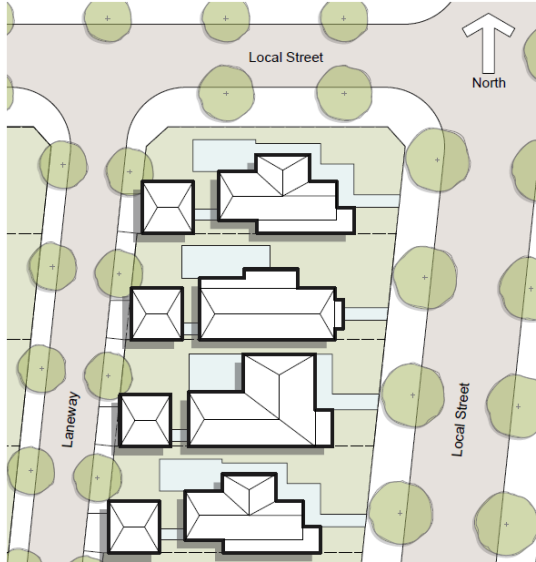
Note: Refer to Section 7.9 of this Chapter for Landscape Strategy requirements.



Legend

- A: Indicative subdivision pattern for lot types excluding B & C below.*
- B: Indicative subdivision pattern on small lots with shared driveway access*
- C: Indicative subdivision pattern on small lots with rear laneway access*

Figure 4: Indicative Subdivision Patterns

Performance Criteria	Acceptable Solutions
P3 Zero lot line developments are appropriately placed on small lots. Note: At the subdivision stage, a restriction is to be included on a Section 88B Instrument on lots with potential zero lot lines, and the adjacent burdened lot, to: • Include a 900mm easement for ongoing maintenance and support of the zero lot line boundary wall. • Exclude Council from any dispute resolution process between the adjoining lots. • Restrict placement of overhanging eaves, gutters or services (rainwater tanks, air conditioning units, hot water units and the like) within the easement.	A3.1 The location of proposed zero lot lines must be demonstrated on the subdivision plan. A3.2 The location of zero lot lines are based on orientation and topography. The zero lot line should be located on the: • Most southern side of the lot (refer to Figure 5) to maximise solar access, and • Low side of the lot to minimise water penetration and termite issues.  Figure 5: Location of Zero Lot Lines
P4 Corner allotments are designed to encourage safe vehicular and pedestrian movement.	A4.1 Corner lots shall allow for a minimum splay of 2m x 2m to allow for pedestrian and vehicular sight distance (except at the entrance to one-way rear lanes where splays are not required).
P5 Lot layout avoids rear boundaries fronting public spaces.	A5.1 Where residential development adjoins public spaces (excluding laneways) the subdivision design enables the configuration of dwellings or other residential accommodation uses to front the public space.
P6 Subdivision layout enables significant views and vistas to be retained.	A6.1 The street layout enables view lines to be established to riparian corridors, open space and woodland areas within the URA, and to escarpment and

pastoral landscapes beyond the URA as per **Figure 6**.

- A6.2 The subdivision layout considers **views** into the URA from Moss Vale Road, Abernethys Lane, Bells Lane and other nominated viewpoints.

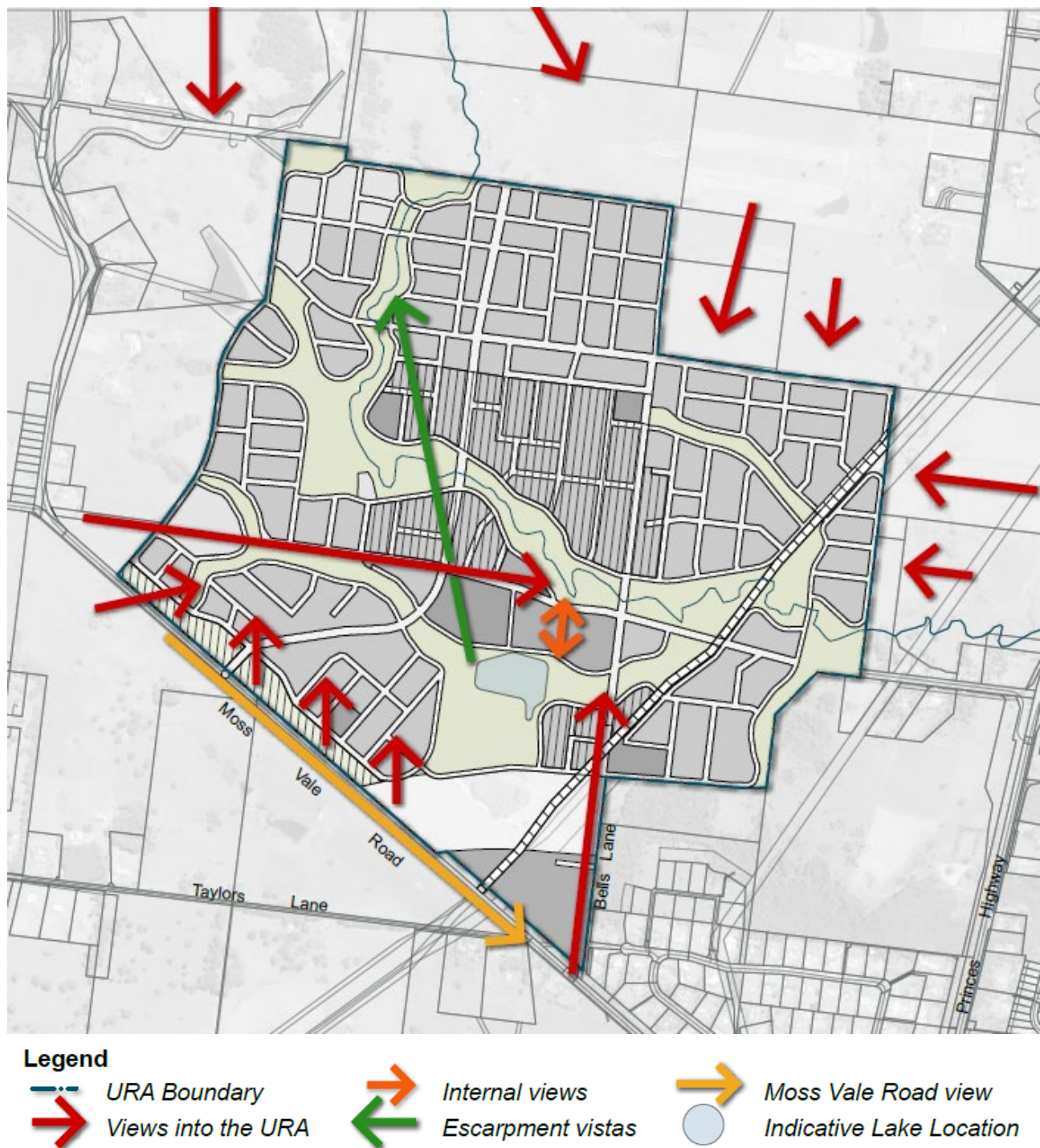


Figure 6: Significant Views and Vistas

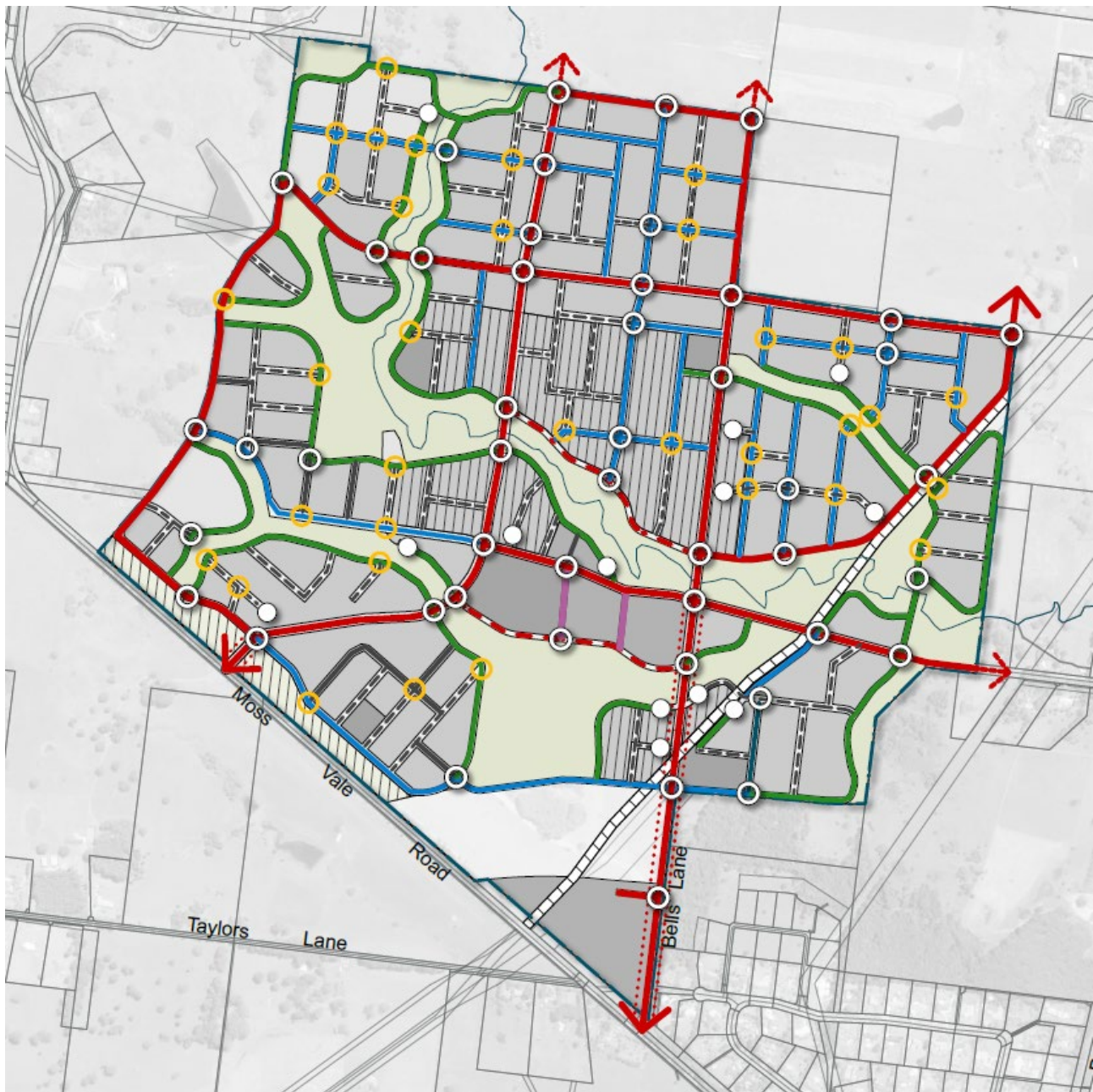
7.4 Street Network and Hierarchy

The specific **objectives** are to:

- i. Achieve a safe, functional and convenient movement network for private vehicles, public transport, pedestrians and cyclists.
- ii. Provide a high quality, visually attractive, connected and legible street network within and beyond the URA that is informed by natural features, terrain and **views** and is distinguishable through changes in the design of the street.

Mandatory Controls

- 1) The street network is to be provided in accordance with the Indicative Layout Plan at **Figure 2** and the Street Hierarchy and Network Plan at **Figure 7**. Where a variation to the street network is proposed, achievement of the following principles must be demonstrated:
 - Establish a defined street hierarchy and permeable street network as per the key development **objectives**.
 - Encourage walking and cycling by ensuring **allotments** are within 400m walking distance from the **Collector Road** network.
 - Maximise connectivity between residential and open space.
 - Take account of topography and improve connectivity between significant and **remnant vegetation** through revegetation.
 - Optimise **solar access** opportunities for **dwelling**s.
 - Provide frontage to and maximise surveillance of open space and riparian corridors.
 - Provide **views** and **vistas** to key landscape features.
 - Maximise the use of **water sensitive urban design** measures.
 - Minimise the use of cul-de-sacs.
 - Provide well landscaped, traffic-calming and connected streets.



Legend

	URA Boundary		Retail Street		Restricted Access		Priority Control
	Collector Tier 1		Riparian Street		Cul-de-sac Locations		Immediate Connection
	Collector Tier 2		Access Street Tier 1		Roundabouts		Potential Future Connections
	Local Street		Access Street Tier 2		Eastern Gas Pipeline Easement		

Figure 7: Street Hierarchy and Network Plan

- 2) Streets are designed in accordance with **Table 2 to Table 8** and **Figure 10 to Figure 16** in this Section. **Carriageway** widths are measured from invert to invert.

Note: Construction of **roads** is to be in accordance with the requirements of Chapter G11: Subdivision of Land. Indicative layouts are diagrammatic only and do not represent the minimum widths to true scale.

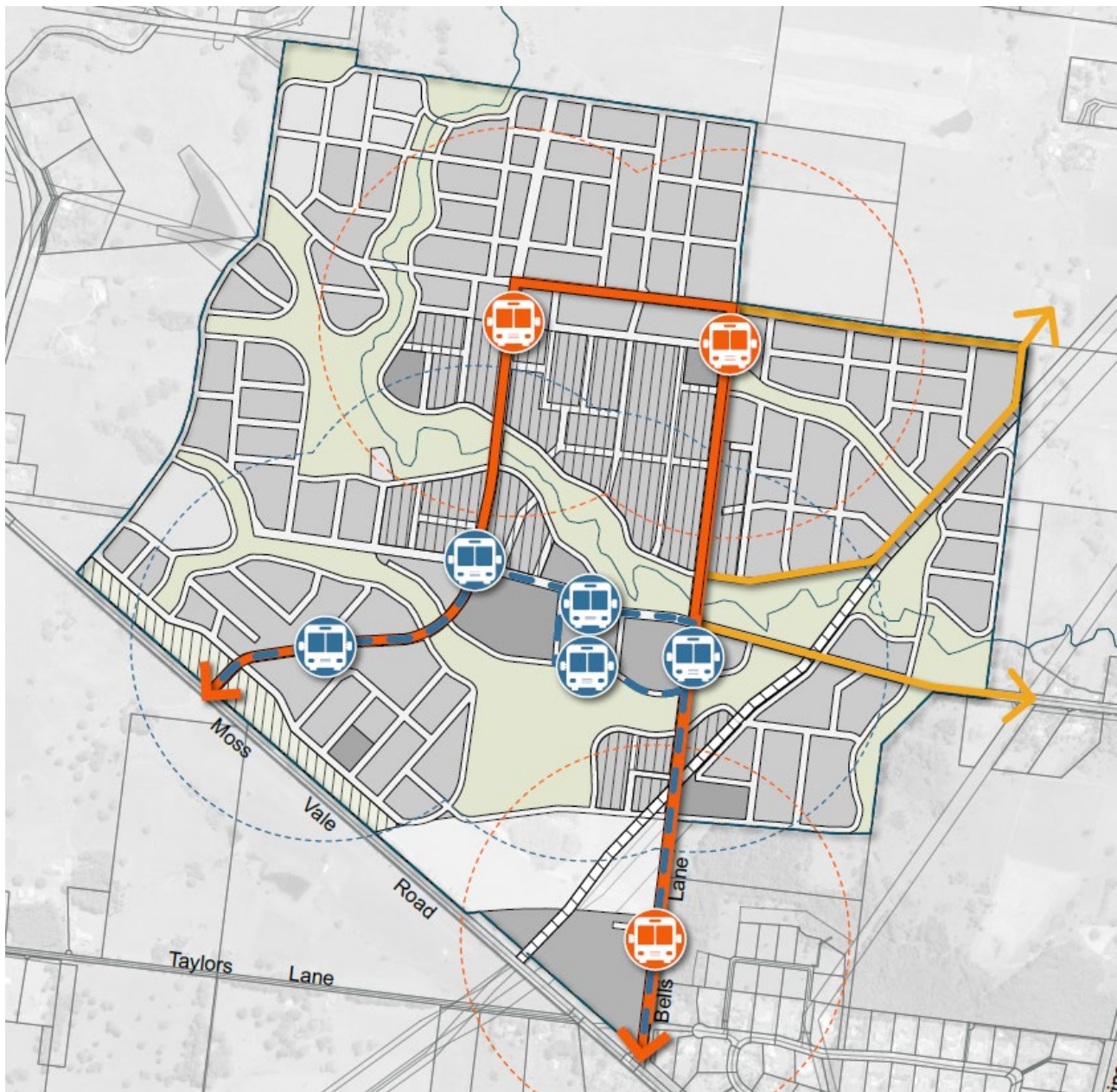
- 3) No direct vehicular access or **waste** collection is permitted on the restricted access section of the **Collector Roads**, as illustrated by the dashed line in **Figure 7**.

Note: At the subdivision stage, a restriction is to be included on a Section 88B Instrument on **lots** located on the restricted access section of the **Collector Roads** to restrict vehicular access to a rear laneway or shared driveway only.

- 4) The **road** network is designed to allow for a future public transport route as per **Figure 8**. An interim public transport route is appropriate until the completion of Stages 1 to 3/4 (by 2031) and the ultimate public transport route accommodates Stages 5 to 7 (by 2041).

Note: **Collector Roads** (Tier 1 and Tier 2) and Local Streets have been designed to accommodate buses to provide flexibility for future route planning.

- 5) All streets must incorporate appropriate **road** geometry, traffic management and calming devices to produce a low speed traffic environment. Traffic management devices are to be identified at subdivision DA stage.
- 6) Street **trees** are required on all streets and are to be placed within the verge as identified in **Table 2 to Table 8** and **Figure 10 to Figure 16** in this Section. Placement of street **trees** will consider underground services, driveways and easements in accordance with **Figure 9**. Street **tree** species are to be selected from the relevant street plan list at Supporting Document 2, in order to establish a distinct identity for the URA. Street **trees** are planted with appropriate root guards to protect underground infrastructure, pathways, kerb and gutters. Street **tree** planting is alternated with street lighting.



Legend

	URA Boundary		Ultimate Bus Route (2031-2041)		Immediate Bus Route Connection
	Interim Bus route (2026-2031)		Bus Stop (2031-2041)		Potential Bus Route Connection
	Bus Stop (2026-2031)		400m Bus Stop Radius		
	400m Bus Stop Radius		Potential Future Bus Route		

Figure 8: Indicative Interim and Ultimate Public Transport Route

7) Construction of verges provide adequate space for underground service allocation and street trees as per:

- **Figure 9** for verges between 3-3.6m in width.

- The NSW Streets Opening Coordination Council's [Guide to Codes and Practices for Streets Opening](#) for verges greater than 3.6m in width.

Note: Where rear laneways are required, underground service allocation is to be provided along the primary street frontage, not the laneway.

The centre line for street **trees** is determined as an equal distance from the kerb to the trench for the water service allocation.

If water mains are located under the footpath or hard stand areas, connections and service lines must be installed at the time of water main construction and extended into the property boundary by a minimum 0.5m. Pathcocks are to be raised to surface and incorporated if located in hardstand and footpaths. Early consultation with Shoalhaven Water is encouraged.

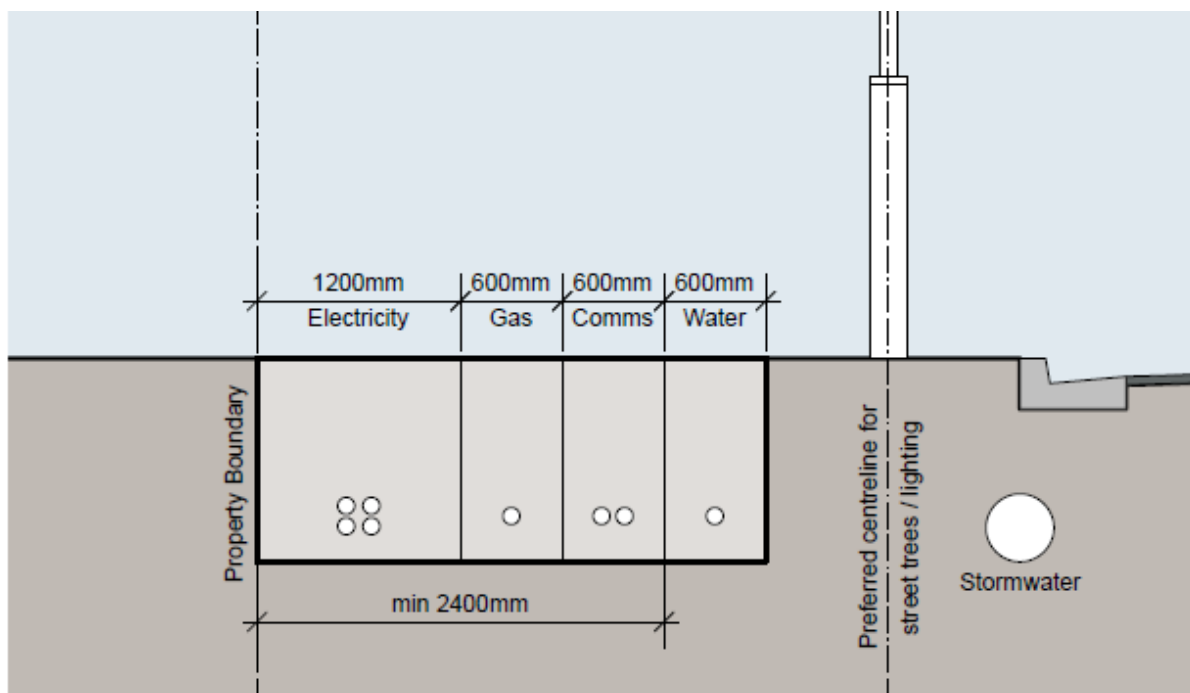


Figure 9: Underground Service Allocation (verge width 3-3.6m)

7.4.1 Collector Road – Tier 1

Table 2: Minimum Cross-section Width – Collector Road – Tier 1

Verge (m)			Carriageway (m)			Verge (m)			Total Reserve
Offset	Path	Plant	Parking	Lane	Parking	Plant	Path	Offset	
1 - 1.5	1.5 – 2*	1.5	3.5	7	3.5	1.5	1.5 – 2*	1 - 1.5	23m
4.5			14			4.5			

* a 2m wide shared use path is provided within at least one verge, with a 1.5m wide pathway provided on the other verge.

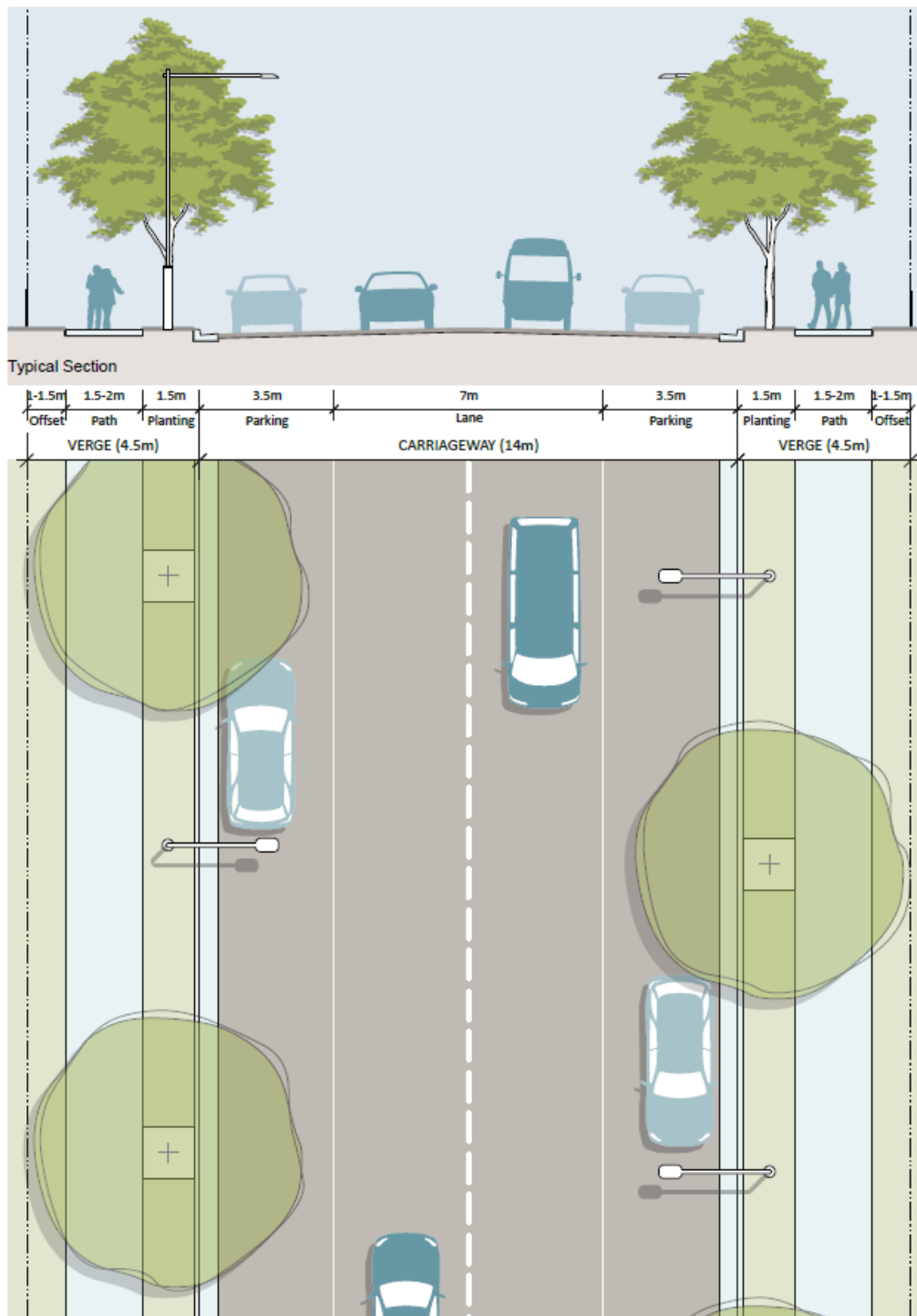


Figure 10: Typical Plan and Section – Collector Road – Tier 1

7.4.2 Collector Road – Tier 2

Table 3: Minimum Cross-Section Widths – Collector Road – Tier 2

Verge (m)			Carriageway (m)			Verge (m)			Total Reserve
Offset	Path	Plant	Parking	Lane	Parking	Plant	Path	Offset	
1 - 1.5	1.5 – 2*	1.5	3	7	3	1.5	1.5 – 2*	1 - 1.5	22m
4.5			13			4.5			

* a 2m wide shared use path is provided within at least one verge, with a 1.5m wide pathway provided on the other verge.

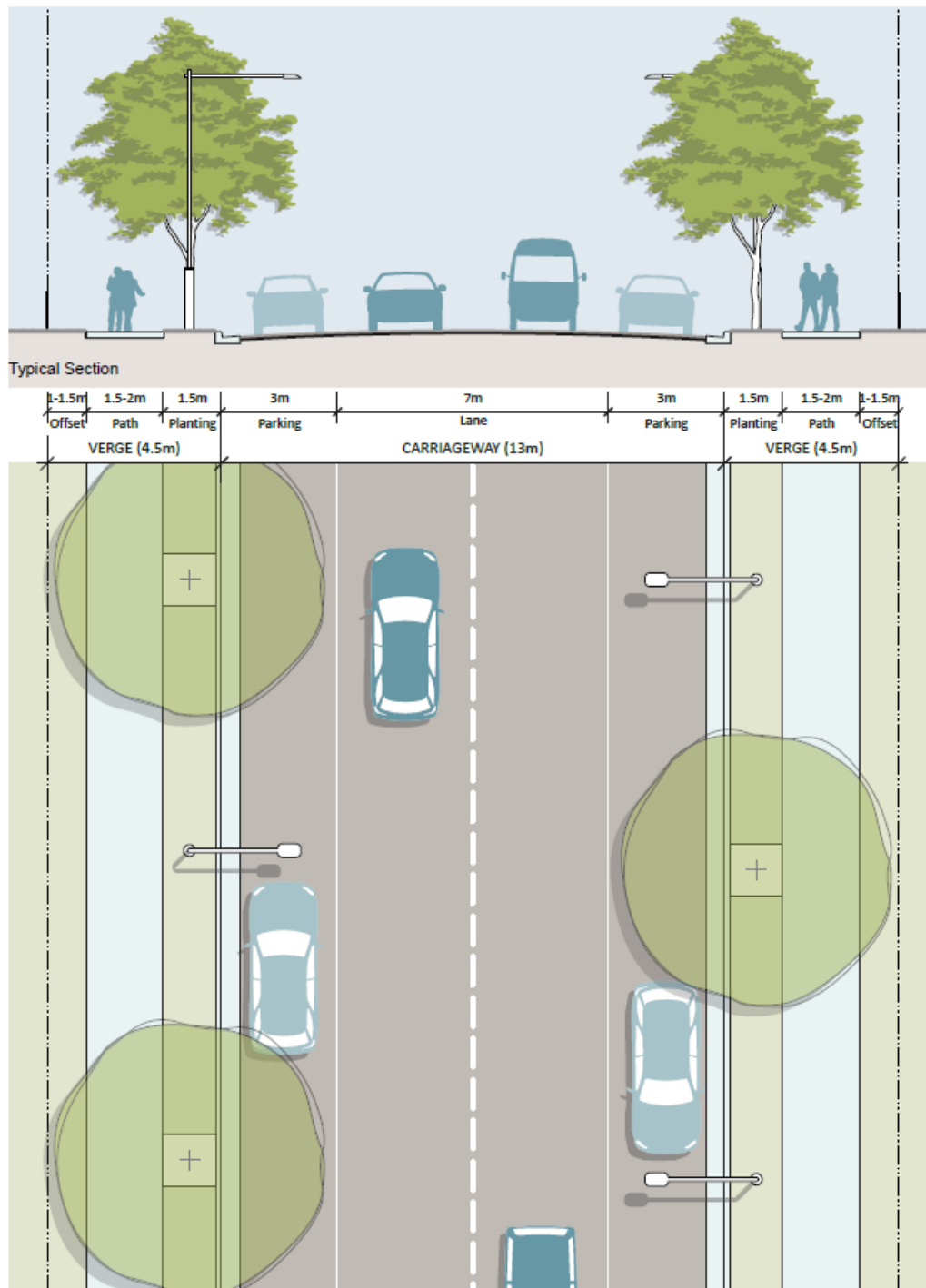


Figure 11: Typical Plan and Section – Collector Road – Tier 2

7.4.3 Local and Retail Streets

Table 4: Minimum Cross-section Widths – Local and Retail Streets

Verge (m)			Carriageway (m)			Verge (m)			Total Reserve
Offset	Path	Plant	Parking	Lane	Parking	Plant	Path	Offset	
1	1.5 – 1.8*	2	2.3	9	2.3	2	1.5 – 1.8*	1	22.6-23.2m
4.5 – 4.8			13.6			4.5 – 4.8			

* a 1.8m wide path is provided for Retail Streets.

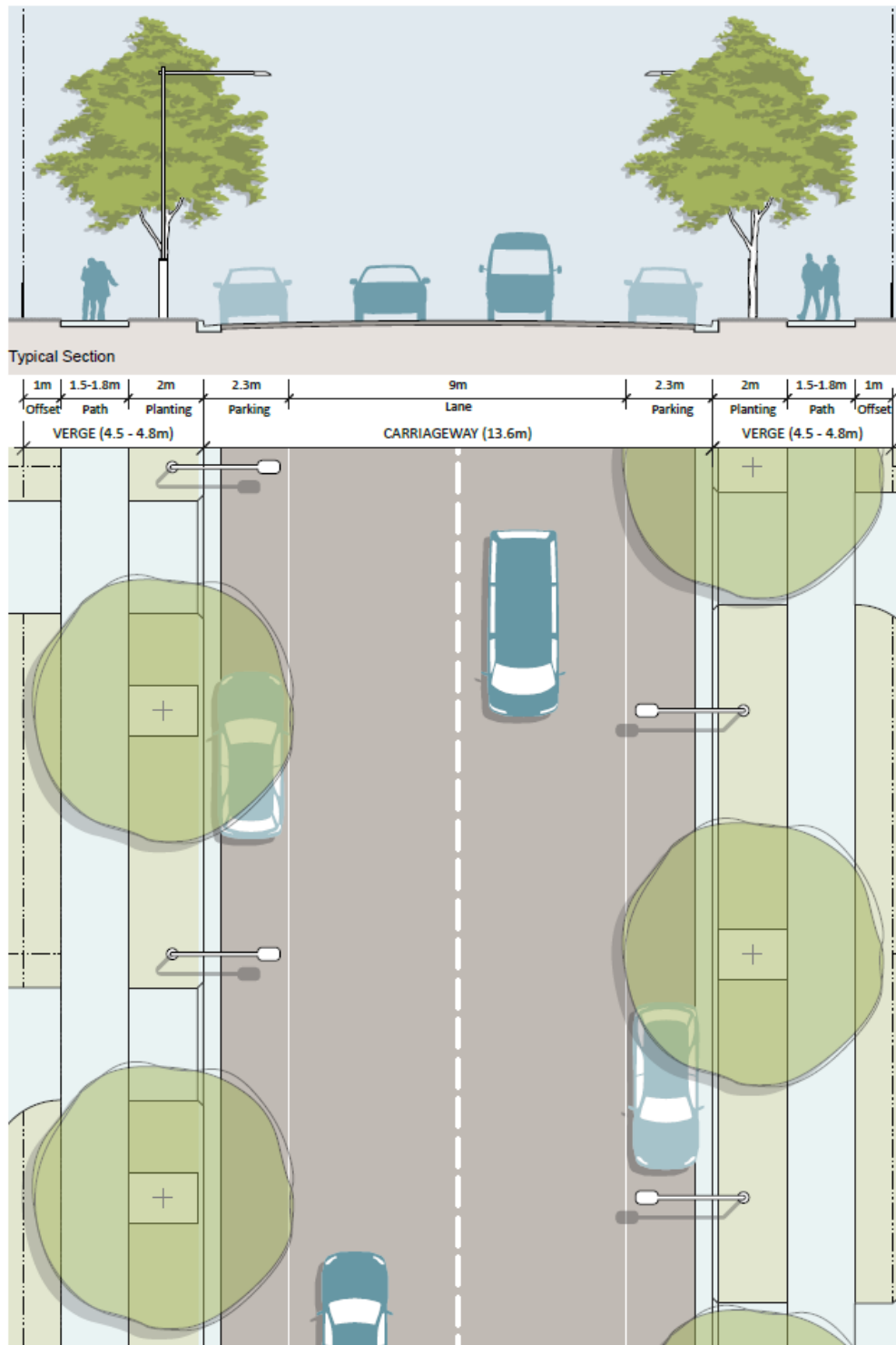


Figure 12: Typical Plan and Section – Local and Retail Streets

7.4.4 Access Street – Tier 1

Table 5: Minimum Cross-section Widths – Access Street – Tier 1

Verge (m)			Carriageway (m)			Verge (m)			Total Reserve
Offset	Path	Plant	Parking	Lane	Parking	Plant	Path	Offset	
1	1.5	1	2	5.5	2	1	1.5	1	16.5m
3.5			9.5			3.5			

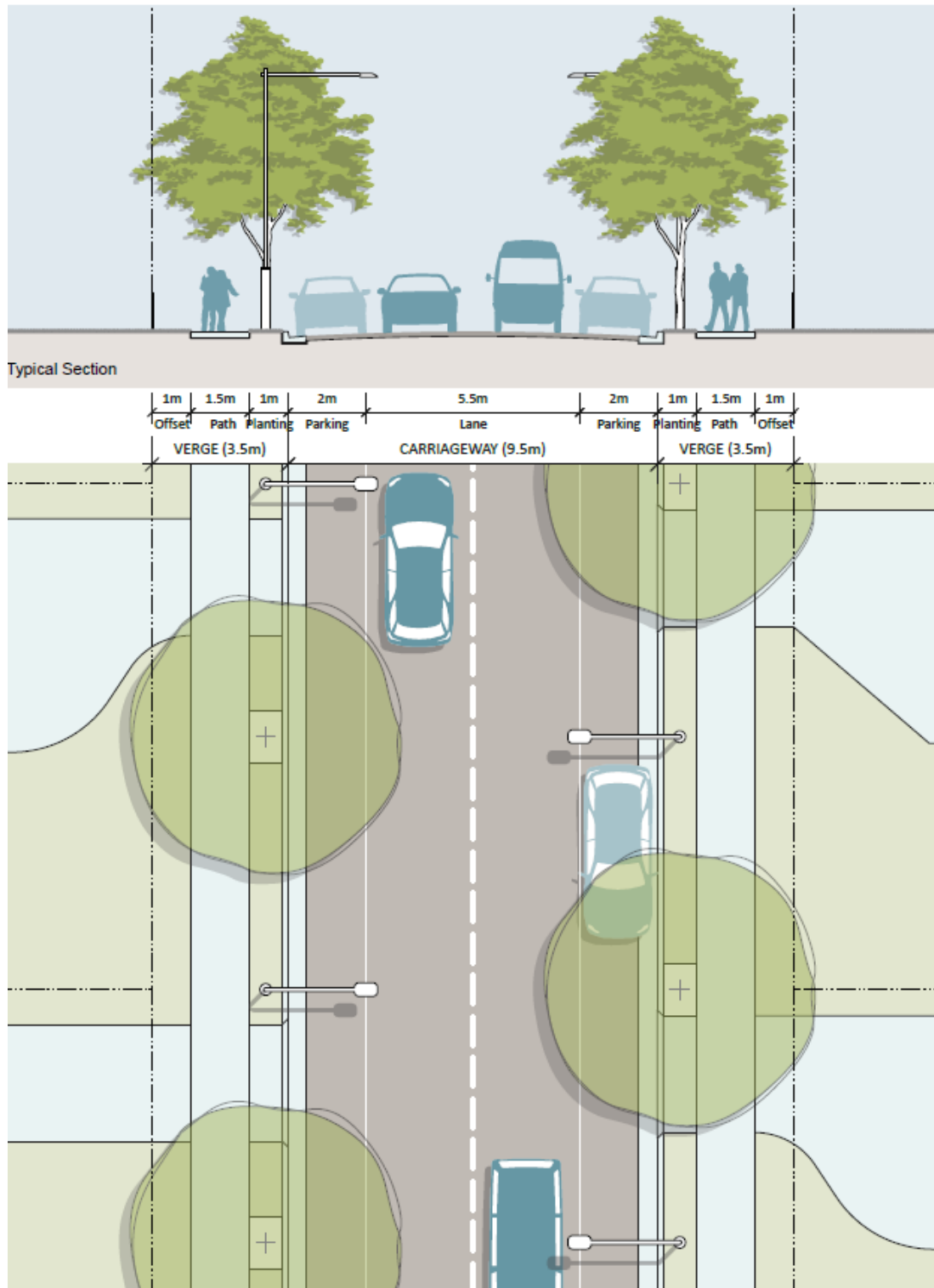


Figure 13: Typical Plan and Section – Access Street – Tier 1

7.4.5 Access Street – Tier 2

Table 6: Minimum Cross-section Widths – Access Street – Tier 2

Verge (m)			Carriageway (m)	Verge (m)			Total Reserve
Offset	Path	Plant	Lane	Plant	Path	Offset	
1	1.5 – 2.0	1.5 – 2.0	7.5	1.5 – 2.0	1.5 – 2.0	1	16.5m
	4.5		7.5		4.5		

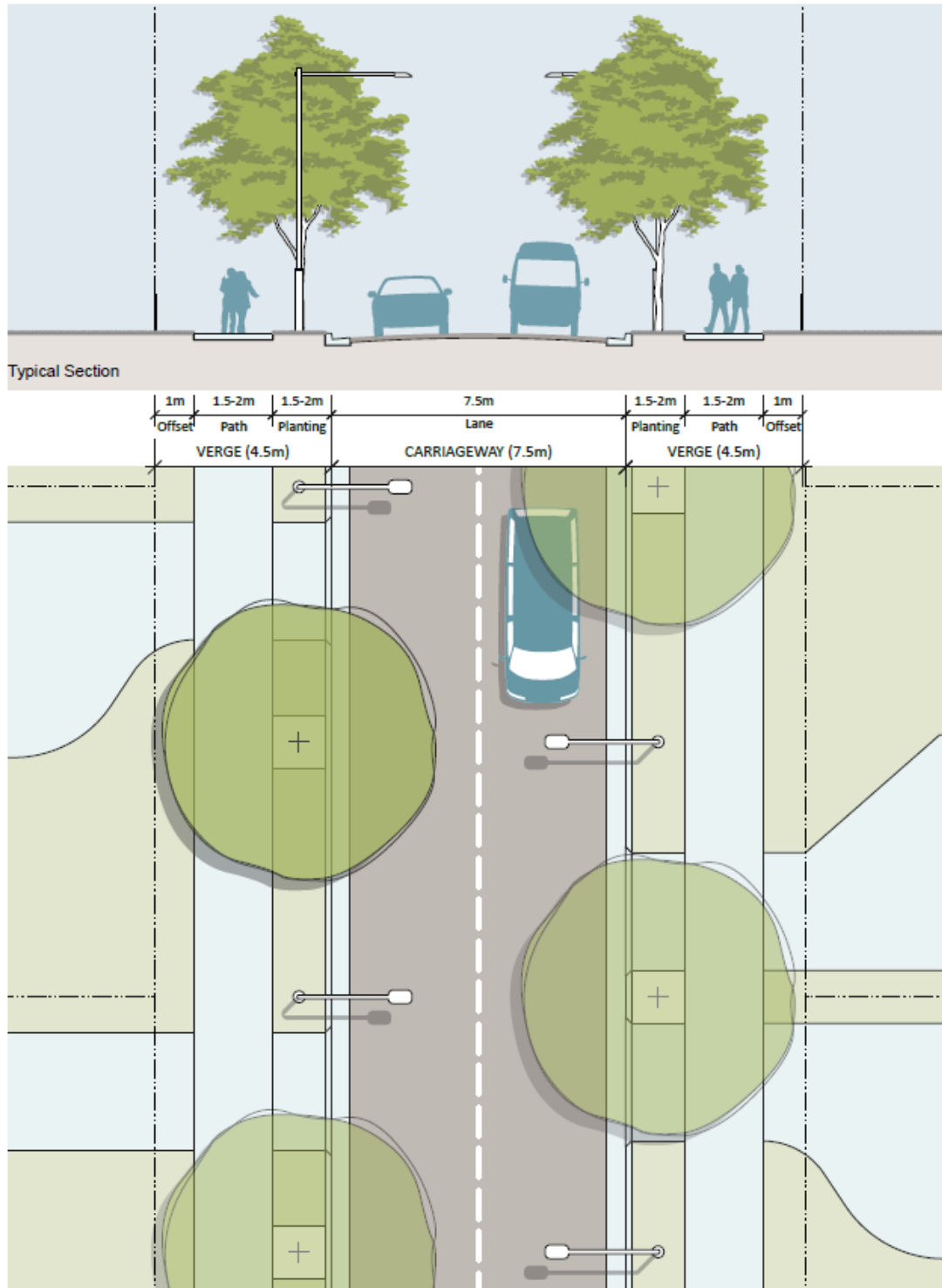


Figure 14: Typical Plan and Section – Access Street – Tier 2

7.4.6 Riparian Street

Table 7: Minimum Cross-section Widths – Riparian Street

Verge (m)		Carriageway (m)		Verge (m)	Total Reserve
Grass *	Path	Lane	Parking	Plant	
0 - 15	2.5	7	3	4.5	17–32m
2.5 – 17.5		10		4.5	

Note: Asset protection zones along Riparian Streets are to be located within the road reserve where possible (except where adjacent to the large lot areas). The entire road reserve should provide for the APZ. The verge (riparian side) is to be widened as required*. Where there is a transition between APZ widths, a smooth transition is preferable (i.e., not stepped). Refer to indicative APZ requirements in **Figure 20**.

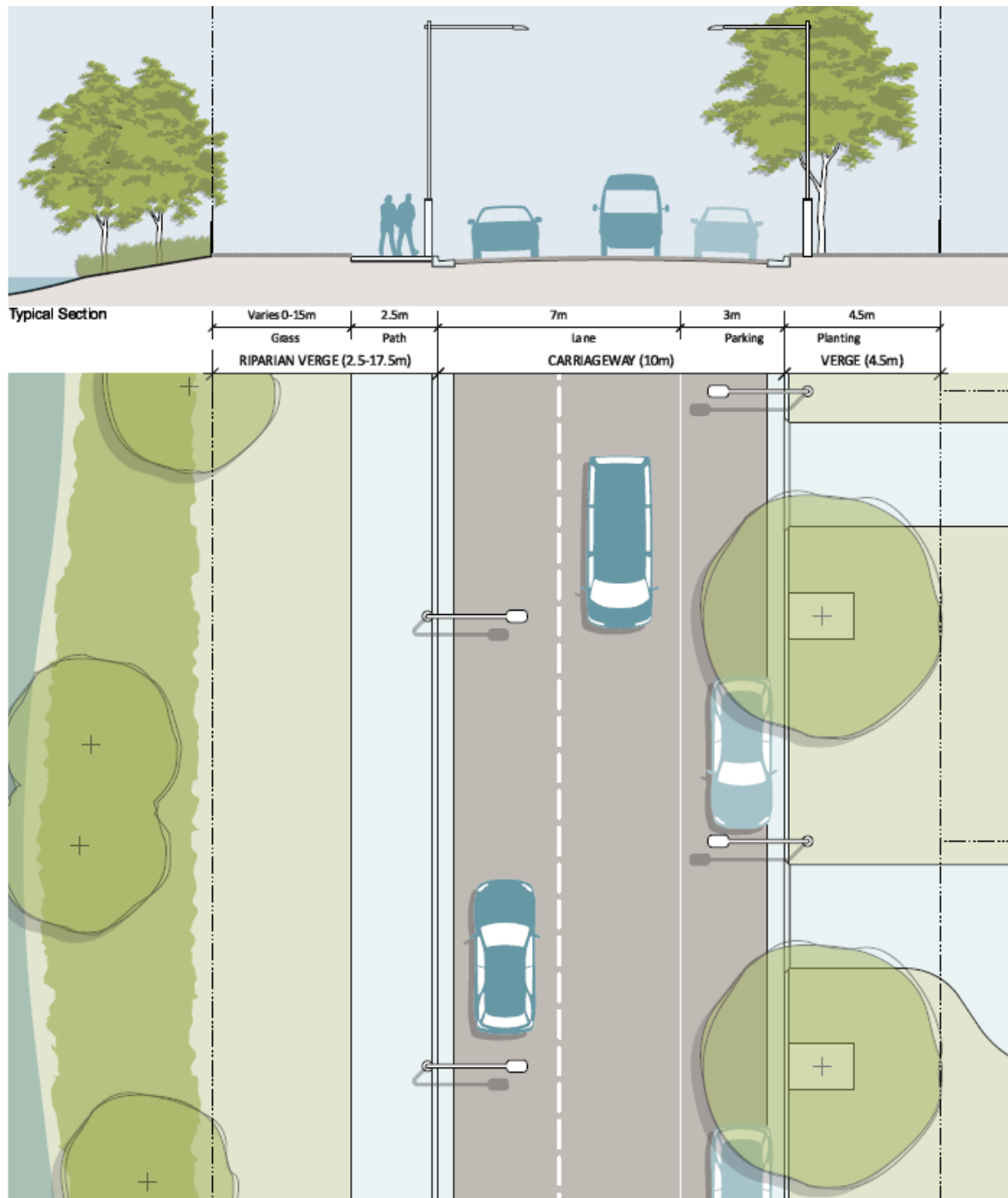


Figure 15: Typical Plan and Section – Riparian Street

7.4.7 Rear Laneway

Table 8: Minimum Cross-section Widths – Riparian Street

Verge (m) Plant	Carriageway (m) Lane	Verge (m) Offset	Total Reserve
2.5	6	2.5m	11m

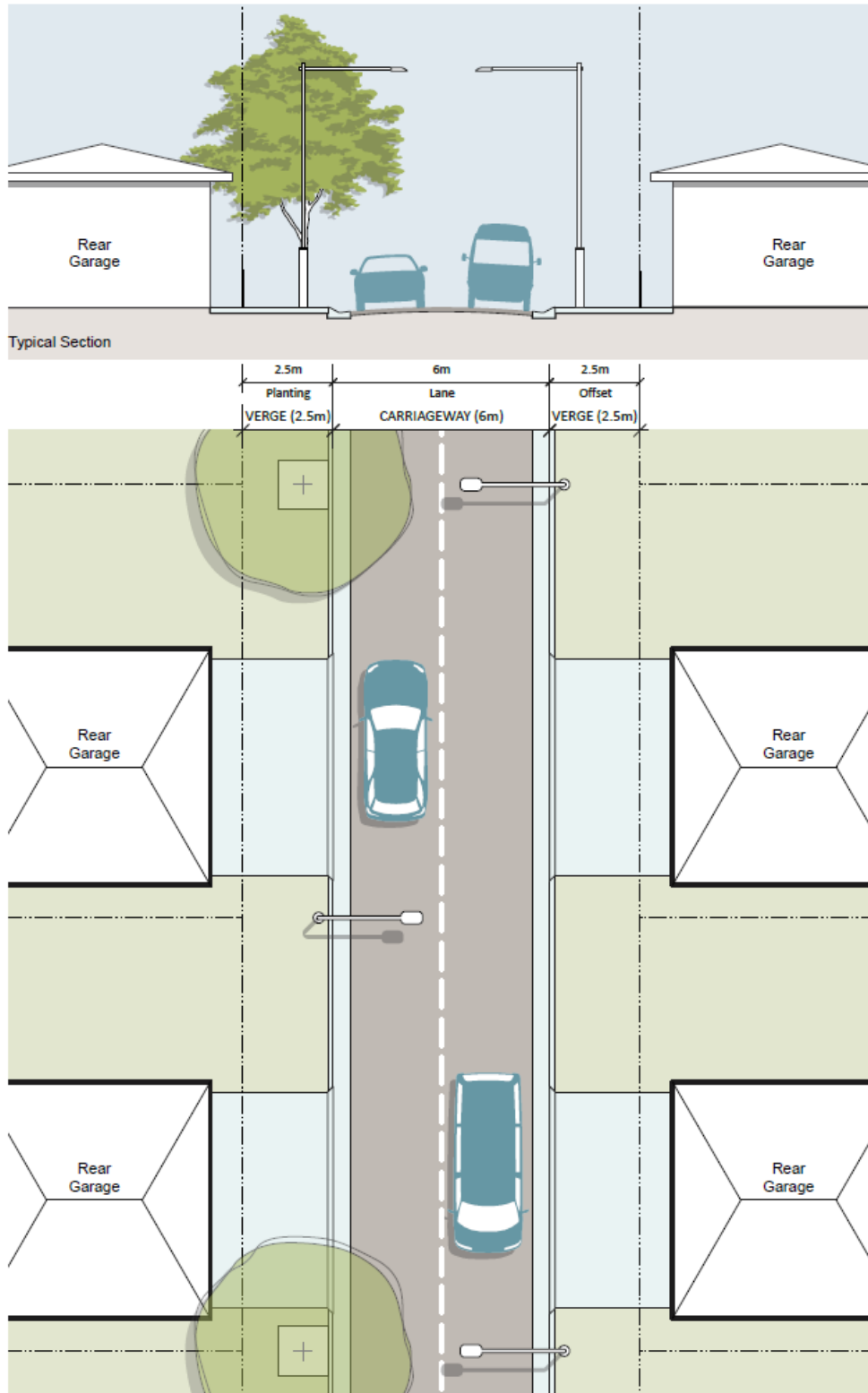


Figure 16: Typical Plan and Section – Rear Laneway

7.5 Laneways

The specific **objectives** are to:

- i. Create attractive **primary frontages** by removing garages and driveway crossovers, improving the presentation of **dwellings** and maximising on street **parking spaces** and street **trees** to the primary frontage.
- ii. Promote housing diversity without compromising amenity, particularly for smaller sized **allotments**.
- iii. Create a slow speed zones that are distinctly different in character and materials to residential streets to reflect the very low volume and frequency of vehicle movements.



Performance Criteria	Acceptable Solutions
P7.1 Laneways are of a size, layout and orientation that encourage low volume and safe use, maximise favourable lot orientations, legibility, passive surveillance, solar access to lots and the laneway and accommodate waste collection. Note: Laneways are secondary frontages providing rear access. They do not: • Act as a primary frontage; • Provide on-street car parking; or • Include footpaths. P7.2	A7.1 Where a site is located on a restricted access street, within the Village Centre or the lot size is less than 400m², waste collection and general vehicular access is to occur from a laneway. A rear lane network is to be established. Note: A restriction is to be included on a Section 88B Instrument to restrict driveways on the primary frontage. A7.2 No more than two sets of continuous laneways are provided, except where they are transected by a Collector Road. A7.3 The laneway verge (excluding driveway crossovers) is to be soft landscaped to

P7.3	A rear lane network is established to support access and serving of development: - On an restricted access street. - Within the Village Centre. - With a lot size of less than 400m².	improve overall amenity and stormwater infiltration.
A7.4	A waste collection point for each lot is to be provided which: - Is directly adjacent to the driveway crossover on the laneway. - Is provided as a constructed bay that is 1.2m deep and 2.5m wide.	
A7.5	Laneways incorporate sufficient lighting to meet Crime Prevention Through Environmental Design (CPTED) principles.	
Note: Refer to Chapter 2: General and Environmental Considerations of this Development Control Plan for an overview of CPTED considerations.		

7.6 Shared Driveways

The specific **objectives** are to:

- Minimise the impact of driveways on the function of main streets, quality of the public domain and pedestrian safety.
- Enable shared driveway access to **lots** fronting restricted access **roads**.
- Provide safe and easy access to garages and on-site parking arrangements.

Performance Criteria	Acceptable Solutions
P8.1 Shared driveways provide access to small allotments to discourage garage dominated streetscapes.	A8.1 Shared driveways are provided for small lots from local streets only.
P8.2 Waste collection points are appropriately sited to facilitate effective collection and avoid adverse impacts on dwelling amenity.	A8.2 Shared driveways provide vehicular access to no more than 4 dwelling s.
Note: Shared driveways are privately owned and maintained driveways that serve two to four dwelling s through a titling arrangement such as a reciprocal right of way or community title subdivision .	A8.3 Shared driveways are configured as per Figure 17 below.
	A8.4 Shared driveways have a different construction material to the general road surface.
	A8.5 Lots that are accessed via a shared driveway must have a primary street frontage.
	A8.6 Shared driveways are a maximum of 6m wide.
	A8.7 The location of driveways must consider dwelling design and orientation, distance

from intersection, street gully pits and street **tree** plantings.

A8.8 Shared driveways must be located a minimum of 10m from splitter islands associated with roundabouts.

A8.9 Shared driveways are a minimum 0.5m from any **drainage** facilities on the kerb and gutter.

A8.10 Shared driveways incorporate soft **landscaped areas** on either side at a minimum width of 1m, suitable for infiltration.

A8.11 **Waste** collection from shared driveways is not permitted. A **waste collection point** is to be provided which:

- Is directly adjacent to the shared driveway crossover on the local street.
- Is provided as a constructed bay.
- Is a minimum 1.2m deep and 5.5m wide and must have sufficient unobstructed kerbside frontage to service all **dwelling**s accessed via the shared driveway. The kerbside frontage required per bin is 1m, with 0.5m separation between bins and 1m behind each bin.



Figure 17: Shared Driveway Configuration

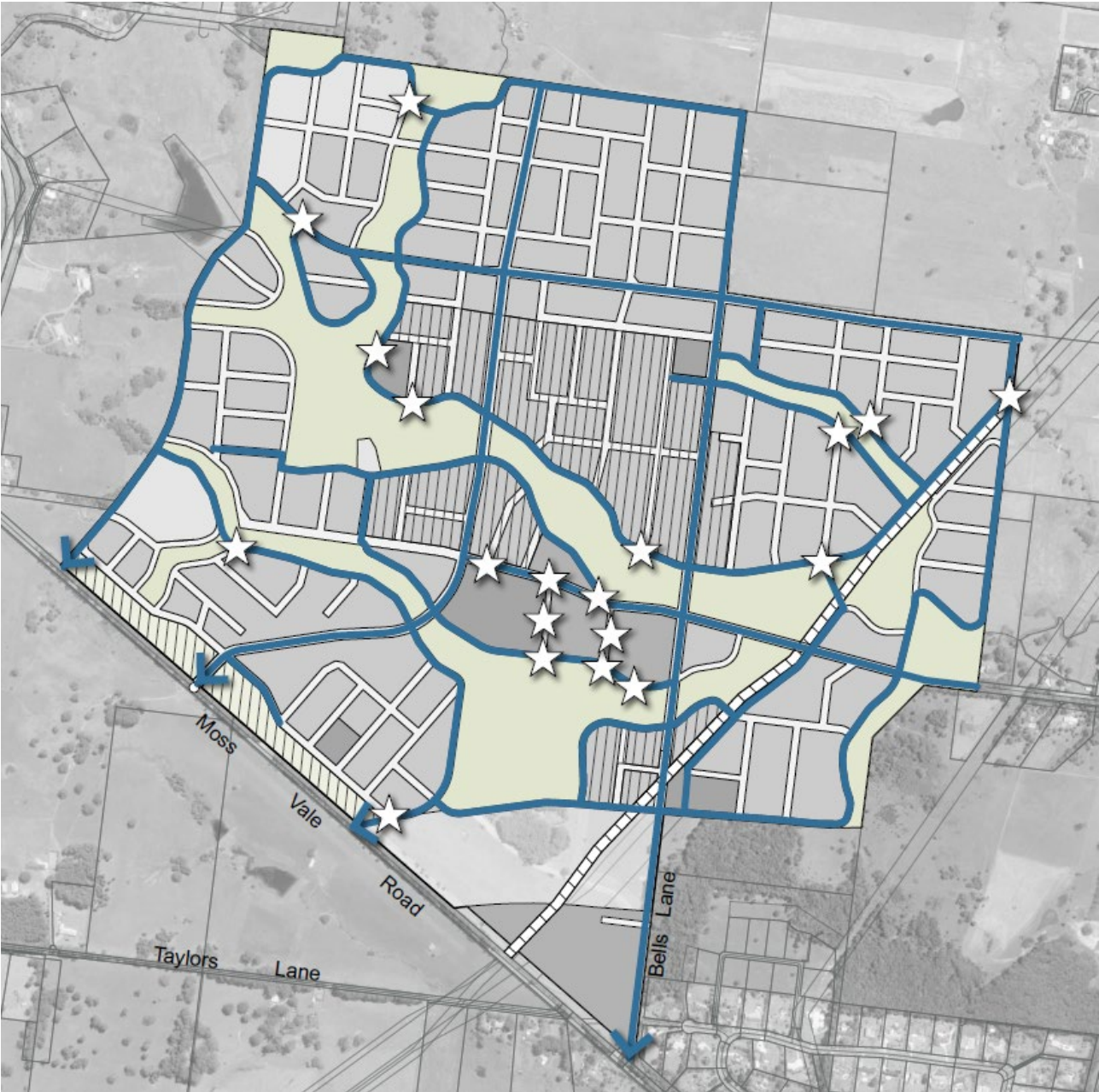
7.7 Shared Use Pathway Network

Shared use pathways are predominantly located adjacent to the riparian corridor and the outskirts of the URA and adjoin Moss Vale Road and certain **Collector Roads**, Riparian Streets and Local Streets.

The specific **objective** is to:

- i. To ensure shared use pathways are part of a comprehensive and connected system which provides a variety of routes to destinations within and outside of the URA.

Performance Criteria	Acceptable Solutions
P9 The shared use pathway network connects to and through the urban area and through to the Village Centre, as well as the riparian and open space networks in accordance with the ILP.	A9.1 Shared use pathways are located within the verge, except where they traverse riparian corridors. Note: The location of shared use pathways in the verge is to avoid any water supply mains.
	A9.2 Shared use pathways are designed to achieve the following minimum width: • Within the verge (excl. Riparian Streets): 2m. • Within the verge (Riparian Streets): 2.5m. • Within the riparian corridors: 2.5-3m.
	A9.3 Shared use pathways, in relation to Riparian Streets, are to be located along the riparian edge and adjacent to the kerb (i.e., no vegetated strip between path and kerb).
	A9.4 Shared use pathways are to be constructed as per Chapter G11: Subdivision of Land.



Legend

-  Shared Use Path
-  Path Connections
-  Proposed Pedestrian Crossing

Figure 18: Shared Use Pathway Network

7.8 Open Space System

The specific **objectives** are to:

- i. To ensure that future residents of all ages and abilities have access to high quality functional formal and natural open space areas for passive and active recreation.
- ii. To ensure the connected network of open spaces within the URA are accessible and include pedestrian and cycle routes.
- iii. To provide multi-functional open space areas that are able to encourage a range of activities within the neighbourhood's diverse open space areas.
- iv. To incorporate significant areas of natural value within the open space network.
- v. To ensure the design and embellishment of the open space is of high quality, robust, low maintenance and addresses the vision of the URA.

Performance Criteria	Acceptable Solutions	
P10 Open space areas are of a high amenity, accessible, well connected and act as a destination to encourage physical movement, activity and social interaction.	A10.1 Open spaces areas are located in accordance with the ILP at Figure 2 .	
	A10.2 Open space areas incorporate facilities such as seating, playgrounds, BBQs, paved areas, landscape planting and exercise equipment in appropriate locations and where they do not compromise revegetation through any Vegetation Management Plan .	
	Note: Refer to Supporting Document 2 for plant species and furniture/embellishments suitable for open space areas.	
	A10.3 The open space areas mark connections and transitions to adjoining areas.	
	A10.4 Open space areas are provided in accordance with Chapter G11: Subdivision of Land.	
P11 Open space areas retain and enhance significant vegetation and provide a wooded backdrop for views within the neighbourhood.	A11.1 Significant areas of natural and environmental value are retained, enhanced and incorporated into the open space network.	

7.9 Landscape Strategy

The specific **objectives** are to:

- i. To achieve a landscape setting to balance the built form through well planted streets, open spaces, **treed** backdrops and **lot** sizes that provide opportunities for planting in **private open space** areas.
- ii. To protect, maintain and enhance areas containing environmental heritage, **remnant vegetation** and established **trees**.
- iii. To enhance both the public and private amenity within the URA.
- iv. To contribute to the overall **water sensitive urban design** approach within the URA.
- v. To protect the valuable landscape and environmental values of the URA.
- vi. To establish a vegetated buffer adjacent to Moss Vale Road to mitigate acoustic and visual impacts.

Performance Criteria	Acceptable Solutions
P12 Landscaping is provided to complement and soften the built form and surrounding natural landscape.	A12.1 A landscape strategy, prepared by a suitably qualified person, is submitted at the subdivision DA stage consistent with: • Chapter G3: Landscaping Design Guidelines of this Development Control Plan, and • Supporting Document 2: Landscape Specifications. As a minimum, the landscape strategy is to include: • A Landscape Plan. • Entry treatment (only for stages that include entry from Moss Vale Road, including Bells Lane); • Extensive landscaping and street tree planting that incorporates deep rooted canopy trees as per Supporting Document 2. • Protection of remnant vegetation and established trees in the public domain. • Allow for the protection and enhancement of riparian corridors and works in conjunction with the

		Vegetation Management Plan (See Section 7.10 below). • Provision of avenue tree planting along the collector road system. • Establishment of a street lighting and furniture palette consistent with Supporting Document 2. • Inclusion of any relevant signage detailing local history, Aboriginal cultural values, environmental education themes and the like. • Deep soil planting to enable a substantial tree cover to be created over time. • Detail of vegetation (low growing shrubs and ground covers only) within the electricity easement area which must not exceed 3m. • Removal of existing noxious and environmental weed species. • Rehabilitation of E2 Environmental Conservation zones in accordance with the Vegetation Management Plan for the land.
	A12.2	Provision of landscaping shall not impact sight distances for traffic and pedestrians. Minimum safe sight distances must be maintained.
P13 Established trees are retained in the public domain network.	A13.1	Landscaping is designed to retain existing established trees in the public domain, including road reserves and open spaces. Sufficient space around existing established trees is to be provided to minimise potential hazards to structures.
	A13.2	A flora and fauna assessment shall consider any trees for removal for risk and safe useful life expectance (SULE).

7.10 Aboriginal Cultural Heritage, Environment and Environmental Risk Management

The specific **objectives** are to:

- i. Achieve a high standard of environmental performance and management of natural assets and environmental heritage within the URA.
- ii. Protect and enhance **remnant vegetation** through incorporation within the open space and **stormwater** network.
- iii. Retain the maximum number of established **trees** as possible in the public domain within the URA.
- iv. Mitigate the impacts of **development** on water quality and quantity.

Performance Criteria	Acceptable Solutions
P14 Significant and remnant vegetation and habitat for threatened species is retained and protected.	A14.1 Significant and remnant vegetation (including native vegetation) within the public domain, including in open space areas, is retained and opportunities for enhancement are included. Note: Threatened species have been identified in this URA. A comprehensive flora and fauna assessment is to be prepared by a suitably qualified and experienced person and is to include an analysis of constraints and opportunities and identify/ map areas for rehabilitation. Refer to Chapter G5: Biodiversity Impact Assessment of this Development Control Plan for further information. An arborist report may be required to consider any trees for removal for risk and safe useful life expectance (SULE). A14.2 Hollow bearing trees are to be retained except where tree removal is required for safety reasons. Where removal is required, the trunks and large limbs (>20cm diameter) are to be re-used as coarse woody debris in the riparian E2 Environmental Conservation zone in locations where they are unlikely to be washed downstream. Note: An arborist assessment may be required to identify any unsound trees that require removal. Conditions of consent may be imposed regarding the removal of hollow bearing trees, including but not limited to fauna

protection measures such as hollow inspections pre and post felling, soft felling and ecologist presence during felling.

A14.3 Impact mitigation and management measures shall be proposed to protect threatened species, including, but not limited to, bats.

P15 Riparian corridors are protected and improved to:

- Improve water quality and riparian **vegetation**.
- Improve ecological health and integrity.
- Maintain and enhance habitat values.

Note: The riparian corridors are linear tracts of land associated with the Shoalhaven River drainage system. They are important for maintaining biodiversity, water quality and bank stability. They are a significant component of the Nowra-Bomaderry conservation strategy and represent both constraints and opportunities to urban development.

A15.1 Continuous riparian zones are provided along Abernethy's Creek and other unnamed tributary creeks.

Note: It is anticipated that the riparian corridor will be dedicated to **Council** and managed as one continuous natural area.

A15.2 Each development application that includes the subdivision of land zoned E2 Environmental Conservation must be accompanied by a 5 year **Vegetation Management Plan** (VMP) that has been prepared in accordance with Supporting Document 3.

A15.3 Each development application is supported by appropriate erosion and sedimentation controls to minimise exposed earth forming in the riparian zones during earth forming stages of the subdivision, and until the site is fully developed.

A15.4 Riparian zones and associated buffers are to be retained and enhanced using local native species to improve the ecological functions of the **watercourses**.

A15.5 Buffers are vegetated to protect the integrity of the riparian zone from weed invasion, littering, sedimentation, erosion control pollution, impacts of climate change and to provide wildlife corridors to facilitate the movement of fauna through the landscape.

A15.6 Flat metal grass edging is required on the riparian side of the Riparian Street road reserve, between the riparian area and the grass area (where required), to minimise the risk of invasion of the riparian area.

A15.7 Fencing within riparian corridors shall be minimised and is not permitted across

[watercourses](#). Where fencing is required for safety purposes, the design must allow terrestrial and aquatic fauna to pass through.

A15.8 [Waterway](#) crossings are to be designed in accordance with NSW Department of Primary Industries Fish Passage Requirements for Waterway Crossings (see the [Council and Developer Toolkit](#) for more information).

P16 A vegetated buffer:

- Provides a visual and acoustic buffer.
- Rehabilitates and regenerates natural [vegetation](#) via a VMP prepared by a suitably qualified ecologist/restoration contractor.
- Minimises chance of vehicle strike along Moss Vale Road.

A16.1 A 45-75m vegetated buffer is to be provided along Moss Vale Road (refer to **Figure 19** and the ILP at **Figure 2**) and is to include:

- Rehabilitation of native [vegetation](#) via a VMP. The VMP must include natural regeneration occurring on the site, as well as revegetation (including multi-strata and canopy species) of any areas as required.
- A fauna fence along Moss Vale Road to minimise chance of vehicle strike.

Note: It is anticipated that the vegetated buffer will be dedicated to [Council](#).

The VMP may be an addendum to any riparian VMP.

P17 Elements of Aboriginal cultural and environmental heritage are incorporated within the open space areas of the URA to ensure their protection.

A17.1 Where culturally appropriate and acceptable, any Aboriginal cultural heritage identified through the Aboriginal Cultural Heritage Assessment shall be used to develop interpretive signage throughout the public domain areas, including road reserves and open spaces.

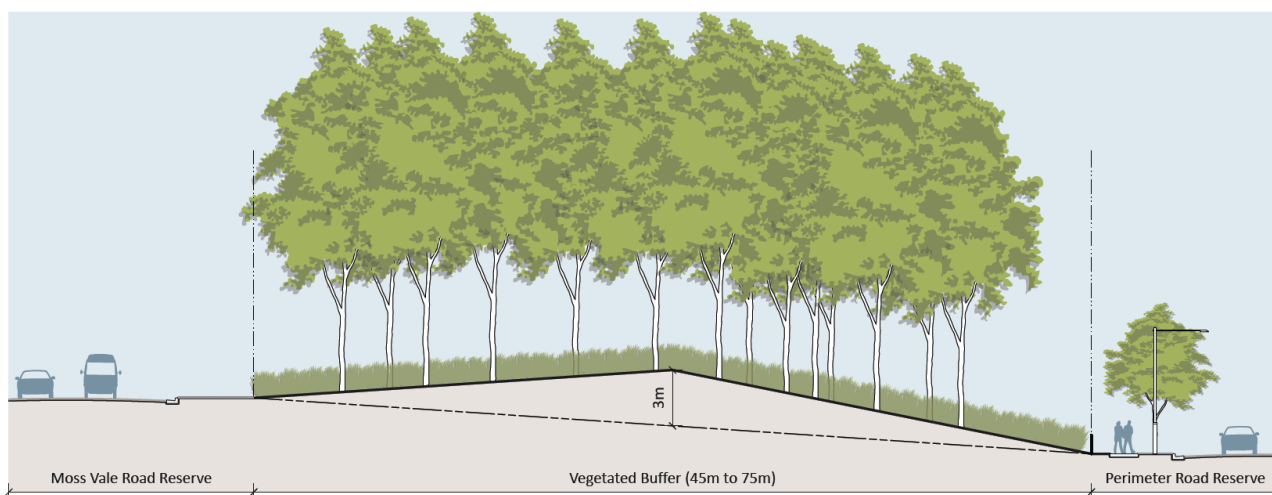


Figure 19: Vegetated Buffer Typical Section

7.11 Bushfire Considerations

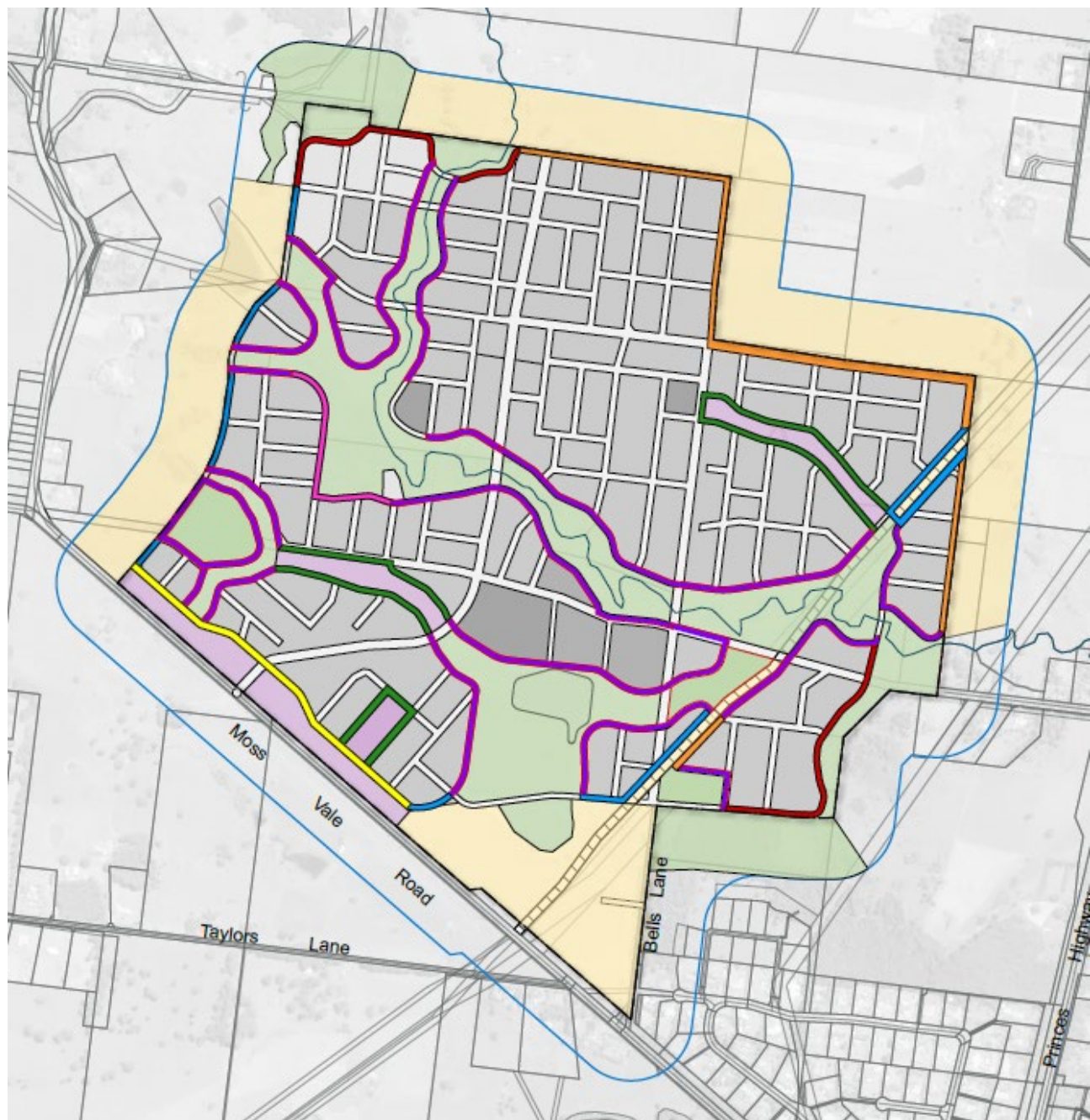
The MVRN URA is characterised as **bush fire prone land** and this risk has been carefully considered through the planning process for the URA.

The subdivision of land within the URA must comply with *Planning for Bush Fire Protection 2019* (PBP), especially (not exclusively):

- Provision of **asset protection zones (APZs)** to comply with Table A1.12.2 for residential development and Table A1.12.1 of PBP for Special Fire Protection Purpose (SFPP) developments.
- Access is to be provided in accordance with Table 5.3b of PBP which will include, but not limited to, a staging plan that demonstrates more than one access **road** in and out of the development at each subdivision stage (where that stage includes three or more **allotments**).

Note: Residential subdivision on **bush fire prone land** requires an approval from the NSW Rural Fire Service, known as a Bush Fire Safety Authority. Applications for the NSW Rural Fire Service's approval must address the extent to which the subdivision complies with Planning for Bushfire Protection, including the preparation of a bushfire assessment. For full requirements, refer to Appendix 2 of PBP *Submission Requirements, Performance based Solutions, and Bush Fire Design Briefs*.

Indicative **APZ** requirements have been established based on residential **development** (**Figure 20**). Greater **APZs** will be required for Special Fire Protection Purpose developments. **APZs** may increase or decrease depending on the **development** outcomes of the bushfire assessments that will be required at the subdivision stage.



Legend

- Subject Land
- 140m buffer
- Residential Layout

Asset Protection Zone (m)

- 10
- 11
- 12
- 14
- 24
- 29
- 36

Vegetation

- Forest
- Grassland
- Low hazard (rainforest)

Figure 20: Bushfire Consideration – APZs

8 Development in the Vicinity of the Eastern Gas Pipeline

The Eastern Gas Pipeline is a high-pressure natural gas pipeline supplying gas to a large portion of New South Wales (NSW), including major demand centres of Sydney, Canberra and Wollongong, as well as regional centres including Nowra-Bomaderry. The pipeline has been constructed to a standard suitable for a residential area and is appropriately maintained by its operator, Jemena.

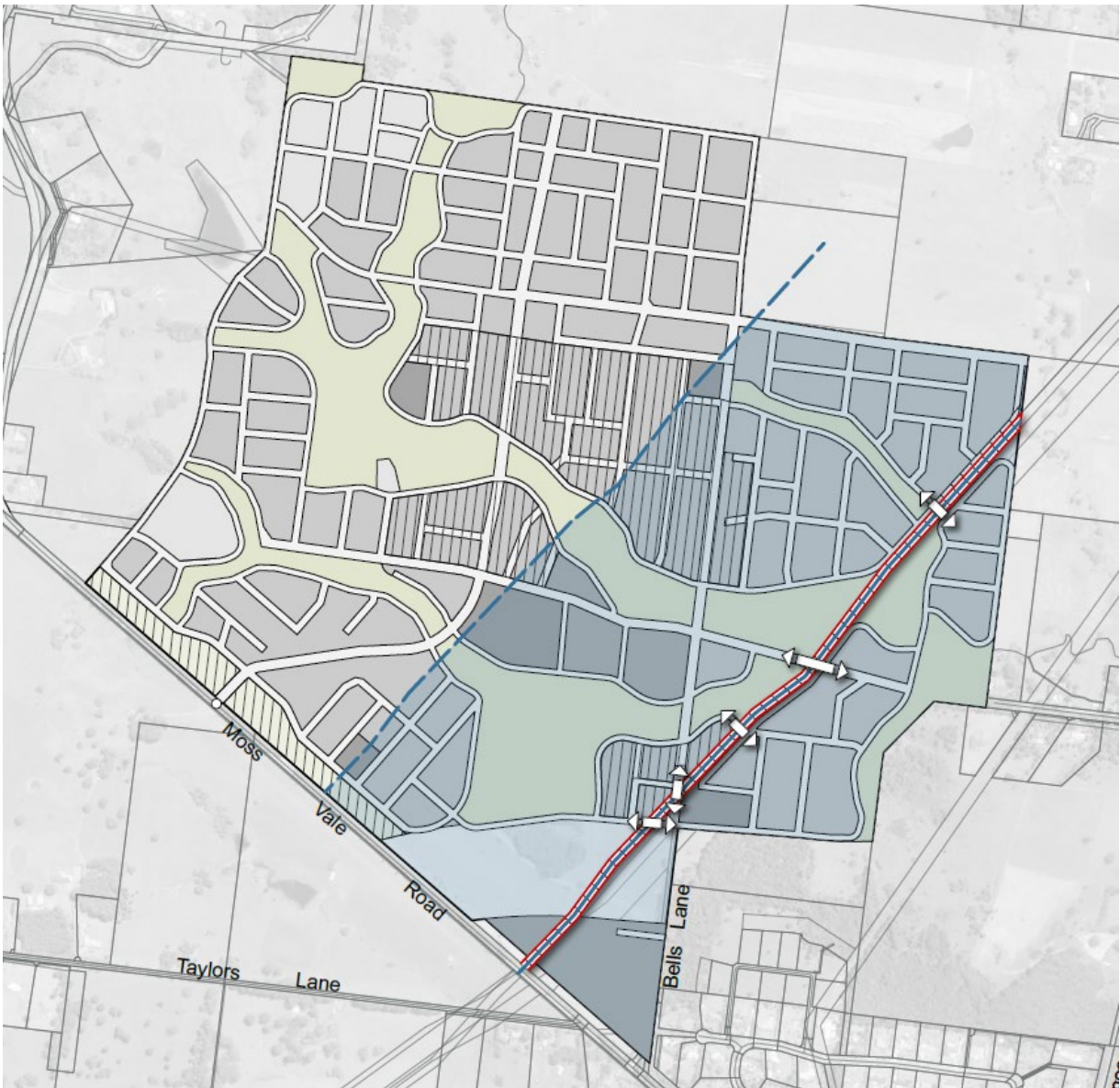
The pipeline spans from Victoria to NSW and crosses the MVRN URA as detailed in **Figure 21**. Construction activity and certain types of development in the vicinity of the pipeline must be considered in the assessment process to avoid impacts on the pipeline, such as potential damage or puncture and to manage the potential risks from any failure of the pipeline.

A 550m buffer (measurement length) has been established from the pipeline to identify the area of the URA likely to be affected should the pipeline fail or be ruptured.

Note: As per the requirements of State Environmental Planning Policy (Infrastructure) 2007, [Council](#) will notify Jemena (the pipeline operator) of any development application adjacent to or within the pipeline corridor (i.e., the easement). Jemena's response will be taken into consideration as part of the assessment process.

The **objectives** of this Section are to:

- i. Ensure development does not impact on the Eastern Gas Pipeline.
- ii. Manage impacts to life, property and the environment.
- iii. Provide for the long-term safety and amenity of residents in the vicinity of the pipeline.



Legend

- | | | | |
|---|---|---|---|
|  | Eastern Gas Pipeline Easement |  | Road Crossing |
|  | Pipe centreline |  | Land in the URA within the 550m measurement length (the buffer area). |
|  | 550m measurement length (550m from the easement on either side) | | |

Figure 21: Key Gas Pipeline Elements

Mandatory Controls

- 1) Jemena must be consulted prior to lodging an application for:
 - Any activity, development or works within the identified easement.
 - Subdivision stages adjacent to the pipeline and within the pipeline buffer area.
 - **Early education and care facilities** (e.g., childcare centres), **medical centres** and **seniors housing** developments within the pipeline buffer area.

Note: A development application must be supported by evidence (to **Council's** satisfaction) which demonstrates consultation with Jemena and provides the outcomes of that consultation.

Consultation with Jemena prior to lodging an application may also be required for other land uses deemed by **Council** or Jemena to be sensitive.

- 2) The minimum design and construction for utility crossings (trenched /trenchless installations), vertical drilling, road work maintenance, changes to surface levels and vehicle crossings in the vicinity of the Jemena Pipelines must comply with:
 - *AS2885: Pipelines – Gas & Liquid Petroleum*.
 - Jemena's Guideline to Designing, Constructing and Operating Around Existing AS2885 Natural Gas Pipelines.
 - Locations of easement road crossings as per **Figure 21**.
- 3) A construction safety management study, developed in consultation with Jemena, must be prepared at the development application stage for:
 - Subdivision activities within the pipeline buffer.
 - Proposed road and utility crossings.
- 4) With the exception of specified crossings, **drainage** infrastructure (storage, conveyance and discharge) is not to be located in the pipeline easement.
- 5) Specified infrastructure (including road and utility crossings), **earthworks**, landscaping and other works within the pipeline easement will be subject to detailed review by Jemena and any subsequent conditions and requirements.
- 6) The subdivision of the pipeline easement is to be minimised.

Note: Dedication of land within the pipeline easement area will be required.

9 Desired Future Character Controls – Colours and Materials

With an aspiration to create an integrated character for the Moss Vale Road North URA, this Section outlines the desired colours and materials for the URA.

The **objectives** of this Section are to:

- i. Avoid the expansive use of any single material or blank walls through appropriate use of design, materials and **articulation**.
- ii. Utilise high quality and durable materials and finishes.

Performance Criteria	Acceptable Solutions
P18 Building materials and colours allow for individual expression whilst: - Establishing a strong local character throughout the URA. - Being sympathetic to the surrounding rural landscape. - Ensuring integration within the streetscape, setting and functional elements of with Village Centre. - Avoiding the expansive use of any single material or blank walls.	A19.1 The materials and colours respond to the existing native bushland context within and surrounding the URA. A19.2 Despite A19.1, the colours of dwellings with a rural interface are to be sympathetic, non-reflective and blend with the surrounding rural landscape. Note: White and bright colours are not acceptable at the rural interface. A19.3 Detailing, signage, and material palette in the Village Centre is to reinforce the character of the Village Centre, whilst distinguishing and capitalising upon the natural and native bushland features in the vicinity.

10 Village Centre Key Design Principles and Controls

Note: This Section should be read in conjunction with the following Chapters of this Development Control Plan:

- Chapter G13: Medium Density and Other Residential Development.
- Chapter G17: Business, Commercial and Retail Activities.

In the event of an inconsistency between a provision in this Section and a provision in a Generic Chapter of this Development Control Plan, the provision in this Section will prevail to the extent of the inconsistency.

Section 11 of this Chapter applies to low density residential development.

Section 12 of this Chapter applies to medium density development.

Centrally located within the URA and with a line of sight from the initial approach from Moss Vale Road, the Village Centre will provide for local shopping, community facilities, services, and **public open space** with medium density housing opportunities. Compact and

centralised, the Village Centre enables easy access to a range of required activities and supports a more socially and ecologically sustainable, and economically viable development form.

The Village Centre consists of the following key precincts (**Figure 22**):

- **The Village Centre Core Area**, the B2 Local Centre zoned land, with the greatest intensity of ground floor use and direct exposure to public space and Abernethys Lane, will provide day to day services, community opportunities, retail and [shop top housing](#). A supermarket, independent retail, parking, and a play space will benefit from north-south street access and vital exposure from the entry from Moss Vale Road across to the public [recreation area](#). Cafés/dining with outdoor dining opportunities will interface with (and provide passive surveillance to) the lake, public [recreation area](#) and public domain.
- **The Village Centre Activation Precinct** – the ‘frame’ area, spans along the north and south of Abernethys Lane.
 - **Area 1** preferences medium density development and flexibility for limited small [scale](#) non-residential uses (around 50 – 100m² per tenancy) to balance activation across Abernethys Lane. This activation could include live-work ground floor uses supporting a focal entry into the Village Centre, as well as [business premises](#), [cafes](#) and dining, childcare and allied health. Development transitions to residential beyond the Abernethys Lane frontage.
 - **Area 2** preferences small [scale](#) retail and services, including local retail, [cafes](#) and dining, allied health, real estate agencies and [medical centres](#), with [shop top housing](#) and medium density residential development to link Bells Lane to the lake and the public [recreation area](#).
 - **Area 3** preferences activated medium density residential development fronting the riparian corridor with a strong presence and interface at the corner of Bells Lane and Abernethys Lane.
- **The Public Open Space area** – the RE1 Public Recreation zoned land to the west of the Village Centre Core provides active and passive recreational opportunities for residents and visitors.



Figure 22: The Village Centre

The **objectives** are to:

- i. Establish a highly desirable Village Centre with day to day local and independent/specialist retail, commercial and social experiences for residents and visitors, that compliments the surrounding natural environment.
- ii. Establish a Village Centre with high quality urban design, exceptional amenity and a strong sense of place and public life.
- iii. Provide a variety of medium/higher density residential opportunities to support and activate the Village Centre.
- iv. Provide pedestrian oriented developments with strong connectivity between residential areas, open space, riparian corridors and retail and service offerings.
- v. Ensure **buildings** are at a human **scale**, are responsive to and integrated with the street **scale** and that future subdivision patterns provide permeability, maximising movement, and accessibility.

Mandatory Controls

- 1) A concept plan is to be submitted for the entire Village Centre area as part of the first development application within Stage 2. The concept plan must respond to the **objectives** and key design principles in this Section.
- 2) Subsequent detailed development applications in the Village Centre area are to be consistent with the approved concept plan and provide a detailed response to the **objectives** and key design principles in this Section.

10.1 Key Design Principle - Land Use

A complementary mix of uses, built form and spaces are to provide flexibility for future adaptability, attract a greater diversity of activity and promote a more inclusive community. Activities should be mutually supportive to promote feasibility and enrich the Village Centre, for example, a **medical centre** and pharmacy or play space and café.

The specific **objectives** are to:

- i. Establish a specific and diverse mix of community-focused and interesting retail, fresh food, essential services, dining and cultural experiences.
- ii. Ensure that the type, distribution, and amount of retail floorspace contributes to the Village Centre developing a URA.
- iii. Provide multi-functional spaces and places that encourage temporary uses, pop-up uses, and early activation and implementation.
- iv. Encourage a mix of medium density **dwelling** types appropriate for a mixed-use village.
- v. Enable flexibility of uses including live work and other permissible non-residential uses that promote creative, small **scale** employment opportunities to bring diversity and prosperity.
- vi. Encourage co-location of uses such as community, recreation and health facilities to generate activity in and around the centre.

The key principles are to:

1. Provide approximately 1,000–2,000m² of viable retail floor space in the Village Centre Core Area.
2. Distribute ground floor land uses as per **Figure 23**.
3. Provide first floor (and above) residential land uses across the Village Centre area.
4. Locate the supermarket (approximately 800m²) in accordance with **Figure 23**.
5. Promote outdoor dining by considering opportunities to widen footpath widths to 3.5m in desirable locations.

Note: Some land in the verge planting area could be utilised for this purpose, ensuring that planting remains a high priority. Opportunities for outdoor dining within front setback should also be considered.

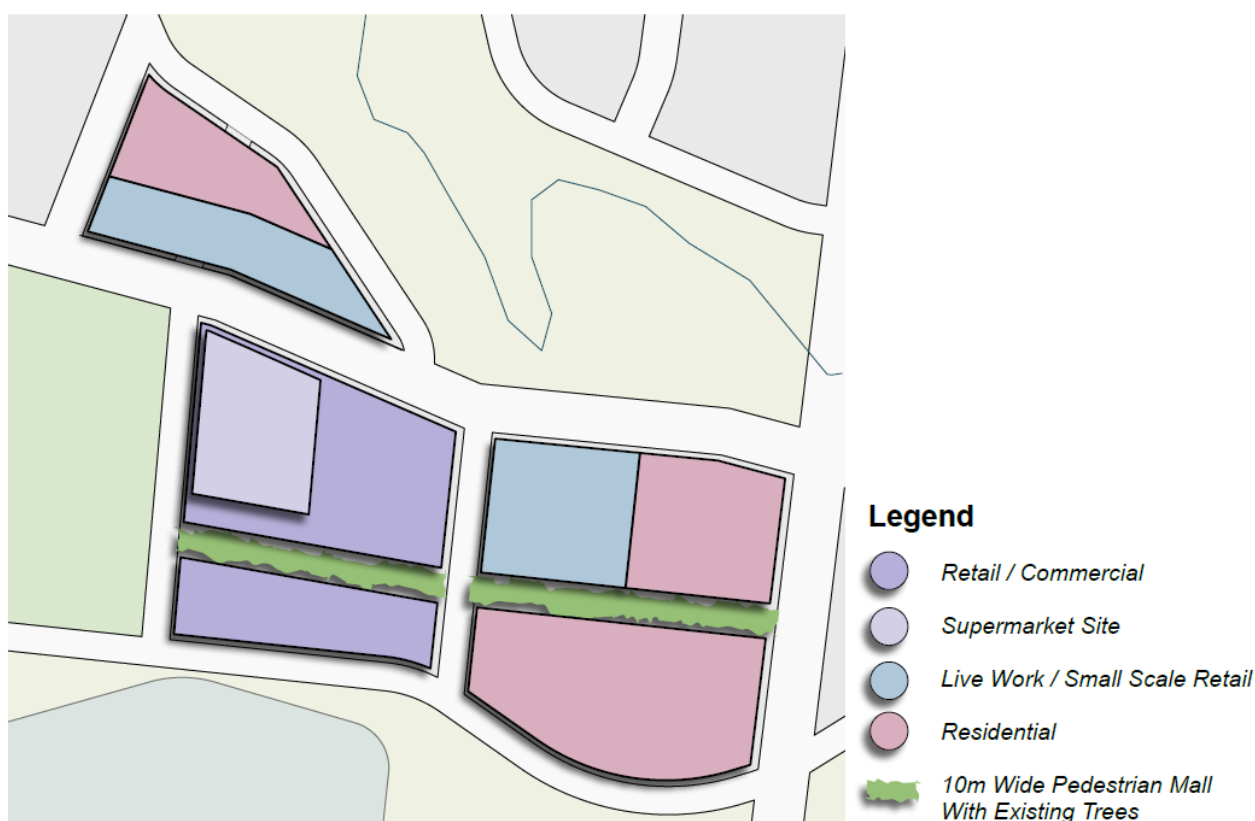


Figure 23: Village Centre Ground Floor Land Uses

10.2 Key Design Principle - Built Form

The built form should clearly define public and private spaces that are appropriate to the hierarchy, function, and character of the Village Centre. The form and fabric of **buildings** and public domain should create spaces with varied **scales** and proportions to support movement and place, and to capture the unique landscape setting.

The specific **objectives** are to:

- i. Create high quality, adaptable and activated built form with attractive street presentations to meet the diverse and changing needs of the community.
- ii. Ensure **buildings** address the street frontage, defining and contributing to ground level activity associated with retail, café/outdoor seating, and commercial uses.
- i. Provide active and defined frontages to key places and streets, reinforcing a fine grain block pattern with limited setback boundaries.
- i. Establish a prominent but intimate built form along the pedestrian mall to signal the Village Centre location.
- ii. Incorporate sustainable and resilient design principles across the aesthetics and function of **buildings**, streetscapes, and public spaces.
- iii. Ensure development minimises impact on the amenity and character of the surrounding area whilst protecting and enhancing **views** towards the escarpment, riparian corridors and the lake.

The key principles are to:

1. Provide heights:
 - Up to 3 **storeys** in the Village Centre Core, providing a transition to the public **recreation area** and public domain interface to minimise overshadowing.
 - That promote an intimate pedestrian and residential **scale** along the pedestrian mall.
 - Between two and three **storeys** in the Activation Precinct, with heights decreasing away from Abernethys Lane in Precinct Area 1.
 2. Provide minimum ceiling heights of 3.3m for non-residential development.
 3. Transition from a greater intensity of use in the west (the Village Centre Core) to the east.
 4. Provide active frontages and setbacks consistent with **Figure 24** and **Figure 25**, ensuring that:
 - Shops/premises along an active frontage have an average width of 5m to 8m. Where wider frontages (>8m in width) are considered appropriate, they are to be limited to five wider frontages per 100m and are to be separated by at least one development with a frontage less than 8m.
 - Ground floor pedestrian entrances to residential development is limited in width and/or accessed from alternate frontages, where possible.
- Note:** The setback and active frontage concept plan elements will enable well-conceived **awnings**, verandah locations, façades, glazing and limited continuous walls at the detailed design stage.
5. Orientate non-residential uses to maximise exposure on Abernethys Lane.
 6. Provide high level detail of the supermarket, including:
 - Anticipated size and development footprint of the supermarket.
 - Location of the entry.
 - Location of the separate at grade parking area and separate servicing/loading area, accessed from a rear laneway.
 7. Provide a strong built form interface to the key intersection of Abernethys Lane and Bells Lane.
 8. Provide an address to the public **recreation area** and lake with **building** elements reinforcing the landform, dominant topography and 'gateway' into the Village Centre precinct.
 9. Maximise opportunities for entries or display **windows** to non-residential land uses or other uses which provide pedestrian interest, social interaction, natural surveillance, and safety. Long and large areas of continuous walls are to be avoided.

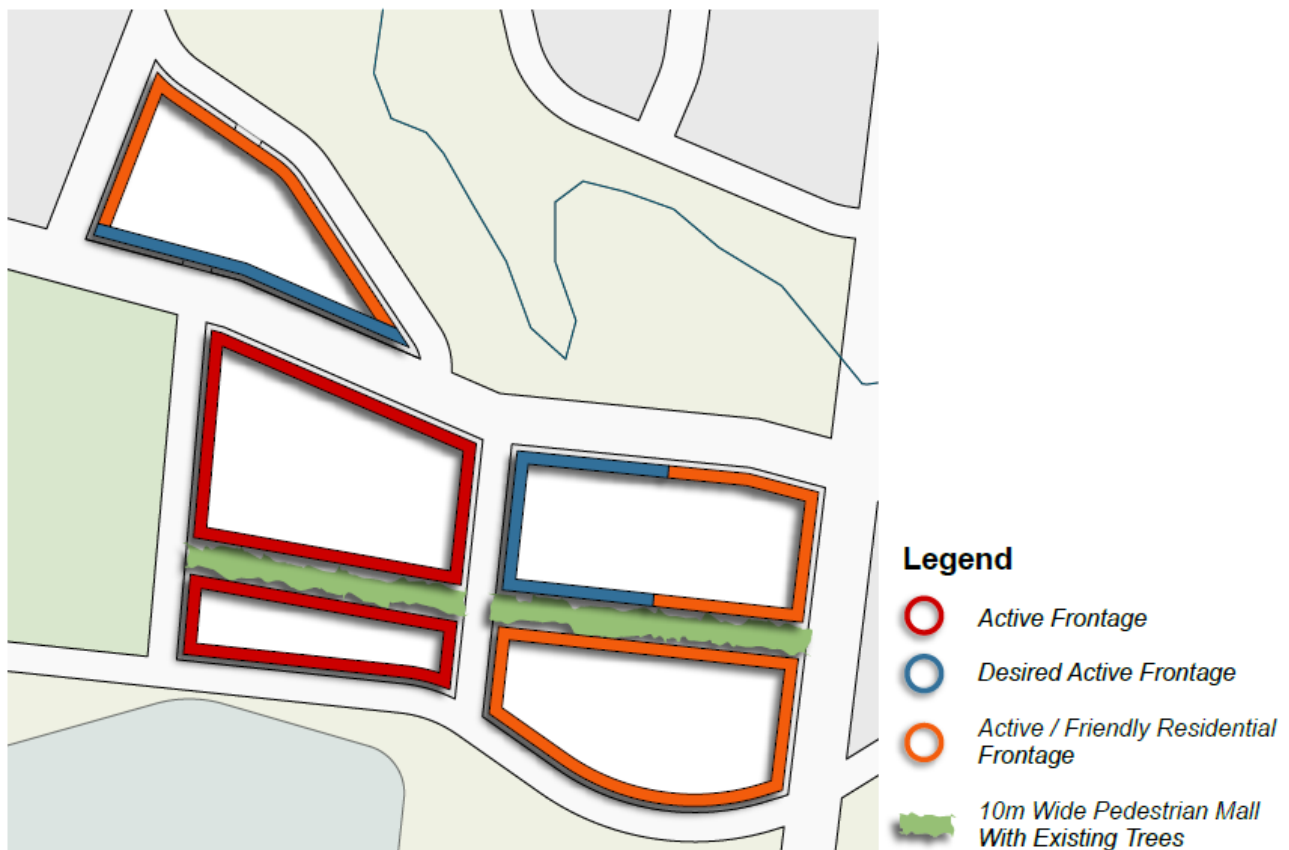


Figure 24: Active Frontages

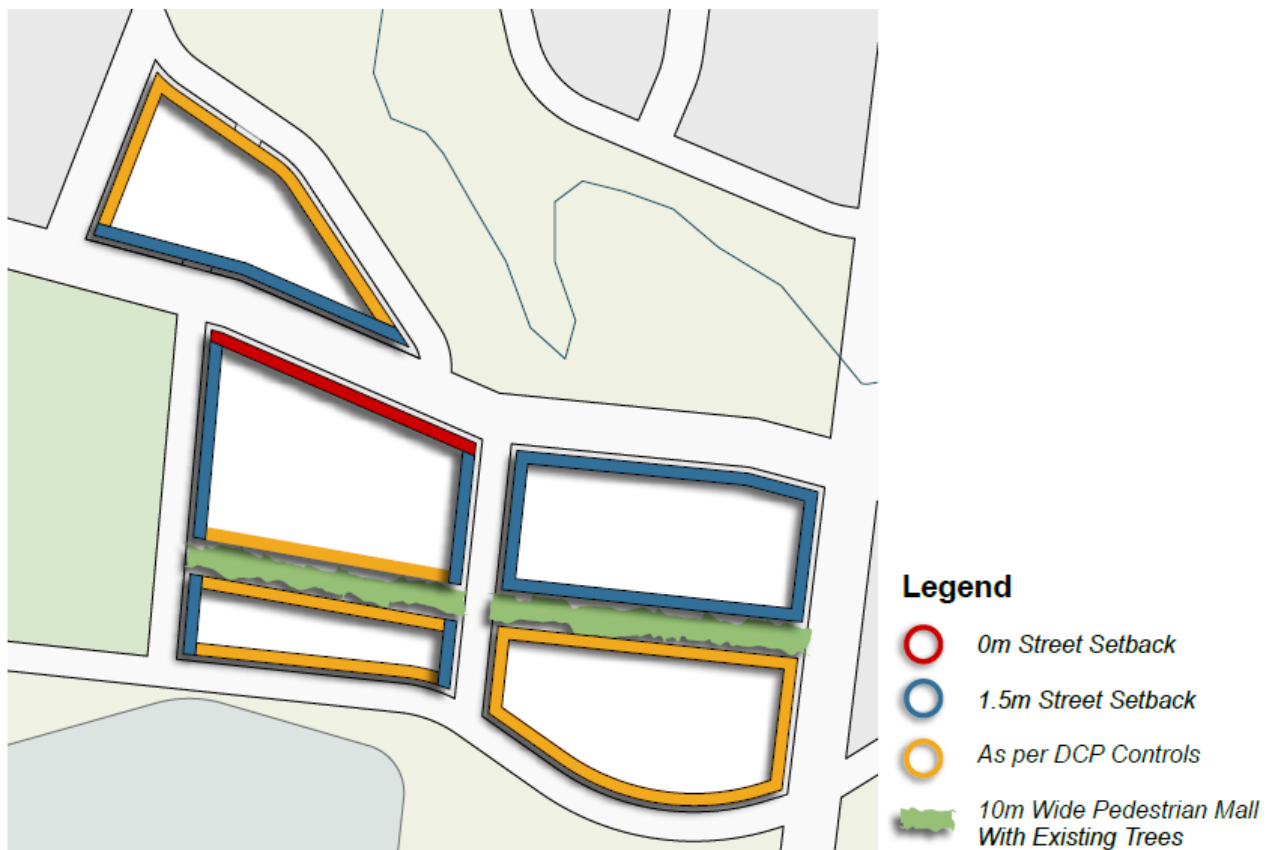


Figure 25: Ground Floor Setbacks

10.3 Key Design Principle - Movement and Access

Movement and accessibility are critical to the centre's viability. Design of the Village Centre should create pedestrian dominated environments with strong connectivity between commercial uses, residential areas and open space. This connectivity and permeability supports community interaction and place activation, further enhanced with focus on multi-modal transport and accommodating evolving sustainable modes.

The specific **objectives** are to:

- i. Ensure a well-connected **tree**-lined street network allows effective movement into and around the Village Centre, maximising connectivity between residential areas and public areas including car parking, **public open space** area and the lake.
- ii. Encourage sustainable transport with a safe, accessible and convenient movement network prioritising pedestrians, cyclists, and public transport.
- iii. Provide a street layout informed by natural features, terrain, and **views**, including a direct connection between the two riparian corridors through active transport links, marking the transition from the Village Centre into residential and open space areas.

The key principles are to:

1. Comply with the street network/hierarchy and shared use pathway network requirements in this Chapter.
2. Provide rear lane access to residential development (including **basements**) and shared parking areas.
3. Establish a pedestrian mall (**Figure 26**) with pedestrian and cycling access to enhance the character and pace of the centre key pedestrian connection.
4. Establish safe and accessible **road** crossing locations to ensure connectivity and walkability (**Figure 26**).
5. Ensure onsite parking does not compromise envisaged setbacks, ability to activate key frontages or the character of the Village Centre. A centralised **car park**/parking court accessed from Retail Street 2 is encouraged and could accommodate up to 50 **parking spaces** for private development. Dedicated parking areas will be required on the development site of specific uses such as the supermarket, as well as any childcare and **medical centres** (for example).

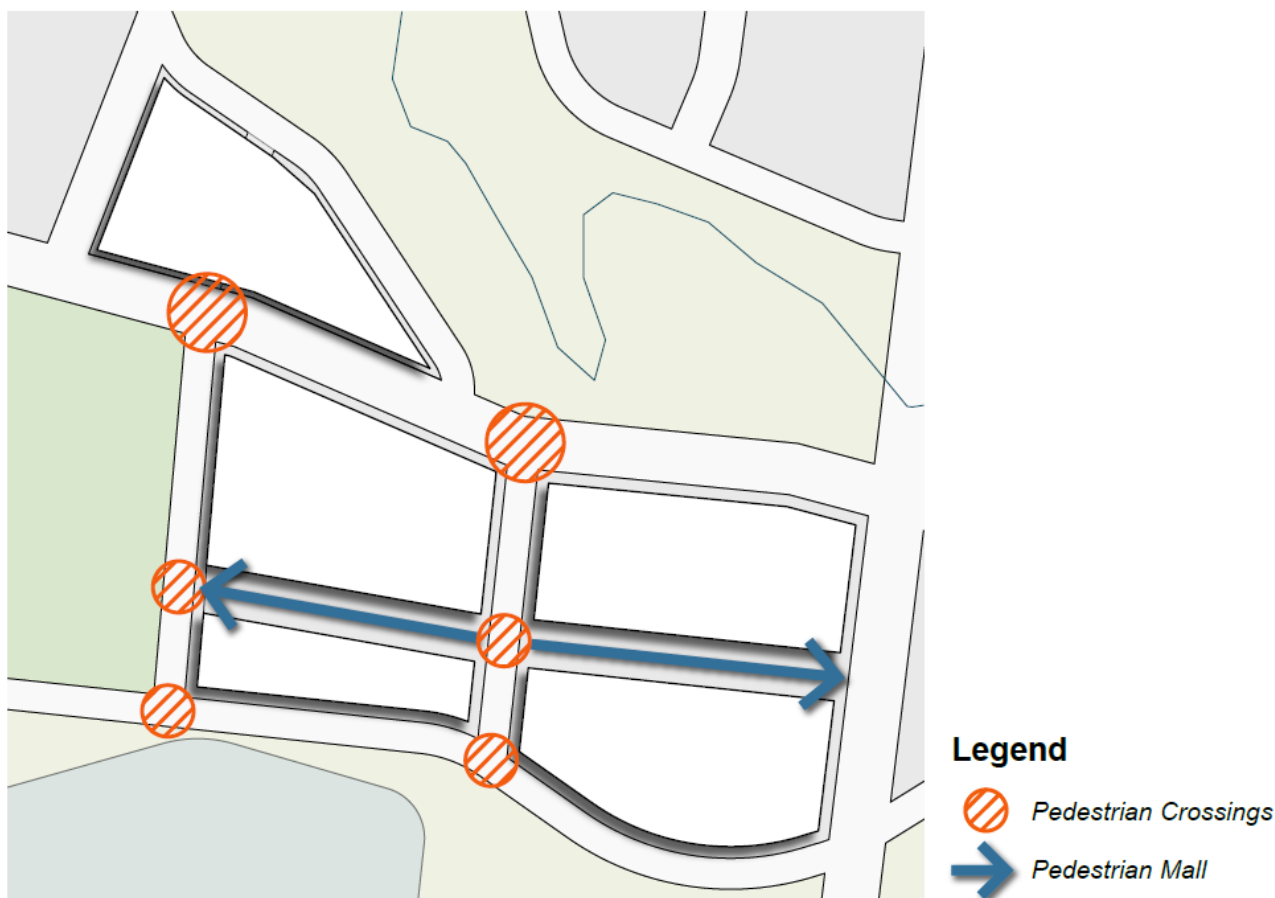


Figure 26: Village Centre Pedestrian Connections

10.4 Key Design Principle - Public Domain

To reinforce the natural character of the Moss Vale Road North URA, the Village Centre will address the lake and riparian **bushland**, and retain **views** to the Escarpment, to provide a backdrop and sense of place and space.

The character of the public domain supports the unique identity for the community, drawing the sense of the wider **bushland** landscapes into the heart of the Village Centre. This ensures that development contributes to the character of Moss Vale Road North URA as a whole and supports and promotes a socially and ecologically resilient public domain.

The **objectives** are to:

- i. Deliver a high-quality and visually attractive public domain to be enjoyed for events and active and passive recreation through the delivery of adaptable spaces for a variety of people, uses, events, weather, times of the day and weekly and seasonal cycles.
- ii. Encourage a functional, legible, high amenity and safe public domain, considering the behaviour and requirements of community and a preference for a generous pedestrian **scale**.

- iii. Create order, interest and sense of place in the public domain through a mix of unifying elements, punctuated by elements that are different at important public spaces and buildings.
- iv. Embrace the native bushland character of the surrounds and integrate existing areas of vegetation into landscaped areas associated with the public domain, to connect residents, workers, and visitors with the natural environment and to soften the visual impact of the built form.
- v. Retain and protect the grand scale of the existing trees along the pedestrian mall.
- vi. Provide an exemplar of sustainable development through benchmark commitments and the integration of green infrastructure and smart technologies in the development of the public domain.

The key principles are to:

- 1. Retain existing trees wherever possible, particularly in open space areas, including the pedestrian mall.
- 2. Preference deciduous trees on east-west streets.
- 3. Establish an indicative colour and material palette that responds to the existing native bushland context within and surrounding the URA.
- 4. Establish strong passive surveillance to the lake, riparian corridor and other public areas.
- 5. Seamlessly incorporate public domain elements into front setback areas.
- 6. Respond to the scale, views and vistas from entry points to and within the Village Centre to the lake and riparian areas.
- 7. Incorporate public art into the public domain. Concept locations are to be identified to ensure early consideration and integration into the public domain.
- 8. Incorporate smart technologies in the public domain.

10.5 Key Design Principle - Staging

Initial staging should consider the capacity and amenity of the Village Centre to be established in advance of the local residential population through destination retail, event and community spaces leveraging the distinguishing natural features of the site, particularly the lake.

Whilst the character of the retail and services will expand over time from more leisure focused to day-to-day amenities, the critical sense of community and place benefits can be potentially realised much earlier through interim and temporary uses, less strictly reliant on precinct population growth.

The objectives are to:

- i. Ensure the development of the Village Centre facilitates and aligns with the efficient release of residential land and essential infrastructure.

- ii. Encourage early activation temporary land uses in the Village Centre Core.
- iii. Provide multi-functional spaces and places to enable the opportunity for temporary activation and early implementation, focusing on a sense of place with consideration of activation during day and night, weekday and weekends, season to season.

The key principles are to:

1. Ensure staging follows key access along Abernethys Lane and Bells Lane with medium density typologies along these routes in early staging to allow for stronger demand for product, services, and community **building**.
2. Identify areas suitable for early activation temporary uses, with a focus on future adaptability.
3. Incorporate multipurpose elements in the Village Centre Core that avoid single purpose uses through generous ceiling heights (refer to **Section 10.2**), street access and minimum internal **scale**.

Note: Early stage community, hospitality and destination offerings fronting the **public open space** area and lake would support the vitality of the setting and engage with the vision for place.

Possible interim uses could include (for example) outdoor cinema, **markets**, local exhibitions, maker spaces, men's shed and food vans.

Suitable road network provision/upgrades must be in place to support early activation temporary uses.

11 Low Density Residential Development Controls

This Section applies to all low density residential development in the URA. Low density residential development includes **dwelling** houses, **secondary dwellings** and ancillary **structures**.

Note: This Section should be read in conjunction with Chapter G12: Dwelling Houses and Other Low Density Residential Development of this Development Control Plan. In the event of an inconsistency between a provision in this Section and a provision in a Chapter G12, the provision in this Section will prevail to the extent of the inconsistency.

Section 10 of this Chapter also applies to development in the Village Centre area.

The **objectives** of this Section are to:

- i. To provide a mix of densities to cater for the various housing needs of a range of different demographic groups.
- ii. To encourage residential development that will contribute to the amenity and streetscape character of the area.
- iii. To encourage innovative design with a high level of water and energy efficiency.
- iv. To encourage the delivery of small housing products that contribute to [affordable housing](#).

Performance Criteria	Acceptable Solutions
P19 The design of residential development contributes to the character and amenity of the URA.	A20.1 Dwellings are designed in accordance with the relevant controls in Table 9. Note: In addition to the provisions outlined in this Chapter, this Development Control Plan must be considered as relevant. In the event of any inconsistency, the provisions in this Chapter will prevail.
P20 Dwellings appropriately address the primary street frontage.	A21.1 Dwellings are sited to face the street, with visible front entries and habitable rooms fronting the street, particularly at ground level. A21.2 The primary street façade of a dwelling must incorporate at least two of the following design features as part of the articulation zone: • Open verandah or porch. • Awnings over windows. • Balcony treatment to first floor elements. • Recessing or projecting architectural elements. • Bay windows or similar features. • Pergolas or similar features above garage doors. A21.3 Dwellings with dual road frontage (corner lots and rear loaded lots): • Must address both the primary and secondary road frontage. • The secondary road frontage must incorporate at least two of the design features mentioned in A21.2. • Landscaping in the front setback should continue around the secondary setback

to the depth of the transition zone (refer to **Section 13** of this Chapter).



- On corner **lots**, carports and garages must be located and accessed from the secondary **road** frontage.
- On rear loaded **lots**, carports and garages must be located and accessed from the laneway or shared driveway.

P21 **Zero lot line developments** provide adequate **solar access** and amenity to neighbouring residences.

A22.1 **Dwellings** built to the **zero lot line** are single **storey**.

Note: **Zero lot lines** are not permitted where an easement to drain **sewage** is within the side setback.

A22.2 The external **zero lot line** wall shall be constructed no more than 250mm from the property boundary.

A22.3 Gutter and **drainage** services must be wholly contained within the **allotment**.

A22.4 A boundary **fence** shall not be constructed adjacent to the **zero lot line** wall.

A22.5 **Zero lot** boundary wall finishes consider the character of the **development** on the neighbouring property which exists at the time of the DA.

P22 Parking and access is to be functional and contribute to streetscape and laneway amenity.

A23.1 On-site car parking is provided in accordance with Chapter G21: Car Parking and Traffic.

A23.2 Carports and garages are to complement the **dwelling** design.

A23.3 Where garages are provided in rear laneways:

- Minimum garage doorway widths shall be 2.4m (single) and 4.8m (double).
- Garage location is based on the orientation of the **allotment** (refer to

Figure 27), so as to improve solar access to the rear yard.

- General vehicular access is to occur from the laneway.
- Vehicle crossings are not to exceed 4.8m in width.

A23.4 Triple fronted garages are not permitted

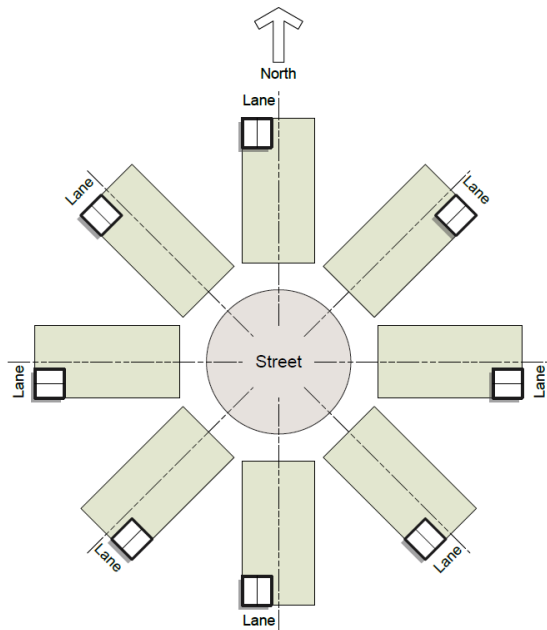


Figure 27: Garage Location Principles

P23 Development on corner lots contribute to streetscape character.	A24.1 Walls facing the secondary frontage (corner lots) shall have an active frontage for at least 4m back from the front building line of the dwelling (i.e., the transition zone) with a maximum continuous a wall length of 6m.
P24 Dwellings are designed to maximise energy efficiency.	A25.1 Dwellings and private open space are sited as per the orientation of the dwelling (refer to Figure 28).
	A25.2 Dwellings on lots less than 400m ² in area are single storey, unless proposed as Integrated Housing with two or more dwellings.

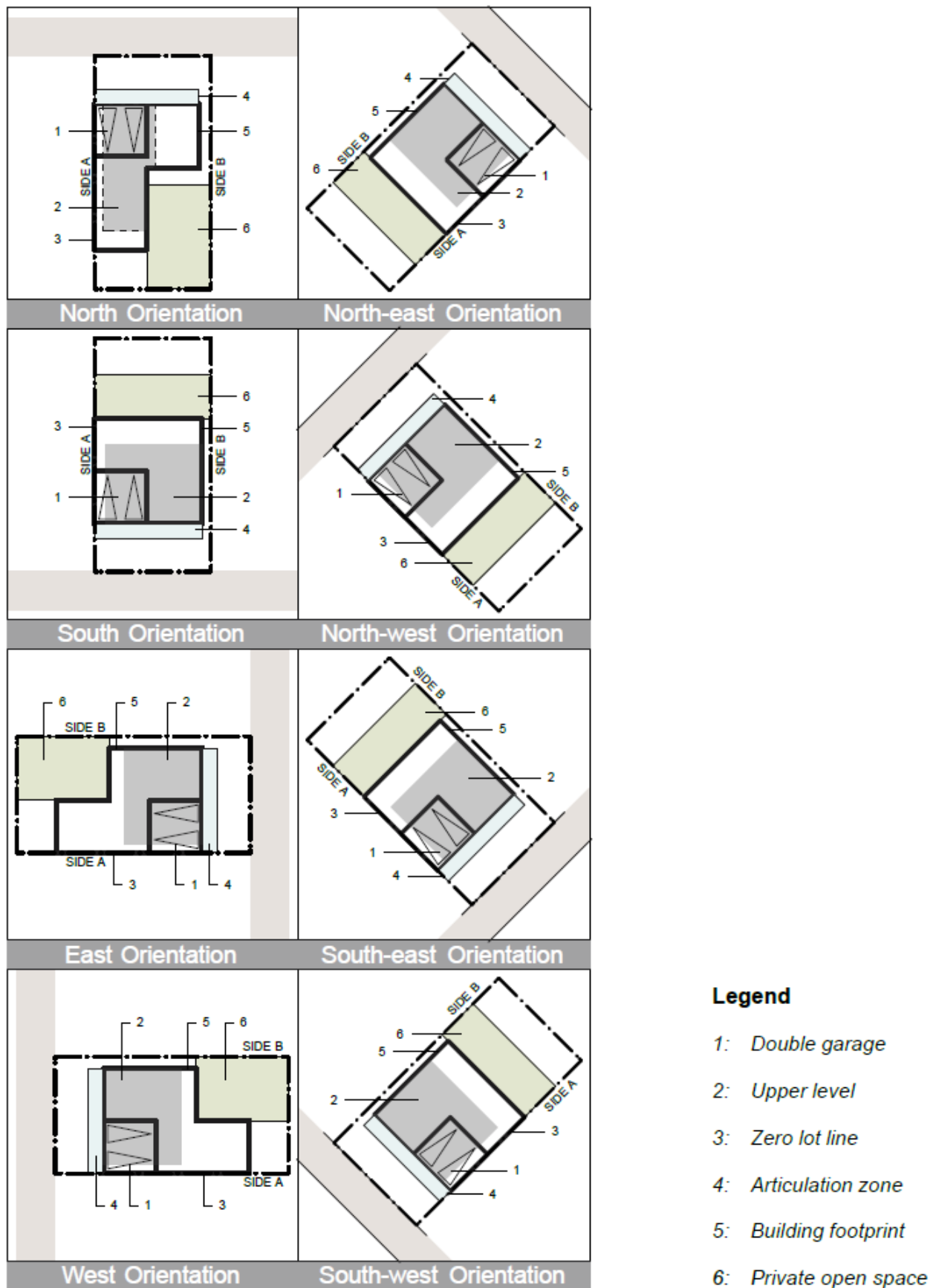


Figure 28: Dwelling Configuration Based on Orientation

Table 9: Key Development Controls for Low Density Residential Development

Built Form Controls - Lot width (measured at front setback line)				
Control	>8m to <12m	>12m to <15m	>15m to <18m	>18m (Large Lot)
Maximum Gross Floor Area (GFA) (excluding garage floor space)	50% of lot area	Ground floor (single storey) – 50% of lot area Ground floor (double storey) – 40% of lot area Upper level – 50% of ground floor GFA	Ground floor (single storey) – 50% of lot area Ground floor (double storey) – 40% of lot area Upper level – 50% of ground floor GFA	Ground floor (single storey) – 50% of lot area Ground floor (double storey) – 40% of lot area Upper level – 50% of ground floor GFA
Front setback – refer to Figure 29 Note: Minimum front setbacks must not encroach into an easement to drain sewage.	3.5m to building façade front setback; 2.5m to articulation zone.	3.5m to building façade front setback; 2.5m to articulation zone.	4m to building façade front setback; 3m to articulation zone.	5m to building façade front setback; 4m to articulation zone.
Minimum front garage setback – refer to Figure 28	N/A	6m	6m	6m

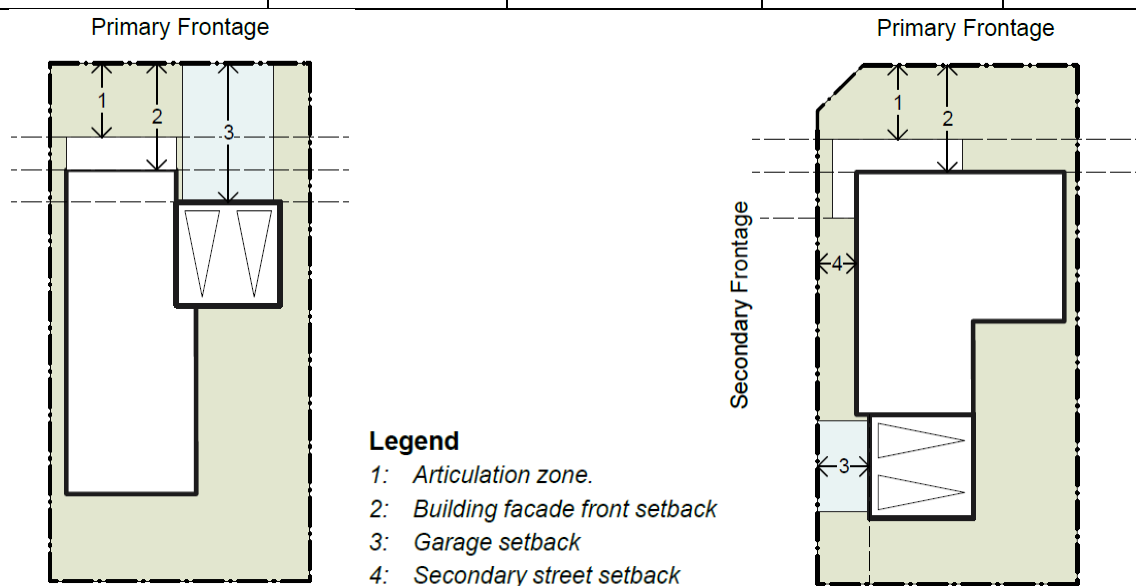


Figure 29: Location of Setbacks (Standard and Corner Lots)

Built Form Controls Continued				
Control	>8m to <12m	>12m to <15m	>15m to <18m	>18m (Large Lot)
Minimum side setbacks (ground floor)	Zero lot or attached boundary (Side A*): 0m Detached boundary (Side B*): 0.9m	Zero lot or attached boundary (Side A*): 0m Detached boundary (Side B*): 0.9m	Side A*:0.9m Side B*:0.9m	Side A*:1.5m Side B*:1.5m
Minimum side setback (upper level)	N/A	Side A:1.5m Side B: 0.9m	Side A:1.5m Side B: 0.9m	Side A:3m Side B:1.5m
Minimum rear setback (single storey)	3m	3m	3m	6m
Minimum rear setback (double storey)	N/A	6m	6m	9m
Corner lots – Minimum secondary street side setback – refer to Figure 29 Note: Minimum setbacks must not encroach into an easement to drain sewage.	2m	2.5m	3m	4.5m
Corner lots – Minimum secondary street garage setback – refer to Figure 29	3m	6m	6m	6m
* Side boundary A and side boundary B are nominated by the applicant or nominated on the plan of subdivision. Where the boundaries are nominated by the applicant the following criteria must be applied: a) where the adjoining development is built to the boundary this boundary is to be nominated as Side A, b) where the adjoining development is setback less than 1.5m from the boundary but not built to the boundary, this boundary is to be nominated as Side B, c) where the lot is burdened by an easement of maintenance and support or easement to drain sewage, this boundary is to be nominated Side B, d) where there is adjoining development only on one side, the other side is to be nominated the alternate, e) a corner lot has two side boundaries and no rear boundary, f) where the lot is located on a corner, the secondary street side setback is neither Side A nor Side B.				

Draft Chapter NB4: Moss Vale Road North Urban Release Area

Front and Side Garages				
Control	>8m to <12m	>12m to <15m	>15m to <18m	>18m (Large Lot)
Maximum garage door width	N/A	Double – 6m	Up to 50% of the façade width or a maximum of 7.2m, whichever is the lesser	Up to 50% of the façade width or a maximum of 7.2m, whichever is the lesser
Maximum driveway width (at front property boundary)	N/A	3m (single)	4.8m	4.8m
Maximum garage door width (access from secondary road only – corner lots)	N/A	7.2m	7.2m	7.2m
Rear Garages – small lots only				
Control	>8m to <12m	>12m to <15m	>15m to <18m	>18m (Large Lot)
Minimum side setback	0m on one side (as per Figure 27) for a maximum length of 6.5m. Other side 0.9m.	0m on one side (as per Figure 27) for a maximum length of 6.5m. Other side 0.9m.	N/A	N/A
Minimum rear garage setback (to lane)	0m	0m	N/A	N/A
Landscape controls				
Control	>8m to <12m	>12m to <15m	>15m to <18m	>18m (Large Lot)
Landscaped area (min. 1.5m wide)	50% of lot area minus 100m ²	50% of lot area minus 100m ²	50% of lot area minus 100m ²	50% of lot area minus 100m ²
Landscaped area within front setback (min. 1.5m wide)	75% of area of the front setback (excluding articulation elements)	50% of area of the front setback (excluding articulation elements)	50% of area of the front setback (excluding articulation elements)	50% of area of the front setback (excluding articulation elements)
Provision of tree planting	Tree to front garden (min.3-5m mature height) Tree to rear garden (min. 8-10m mature height)			

Amenity controls				
Control	>8m to <12m	>12m to <15m	>15m to <18m	>18m (Large Lot)
Window, doors and other openings	No windows, doors or other openings in any wall that is less than 900mm from the boundary.		N/A	N/A
Minimum ceiling heights*	Habitable rooms – 2.7m. Habitable attics – 2.4m for at least two-thirds of the floor area of the room			
* When calculating the area of a room in an attic, any part where the ceiling height is less than 1.8m is not included for the purposes of calculating gross floor area. For alterations and additions, existing ceiling heights can be retained.				
Maximum depth of habitable room from a primary window	6m			

12 Medium Density Residential Development Controls

Note: This Section should be read in conjunction with Chapter G13: Medium Density and Other Residential Development of this Development Control Plan. In the event of an inconsistency between a provision in this Section and a provision in a Chapter G13, the provision in this Section will prevail to the extent of the inconsistency.

Section 10 of this Chapter also applies to development in the Village Centre area.

Whilst medium density development is permissible in varying forms across the Moss Vale Road North URA, this form of development is ideally suited to land in and within 400m of the Village Centre (including the Village Centre Activation Precinct), areas of high amenity adjacent to the riparian corridors/open space areas and areas adjacent to certain **collector roads**.

Medium density development may include (not exclusively) **dual occupancy**, **multi dwelling housing**, **multi dwelling housing (terraces)**, **attached dwellings**, **semi-detached dwellings**, **manor houses**, **integrated housing development**, **residential flat buildings** and **shop top housing**.

The **objectives** are to:

- To locate higher density housing in the URA within the Village Centre, the Village Centre Activation Precincts, and in close proximity to **public open space** areas, **collector roads** and public transport networks.
- To provide a mix of **dwelling** sizes and typologies to cater for the various housing needs of a range of different demographic groups.

- iii. Ensure that the bulk and **scale** of new **development** is compatible with the envisaged character of the area.

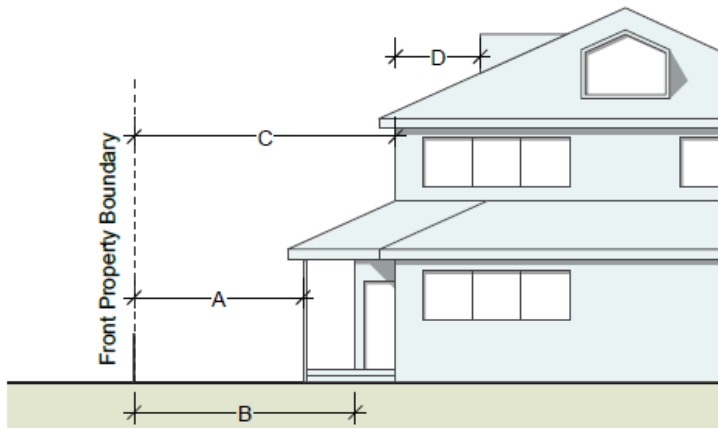
Performance Criteria	Acceptable Solutions
P26.1 The design of residential development contributes to the character, safety and amenity of the URA, including the Village Centre.	A26.1 Medium density development is designed in accordance with the relevant controls in Table 10 . Note: A shadow diagram may be required to demonstrate compliance with solar access requirements, including the location of adjacent buildings affected by shadow as well as the location of its living areas, private open space areas and any solar collectors (existing or likely future). In determining the extent of overshadowing, the impact of fences, roof overhangs and changes in level should be taken into consideration.
P26.2 Landscaping contributes to the public domain by providing opportunities for trees and substantial areas of decorative planting within the front setback.	
P27 In areas outside of the Village Centre Core, the built form contributes to a low-medium scale character, with levels above two storeys appearing hidden when viewed from the public domain or neighbouring sites.	A27.1 Any third level beyond the Village Centre Core is designed to minimise the visibility of that level when viewed at a pedestrian scale from the public domain or neighbouring sites. Note: There are many ways to 'hide' the third level, including (not exclusively) parapets, utilisation of attic space, generous setbacks and structures that are angled back towards the rear of the dwelling/building .
P28 Dwellings with a primary street frontage appropriately address that frontage.	P28 A28.1 Dwellings are sited to face the street, with visible front entries and habitable rooms fronting the street, particularly at ground level. A28.2 Dwellings in the Village Centre are sited to face all street frontages, with visible front entries and habitable rooms fronting the street, particularly at ground level. A28.3 The façade of a dwelling adjacent to a street frontage referred to in A28.1 and A28.2 must incorporate at least two of the following design features as part of the articulation zone: • Open verandah or porch. • Awnings over windows.

	• Balcony treatment to first floor elements. • Recessing or projecting architectural elements. • Bay windows or similar features. • Pergolas or similar features above garage doors.
P29 Parking and access is functional and contributes to streetscape and laneway amenity.	A29.1 On-site car parking is provided in accordance with Chapter G21: Car Parking and Traffic. A29.2 Co-joining of double garages (i.e., a double garage for one dwelling joined with a double garage for another dwelling) is not supported unless: • One double garage is offset from the other by at least 2m. • The garages adjoin a rear laneway. A29.3 Triple fronted garages are not permitted. A29.4 Where garages are provided in rear laneways: • Minimum garage doorway widths are 2.4m (single) and 4.8m (double). • Garage location is based on the orientation of the allotment so as to improve solar access to the rear yard. • General vehicular access is to occur from the laneway. • Vehicle crossings are not to exceed 3m wide in streets or 4.8m wide in lanes.

Table 10: Key Development Controls for Medium Density Development

Control Type	Control		
Maximum Floor Space Ratio (FSR) Note: A maximum of 50m ² for the combined total garage floor area in a dual occupancy development may be excluded from the gross floor area where the garages are located within the dwellings.	Outside of Village Centre	Within the Village Centre	Land Use
	0.6:1	0.8:1	- Dual occupancy. - Semi-detached dwellings. - Integrated housing development.
	0.7:1	1:1	- Multi dwelling housing. - Multi dwelling housing (terraces). - Manor houses. - Attached dwellings.
	Not encouraged	1.25:1	- Shop top housing. - Residential apartment buildings.
Height	1 to 3 storeys. Dwellings beyond the Village Centre Core must present as up to two storeys, with any third level recessed (refer to A27.1 and the setback and building envelope provisions below).		
Setbacks (in the Village Centre Core)	Minimum Setbacks in Section 10 of this Chapter, at all levels. Articulation and varied setbacks are encouraged in the design to promote interest.		
Setbacks (beyond the Village Centre Core) Note: Vehicular access to medium density residential development in the Village Centre Activation Precinct is to be via a rear lane. No garages are to be accessed via the primary or secondary frontage.	Setbacks in Section 10 of this Chapter prevail to the extent of any inconsistency.		
	Setback	In the Village Centre Activation Precinct	All other areas
	Front Setback <i>Primary frontage</i>	Ground level: 1.5m to articulation zone. 3m to dwelling.	Ground level: 3.5m to articulation zone. 5m to dwelling.

		6m to the garage.
	Second level: A further 1m from the dwelling setback at the ground level. Third level: As required from the setback at the second level to minimise the visibility of that level as per A27.1. Refer to Figure 30.	
Front Setback <i>Secondary frontage</i>	Ground level: 1.5m to articulation zone. 3m to dwelling.	Ground level: 3m to dwellings (including any articulation features). 5.5m to the garage.
	Second level: A further 1m from the setback at the ground level. Third level: As required from the setback at the second level to minimise the visibility of that level as per A27.1. Refer to Figure 30.	
Rear setback <i>Including to public reserve</i>	0m to garages opening to a laneway. 3m (average) to dwellings, with minimum setback of 900mm.	



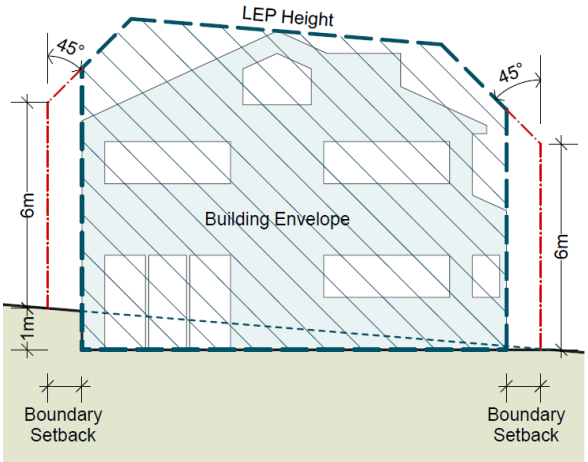
A: Minimum of 3.5m

B: Minimum of 5m

C: Setback at B + 1m

D: As required from the setback at the second level to minimise the visibility of that level

Figure 30: Front Setbacks for Medium Density Development

Cumulative impacts	The design of a medium density development is to be different to other medium density development in the vicinity to provide visual interest and avoid repetition in the streetscape. Despite Chapter G13 of this Development Control Plan, more than three (3) consecutive medium density developments may be considered within a street in the Village Centre and the small lot residential areas.
Building envelope Note: - Exemptions to building envelope encroachments include gutter, fascias, downpipes, eaves up to 0.6m, aerials and masonry chimneys. - For site slopes greater than 10%, or involving cut, fill or site excavations, the ground level (existing) and proposed building levels must be clearly identified on the plans and verified by a registered surveyor.	Buildings beyond the Village Centre are sited within a building envelope determined by the following method: planes are projected at 45 degrees from a height of 6m above ground level (existing) at the side and rear boundary. See Figure 31.  Figure 31: Building Envelope
Landscaping Note: Refer to the Moss Vale Road North Species List [link] for appropriate hedge species.	Where setbacks allow, a tree to the front garden of each dwelling with a primary street frontage is provided (min.3-5m mature height). A tree to the rear/side garden of all dwellings is provided (min.3-5m mature height). Hedge planting along front fences is encouraged.
Private open space for dwellings with a ground floor component Note: This provision does not apply to dual occupancy development or dwellings without a ground floor component. Refer to Chapter G13 for relevant provisions. Refer to the Apartment Design Guide for private open space requirements for apartments.	A minimum area of 24m² shall be provided for each dwelling in the following development types: - Multi dwelling housing. - Multi dwelling housing (terraces). - Attached dwellings. - Semi-detached dwellings. - Manor houses. - Integrated housing development. Private open space is not to be located forward of the building line.

Minimum ceiling heights Note: When calculating the area of a room in an attic, any part where the ceiling height is less than 1.8m is not included for the purposes of calculating gross floor area. For alterations and additions, existing ceiling heights can be retained.	Non-habitable rooms – 2.4m. Habitable rooms – 2.7m. Habitable attics – 2.4m for at least two-thirds of the floor area of the room.
Maximum depth of a habitable room from a window	6m

13 Fencing Controls

Note: Certain fencing is considered **exempt development** under State Environmental Planning Policy (Exempt and Complying Development Codes) 2008. If the proposal does not meet the exempt criteria, **consent** is required from **Council** and the proposal is to comply with the standards below.

This Section outlines the fencing requirements for residential development within the URA, where proposed.

The **objectives** are to:

- To define the interface between the private and public domain.
- To ensure boundary fencing is of a high quality, promotes safety and surveillance, encourages social engagement and does not detract from the streetscape or **public open space** areas.
- To ensure boundary treatments contribute to the desired character of the URA.

Performance Criteria	Acceptable Solutions
P30 Fences and walls adjacent to the public domain: - Enable some outlook from buildings to the street for safety and surveillance. - Contributes to safety and amenity of public open space. - Assist, where appropriate, in highlighting entrances and in creating a sense of communal identity within the streetscape.	A30.1 Front fences and walls forward of the building line , (see Area 1 - Figure 32), should: - Be no higher than 1.2m. - Use similar or compatible materials to that used for the dwelling on the subject lot. Note: Living fences (e.g., hedges) are encouraged.

- Are designed and detailed to provide visual interest to the streetscape.
- Are constructed of materials compatible with:
 - Existing and proposed housing, and
 - High quality existing fences and walls in the streetscape to encourage continuity.
- Are compatible with facilities in the street frontage area, such as mailboxes and waste collection points.

- Contain open elements that make it at least 50% transparent (e.g., vertical timber or metal pickets), or where there are solid panels (e.g., brick), must contain articulated elements such as landscape screening, setbacks and varied materials.



Figure 33: Example of Good Fence Design

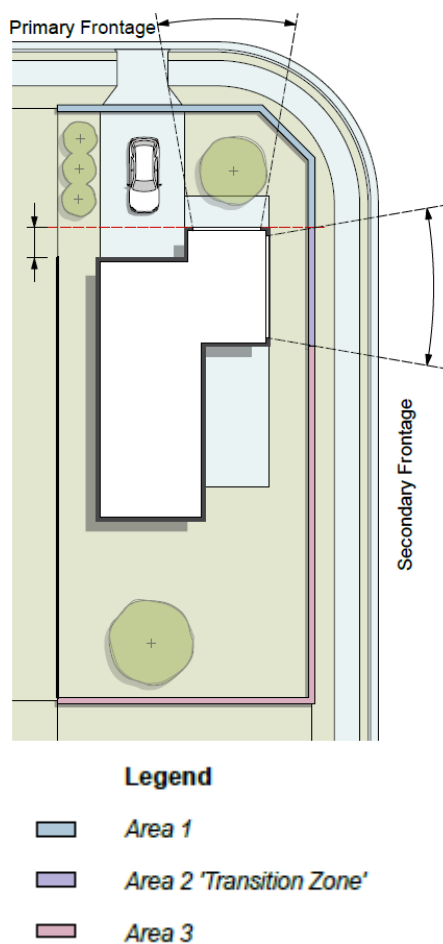


Figure 32: Location of Fencing "Areas"

A30.2 On a corner lot, the fence along the secondary frontage in the "transition zone" (4m behind the front building line for low density residential development and 2m behind the front building line for medium density residential development, refer to Area 2 in Figure 32) should:

- Be no higher than 1.2m.
- Be a continuation of the fence or landscaping on the primary street frontage.

A30.3 Fences beyond the "transition zone" along the secondary frontage and along the rear boundary (where the rear boundary is adjacent to public domain or public open space), see Area 3 - Figure 31, should be:

- No higher than 1.8m.
- Lapped and capped timber.

A30.4 Fencing is to be of high-quality material and finish. The use of metal fencing materials is discouraged directly adjacent to the public domain, except adjacent to laneways.

A30.5 Fences in large lot residential areas (the outer areas of the URA) are encouraged to use semi-rural post and wire or post

and rail fencing to blend in with the adjoining rural landscape.

14 Advisory Information

14.1 Information required with subdivision applications

14.1.1 Subdivision Plans

Must demonstrate the location of proposed or potential zero-allotments.

14.1.2 Staging Plans & Infrastructure Delivery

All subdivision applications must demonstrate consistency with the indicative staging plan at **Figure 3** in this Chapter. Staging plans must identify the indicative dwelling yield and provision of infrastructure to be delivered for that stage of the development.

14.1.3 Local Centre Concept Plan

A concept plan is to be submitted for the entire Village Centre area as part of the first development application within Stage 2. The concept plan must respond to the objectives and key design principles in **Section 10** of this Chapter.

14.1.4 Design Verification Statement (DVS)

A DVS is a document that provides clear and sound reasoning on how the proposed development meets the relevant objectives, mandatory controls, performance criteria and acceptable solutions of this Chapter.

The DVS must include, but is not limited to:

- A description of the proposed development (except for where the DVS is contained within a Statement of Environmental Effects).
- A robust explanation of the design of the subdivision and how it meets the individual key development outcomes (refer to **Section 6** of this Chapter).
- Identify and justify any variations to the ILP.

14.2 Satisfactory Arrangements for Local Infrastructure

To ensure the efficient delivery and ongoing operation of a new urban area, when assessing a development application, the Council will consider whether satisfactory arrangements exist or are proposed by the developer for the provision of good quality infrastructure that is essential to support the proposed development and the orderly and economic development of that new urban area, including open spaces, parks, local roads, footpaths and stormwater drainage. The provision of this essential infrastructure is important as it facilitates the timely delivery of new housing, increases liveability and meets the ongoing needs of a growing population. New development should not occur in the absence of the provision of or satisfactory arrangements for the provision of such essential infrastructure.

The MVRN URA is a large and diverse URA that by its nature requires the provision of a range of infrastructure to support it during the development phase and into the future. The

following specific infrastructure is considered to be essential to support the orderly and economic development of land within the MVRN URA:

- Road network (as outlined in **Figure 34**) to be delivered via the Shoalhaven Contributions Plan 2019:
 - External connections to the existing road network (Bells Lane (including Moss Vale Road intersection upgrade) and Pestells Lane).
 - The construction of collector roads and minor roads connecting subdivision stages/spanning large distances of open space and environmental areas (including bridges and crossings).
- Drainage network:
 - At least 2 wetlands, 8 bio-retention basins, and a selection of other devices (e.g. gross pollutant traps, sediment basins and trash racks) to be delivered via the Shoalhaven Contributions Plan 2019.
 - Fixed term or ongoing maintenance is required (as appropriate to the infrastructure).
- Passive and active recreation to be delivered via the Shoalhaven Contributions Plan 2019:
 - A district park (2.7ha) containing a multi-sports court, playground, amenities block, car parking (including provision for mobile library service) and embellishment.
 - Four local parks (between 4,500-7,200m²), with 2 containing embellishments such as nature play/playground, exercise equipment, seating etc.
- Riparian network – To support the required Vegetation Management Plan, extended developer maintenance/handover periods and maintenance funding is required.

The provision of essential infrastructure needs to be properly sequenced to result in the best outcome for the MVRN URA. Core infrastructure, services and facilities are to be established at the early phases of each development stage (refer to **Figure 3**).

Note: Refer to the Shoalhaven Contributions Plan 2019 for further detail on the contributions projects relevant to the MVRN URA, both within and external to the URA.



Figure 34: Required Satisfactory Arrangements for Infrastructure

14.3 Other legislation you may need to check

Council Policies & Guidelines	• Moss Vale Road North Species List [link] • Shoalhaven Contributions Plan 2019 • Shoalhaven Weed Management
External Policies & Guidelines	• Aboriginal cultural heritage consultation requirements for proponents 2010 • Apartment Design Guide • AS2885: Pipelines – Gas & Liquid Petroleum • Building Code of Australia • Code of practice for archaeological investigation of Aboriginal objects in New South Wales • Guide to Codes and Practices for Streets Opening • Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW • Jemena's Guideline to Designing, Constructing and Operating Around Existing AS2885 Natural Gas Pipelines • NSW Department of Primary Industries Council and Developer Toolkit • NSW Rural Fire Service Planning for Bushfire Protection 2019 • Planning Circular PS 18-010 Development adjacent to high pressure pipelines transporting dangerous goods • Relevant Australia Standards • Telecommunications in New Developments Policy
Legislation	• <i>Biodiversity Conservation Act 2016</i> • <i>Environmental Planning and Assessment Act 1979</i> • Shoalhaven Local Environmental Plan 2014 • State Environmental Planning Policy (Infrastructure) 2007 • <i>Water Management Act 2000</i>

Supporting Document 1



Integrated Water Cycle Assessment for Moss Vale Road North Urban Release Area.

Prepared by: Bill Johnson

SEEC Reference 17000346-IWCA-OC

29th March 2022



SEEC

Strategic Environmental and Engineering Consulting

PO Box 1098, Bowral NSW 2576

phone: (02) 4862 1633 • fax: (02) 4862 3088 • email: reception@seec.com.au

Document Certification

This report has been developed based on agreed requirements as understood by SEEC at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects. Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

Bill Johnson
SEEC

29th March 2022

Copyright

The information, including the intellectual property contained in this document is confidential and proprietary to SEEC. It may be used only by the person, company or organisation to whom it is provided for the stated purpose for which it is provided. It must not be given to any other person, company or organisation without the prior written approval of a Director of SEEC. SEEC reserves all legal rights and remedies in relation to any infringement of its rights in respect of confidential information. © SEEC, 2022

Document Table

Issue Number	By	Reviewed by	Date
DRAFT-0A	BJ	MP	6 th June 2019
DRAFT-0B	BJ	JA	12 th March 2020
FINAL-01	BJ	JA	1 st April 2020
FINAL-02	BJ	JA	16 th April 2020
FINAL-03	BJ	JA	3 rd July 2020
FINAL-04	BJ	JA	8 th July 2020
DRAFT -0C	BJ	-	29 th March 2022

TABLE OF CONTENTS

1	Introduction	1
2	Data Sources.....	3
3	Land Description and Identification of Constraints	4
3.1	Current Zoning	4
3.2	Indicative Development	4
3.3	Catchment Description	8
3.4	Geology and soils	9
3.4.1	Geology.....	9
3.4.2	Soil Landscape Mapping.....	10
3.4.3	The Coolongatta Soil Landscape.....	10
3.4.4	Shoalhaven Soil Landscape	11
3.4.5	Nowra Soil Landscape.....	12
3.5	Flooding.....	13
3.6	Drainage.....	16
3.7	Climate.....	16
4	Stormwater Management	17
4.1	Stormwater Quantity Controls	18
4.2	Stormwater Reuse Controls	18
4.3	Stormwater Quality and Waterway Protection Controls	19
5	Stormwater Quantity Modelling.....	19
5.1	Existing Flows	20
5.2	Developed Flows	23
5.3	On-site Detention.....	27
6	Selection of WSUD Measures	30
6.1	Introduction.....	30
6.2	Pollutants of concern.....	30
6.3	Opportunities and Constraints to Urban Development	31
6.4	WSUD Selection.....	33
7	Stormwater Quality Modelling	37

7.1	Climate Data Selection.....	37
7.2	MUSIC Data	39
7.3	Other Assumptions	40
7.4	Modelling Results.....	42
7.5	Wetland Water Levels.....	42
8	Life Cycle Costs	45
9	Operation and Maintenance	50
10	Erosion and Sediment Control	52
11	Staging	53
12	Development Controls	55
12.1	Objectives	55
12.2	Controls.....	55
13	Summary	57
14	References.....	58
	Appendices	59
	Appendix A – Regional Flood Frequency Estimation	59
	Appendix B – WSUD Cost Benefit framework: medium to high density residential developments (Water By Design, 2010)	61

TABLE OF FIGURES AND TABLES

Figure 1 - Site Location.....	2
Figure 2 - Zoning under SLEP 2014	5
Figure 3 - DRAFT Indicative Layout Plan	6
Figure 4 - Geology	9
Figure 5 - Soil Landscape Mapping (Hazleton P.A. ,1992) and Site Location (approx.).....	13
Figure 6 - Flood Extents (Data Source: Rhelm 2018)	14
Figure 7 - Mean Monthly Rainfall	16
Figure 8 - Existing Catchments.....	21
Figure 9 - Estimated Developed Catchments	25
Figure 10 - Proposed Location of On-Site Detention.....	28
Figure 11 - WSUD Layout	36
Figure 12 - Rainfall and PET Statistics	38
Figure 13 - Wetland Storage and Water Level Fluctuations	43
Figure 14 - Wetland Outflow and Water Level Fluctuations.....	43
Table 1 - Assumed Land use lots per hectare	7
Table 2 - Soil Landscape Limitations for the Coolongatta Soil Landscape	10
Table 3 - Soil Landscape Limitations for the Shoalhaven Soil Landscape	11
Table 4 - Soil Landscape Limitations for the Coolongatta Soil Landscape	12
Table 5 - Mean Monthly Rainfall - Nowra RAN AWS - Site number: 068072.....	16
Table 6 - Stormwater Quantity Controls.....	18
Table 7 - Stormwater Reuse Controls.....	18
Table 8 - Stormwater Quality and Waterway Protection Controls.....	19
Table 9 - Existing Sub-Catchment Area Characteristics	20
Table 10 - Existing Catchment Peak Flows.....	22
Table 11 - RFFE - Discharge Point East	22
Table 12 - Developed Sub-Catchment Areas.....	23
Table 13 - Developed Sub-Catchment Area Assumptions.....	24
Table 14 - Developed Catchment Peak Flows.....	26
Table 15 - Impact to Peak Flows from Proposed Development	26
Table 16 - Impact to Peak Flows from Proposed Development Without Upstream Catchment Areas	26

Table 17 - On-site Detention Volumes – 1% AEP Event.....	27
Table 18 - On-site Detention Volumes	27
Table 19 - On-site Detention Volumes – 5% AEP (20 year) Event	29
Table 20 - On-site Detention Volumes – 18.13% AEP (5 year) Event	29
Table 21 - Opportunities and Constraints	31
Table 22 – Scale and Effectiveness of WSUD Measures (Source HW, 2006)	33
Table 23 – Site Constraints for WSUD Measures (Source HW, 2006).....	33
Table 24 – Target Particle Size Range of WSUD Measures (Source Lloyd et al, 2002)	34
Table 25 - Rainfall and PET statistics adopted	38
Table 26 – Determination of % Imperviousness used in MUSIC.....	39
Table 27 - Storm flow concentration calibrations used in MUSIC.....	39
Table 28 - Pervious area calibrations used in MUSIC.....	40
Table 29 – Adopted Bio-filter Treatment Area.....	41
Table 30 - MUSIC Results.....	42
Table 31 - WSUD costs as identified by the Water by Design Business Case	45
Table 32 - Cost summary.....	47
Table 33 - Combined estimated costs for WSUD in Moss Vale Road North URA.....	49
Table 34 - Recommended frequency of inspections and regular maintenance	50
Table 35 –Required WSUD Pollutant Reduction Targets.....	56
Table 36 – Summary of Required WSUD Measures	57

1 Introduction

SEEC have been commissioned by Shoalhaven City Council to develop an Integrated Water Cycle Management Assessment (IWCMA) for the Moss Vale Road North Urban Release Area (URA). The assessment will inform the preparation of a site-specific Development Control Plan (DCP). The DCP will seek to guide residential development in the URA in accordance with Part 6 of Shoalhaven Local Environmental Plan (SLEP) 2014.

The scope of the IWCMA is to ensure the protection of water quality and the environmental values of an E2-Environmental Conservation area and other downstream environments during both the construction and post-construction development phases. The IWCMA presents:

- A conceptual stormwater treatment system;
- Post-development stormwater quality modelling to show how water quality objectives can be met;
- Advice on any changes required to the Indicative Layout Plan;
- A preliminary life cycle assessment;
- Identification of any significant soil constraints; and
- Advice on subdivision staging.

Potable water and sewerage for the URA are not included in the scope of this IWCMA.

The URA is located on Moss Vale Road, east of Camberwarra Village and north west of Bomaderry. It has a total area of approximately 266 hectares and comprises 17 separate lots. The URA boundary is shown in Figure 1.

This conceptual investigation is based on a desktop assessment of available information (e.g. flood assessment by Rhelm (2018)) and is not intended to be used for detailed design or construction advice.

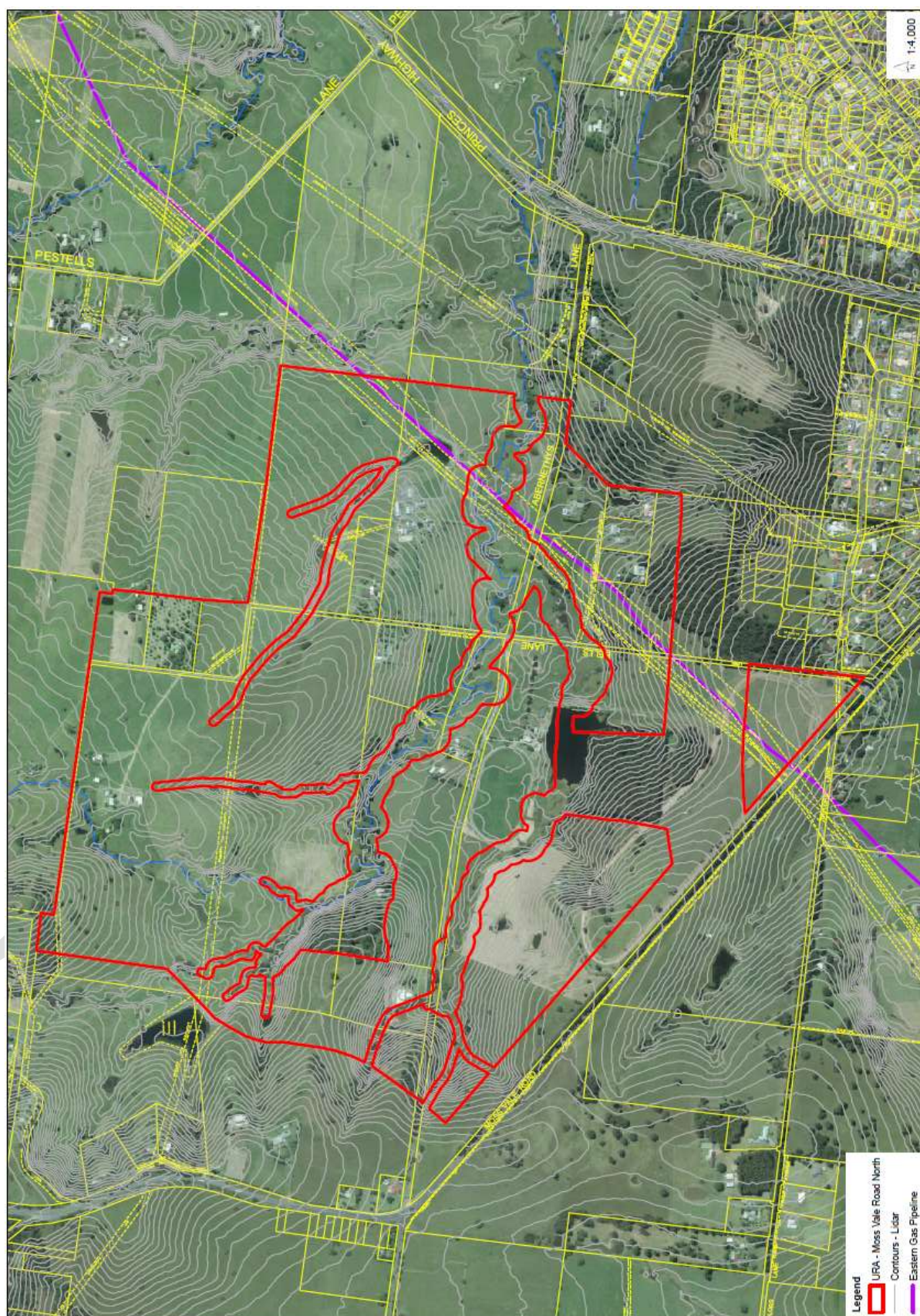


Figure 1 - Site Location

2 Data Sources

Data for the assessment has been sourced from the following

- SLEP 2014, specifically clauses 7.2 Earthworks and 7.3 Flood Planning;
- Chapter G2 of Shoalhaven DCP 2014 and supporting technical guidelines;
- Water Sensitive Urban Design (WSUD) principles as described in Chapter G2: Sustainable Stormwater Management and Erosion/Sediment Control Supporting Document 2: Sustainable Stormwater Technical Guidelines and associated document references;
- Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) (the “Blue Book”);
- Illawarra – Shoalhaven Regional Plan – Section 5.2.1;
- Council’s Engineering Design Specifications (Chapter G2 of the DCP);
- Australian Rainfall and Runoff Guidelines, 2019;
- Bureau of Meteorology Rainfall Data, 2016;
- Moss Vale Road North Urban Release Area – masterplan and DCP – Flood Study and Riparian Lands Review (2018);
- E-Spade - State of NSW and Office of Environment and Heritage 2017;
- A site visit; and
- Council-provided GIS data.

3 Land Description and Identification of Constraints

3.1 Current Zoning

The subject land is currently largely zoned General Residential (R1) (Figure 2), apart from:

- An area of Environmental Conservation (E2) corresponding to watercourses running through the development area including Abernethys Creek and a number of tributaries;
- Two areas reserved zoned as a Neighbourhood Centre (B1); and a Public Recreation (RE1) area side by side on Abernethys Lane, Cambewerra.; and
- An area zoned as business park (B7) at the intersection of Bells Lane and Moss Vale Road.

The minimum lot size is currently mapped at 500m² corresponding with the R1 General Residential zoned land. A Planning Proposal (PP) has been prepared for the URA to allow for an exception to the minimum lot size to allow for the subdivision of lots as small as 300m² in certain circumstances (generally in accordance with the small lot areas shown in the Indicative Layout Plan (ILP) in Figure 3). Medium density /integrated apartments have been nominated for areas less than 300m². Further information on the proposed subdivision layout is provided in Section 3.2.

Under SLEP 2014, the subject land is partly affected by the following:

- Clause 7.21 – Western Bypass Corridor Sch 1.5 – Additional Permitted Uses

Lot 4 on DP 708356 is partly listed as a biodiversity habitat corridor but the area nominated is within the E2 environmental conservation zoning.

3.2 Indicative Development

To encourage a range of housing types within the URA, Council is seeking to introduce an exception to the minimum lot size that will allow for lots as small as 300m² in certain locations and in certain circumstances. This will be achieved via planning policy to facilitate smaller lots in high amenity locations adjacent to open space areas, main roads and tree lined boulevards proposed for the URA.

An Indicative Layout Plan (ILP) for the URA is shown in Figure 3. It will form part of a relevant Development Control Policy (DCP) Chapter, along with a suite of controls to guide the subdivision layout and residential design. Together, they will support the reduced minimum lot size in appropriate locations. It is anticipated that the planning policy and draft DCP Chapter will be exhibited as a package at an appropriate time. The intended development outcomes for the Moss Vale Road North URA are illustrated by the ILP in Figure 3.

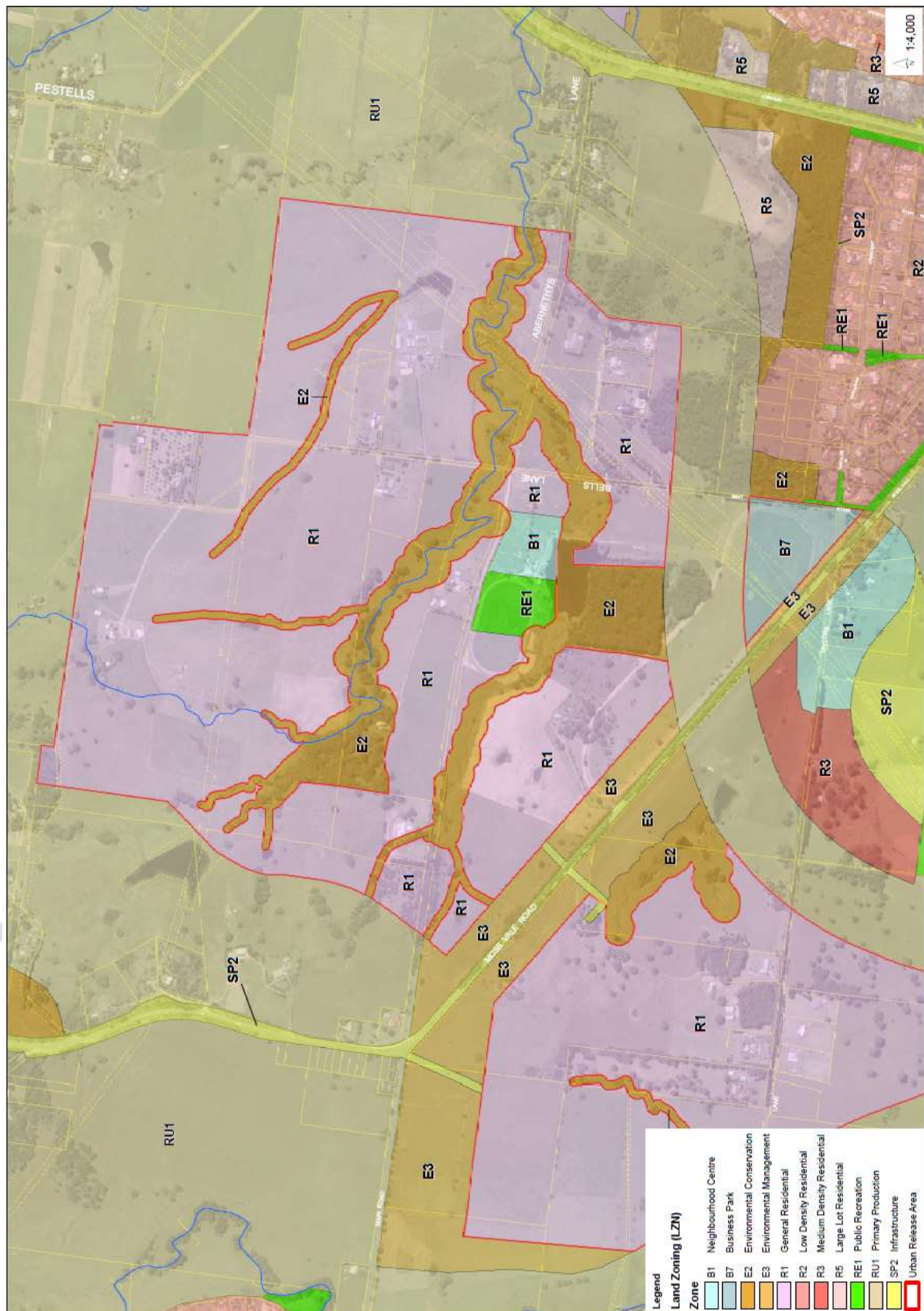


Figure 2 - Zoning under SLEP 2014

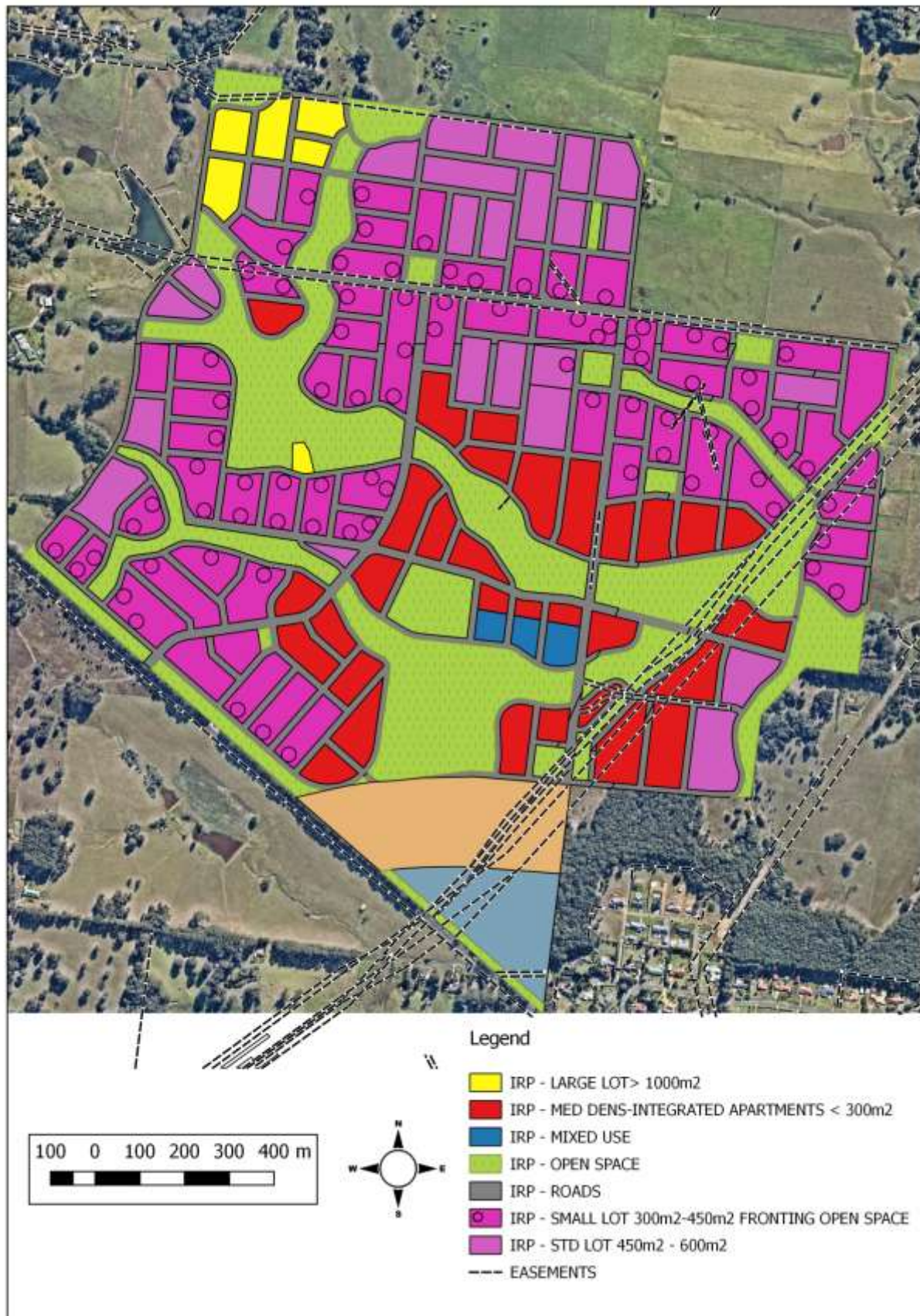


Figure 3 - DRAFT Indicative Layout Plan

(Supplied by Peter Annand and Associates and Allen Price and Scarratts)

The ILP contains a mix of small to large residential, open space, and medium density /integrated housing density. The relative density / number of dwellings per hectare for each proposed land use, and their respective level of imperviousness (as required by Chapter G2 of Shoalhaven DCP 2014) is provided in Table 1.

Table 1 - Assumed Land use lots per hectare

Density	Lots/ha	% Imperviousness	Average Allotment Area (m²)
Large Lot Residential	10	60%	1000
Standard Lot Residential	20	70%	500
Small Lot Residential	25	80%	400
Medium Density / Integrated Residential Housing	40.0	80%	250
Public Open Space	1.0	25%	10000
Sealed Road Corridors		60%	
Mixed Use	10.0	80%	1000
Business Park	10.0	90%	1000
Rural Uses	1.0	30%	10000

Using the assumed lots/hectare, the ILP can support 2,916 dwellings. It is expected that the dwellings will include detached houses, town houses, villas or cottages, and terrace housing.

Reticulated water and sewer is proposed to be provided to all parts of the URA. All roads in the development will be sealed.

The public open spaces will be passive recreation / open spaces and will contain limited infrastructure. There will be no sporting grounds and no requirement for the use of stormwater as an alternative water supply.

The site is generally cleared of vegetation but there is a significant pocket of vegetation in the south of the site on the southern side of the large dam and another significant pocket of vegetation in the west on the bank of Abernethy's Creek. These areas of remnant vegetation are within the E2 conservation area and are expected to be protected and enhanced as future development progresses to provide some areas of natural bushland in the urban area.

A number of parks will form linear passive recreation open space which provides pedestrian connectivity and may also aid in providing ecological corridors and links for flora and fauna due to the provision of green inter-connectivity. Natural flow paths and flood-storage would be located within some linear open spaces and any walkways or infrastructure would be located above expected flood levels or designed to withstand expected flood velocities and debris loadings.

3.3 Catchment Description

The URA is largely cleared and, at the time of writing, was being used for extensive agriculture (e.g. grazing). The development area is predominantly within the Abernethys Creek catchment which has source waters in the upper slopes of Cambewarra Mountain and drains towards the south east and across the Princes Highway. There is a major tributary to Abernethys Creek (a category 2 stream as shown on the SLEP 2014 Riparian Lands and Watercourses Map - Sheet WCL_013D) that traverses the proposed development area originating in the south western area of the catchment and joining with Abernethys Creek near the eastern extents of the development, upstream in the Princes Highway. This tributary is fed by various smaller gullies (category 3 streams) throughout the southern and south western areas of the catchment and has a large permanent dam feature two third of the way down the watercourse.

Moss Vale Road skirts the southwestern and western extents of the catchment along a ridge line, which continues northwards towards Cambewarra Mountain. From Cambewarra Mountain, a ridge line runs in a southeasterly direction to define the northern extents of the catchment connecting with the northern extents of Bells Lane and continuing on towards the Princes Highway.

In the western extents of the catchment there is a short tributary (category 2 stream) which is fed by a number of steep upper catchment gullies (category 3 streams), the largest of which has a dam that captures runoff from the far western extremities of the catchment (immediately east of 370 Moss Vale Road).

In the northern areas of the catchment there is a tributary which runs east to traverse Bell Lane, then south through Bell View Park Stud, where the watercourse is dammed and continues south to join with Abernethys Creek immediately downstream of the dam nearby Abernethys Lane.

The watercourses function as important biodiversity connectors between the top and bottom of the catchment. Maintaining the health of the receiving watercourses, including the lower reaches of Abernethys Creek and the Shoalhaven River, is a key concern and focus of this IWCA.

The total area of the catchment draining through the site is approximately 457 ha. The area that will remain undeveloped is 226.5 ha resulting in the URA area of approximately 230.5 ha or 50.4% of the catchment.

The URA includes existing easements for electrical purposes, transmission lines, future road corridors, water supply, stormwater, sewer and other services that may impact the location of proposed development and associated services.

3.4.2 Soil Landscape Mapping

Hazleton P.A. (1992) shows the site to be located on three soil landscapes, the Coolongatta Soil Landscape (on elevated lands), the Shoalhaven Soil Landscape through the central areas of the development and the Nowra Soil landscape in the lower eastern areas (**Figure 5**). Descriptions of these soil landscapes are included below.

3.4.3 The Coolongatta Soil Landscape

The Coolongatta Soil Landscape exists in the steep elevated western areas of the development and represents approximately one third of the site. It is an erosional soil landscape formed on the Berry Formation. It is characterised by rolling to low hills with slopes ranging from 5 to 20%. Soils typically consist of sandy loam to loam topsoil over sandy clay loam to sandy clay subsoil. Soil texture generally becomes finer on lower slopes and the total soil depth is generally less than 2.0m.

Hazleton P.A. (1992) identifies the soil landscape has some limitations to urban development (Table 2) but, those constraints are only localised and so the overall limitations to development is only moderate.

Table 2 – Soil Landscape Limitations for the Coolongatta Soil Landscape

Limitation	Occurrence
Steep slopes	Localised
Mass Movement	Localised
Shallow Soils	Localised
Rock Outcrop	Localised
Water Erosion Hazard	Localised
Surface Movement Potential	Localised

Other relevant characteristics of the Coolongatta Soil Landscape are:

- Fertility is low
- Soils can be hardsetting
- Soils are weakly structured
- Soils are strongly acidic
- Soils have low to moderate Cation Exchange Capacity
- Topsoil is moderately erodible (K-Factor = 0.02) (Landcom, 2004)
- Subsoil is moderately erodible (K-Factor = 0.038) (Landcom, 2004)
- Soils are Hydrological Group C (Landcom, 2004). Runoff would occur under moderate rainfall events.
- Soils are Type F for the purpose of sediment control (Landcom, 2004); total capture (Type F/D) sediment basins will be required.
- Soils are Type C for basin wall construction i.e. they are aggregated materials that might not hold water, testing is recommended.

3.4.4 Shoalhaven Soil Landscape

The Shoalhaven Soil Landscape is a fluvial soil landscape associated with the Shoalhaven River and its tributaries. It comprises flood plains, levees, backwater swamps and river terraces that are typically flat to gently undulating with slopes less than 3%. This soil landscape is the predominant one across the central areas of the development site. It has high to severe limitations to urban development (Hazleton P.A. (1992) (Table 3).

Table 3 - Soil Landscape Limitations for the Shoalhaven Soil Landscape

Limitation	Occurrence
Flooding	Widespread
Permanent waterlogging	Localised
Seasonal waterlogging	Widespread
Permanently high watertable	Widespread

Total soil depth is generally greater than 1.0m. Soils typically consist of sandy loam topsoil over sandy clay loam to sandy clay subsoil and have the following typical characteristics:

- Fertility is low
- Soils can be hardsetting
- Soils can have a low water-holding capacity
- Soils are strongly acidic
- Soils have a moderate Cation Exchange Capacity
- Subsoil is moderately erodible (K-Factor = 0.039) (Landcom, 2004)
- Soils are Hydrological Group C (Landcom, 2004). Runoff would occur under moderate rainfall events.
- Soils are Type F for the purpose of sediment control (Landcom, 2004); total capture (Type F) sediment basins will be required.
- Soils are Type C for basin wall construction i.e. they are aggregated materials that might not hold water, testing is recommended.

Based on the URA's topography, the extent of the Shoalhaven Soil landscape is shown to cover significant areas of the proposed development. Care should be taken in the allocation of land uses e.g. positioning/site selection for residential lots and road alignments. As a guide, development should only be allowed on this soil landscape if:

- The development is outside of the floodplain, or can be raised above it.
- Soils are not waterlogged or likely to become waterlogged; unless they can be adequately and permanently drained.
- Sufficient erosion controls are in place to limit soil loss during and after construction.
- Stormwater discharges from the site are at a velocity that does not cause scour during minor rain events.

3.4.5 Nowra Soil Landscape

The Nowra Soil Landscape is a depositional landscape derived on the Nowra Sandstone. It occupies moderately to gently undulating rises and undulating low hills. Soil profiles commonly consist of sandy to clayey sand topsoil over clay loam to light clay subsoil.

Hazleton P.A. (1992) identifies the soil landscape has some limitations to urban development (Table 4) but, those constraints are localised and so the overall limitations to development is generally low.

Table 4 – Soil Landscape Limitations for the Coolongatta Soil Landscape

Limitation	Occurrence
Steep slopes	Localised
Mass Movement	Localised
Shallow Soils	Localised
Rock Outcrop	Localised
Water Erosion Hazard	Localised
Run-on	Localised

Other relevant characteristics of the Nowra Soil Landscape are:

- Fertility is moderate to high
- Soils can be hardsetting
- Topsoil is weakly structured
- Soils can be strongly acidic
- Soils have low to moderate Cation Exchange Capacity
- Topsoil is erodible (K-Factor = 0.47) (Landcom, 2004)
- Subsoil is moderately erodible (K-Factor = 0.02) (Landcom, 2004)
- Soils are Hydrological Group C (Landcom, 2004). Runoff would occur under moderate rainfall events.
- Soils are Type F or D for the purpose of sediment control (Landcom, 2004); total capture (Type F/D) sediment basins will be required.
- Soils are Type A for basin wall construction i.e. they are suitable for use in dam wall construction.

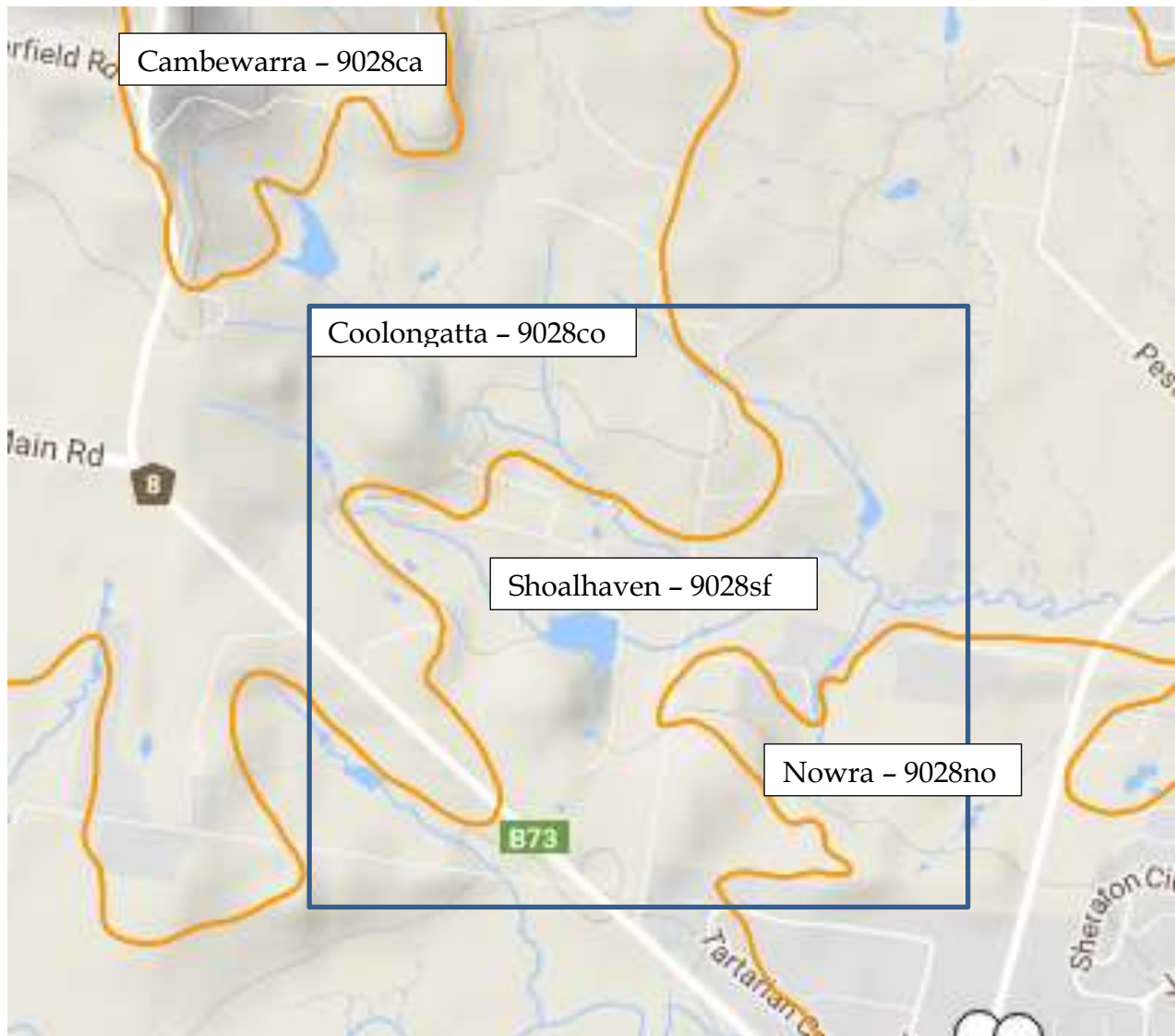


Figure 5 – Soil Landscape Mapping (Hazleton P.A., 1992) and Site Location (approx.)

3.5 Flooding

A detailed flood assessment has been undertaken for the URA by Rhelm (Rhelm, 2018). The study estimated the extent, depth and velocity of flood waters for the 1% Annual Exceedance Probability (AEP) flood (a rare flood) and for the Probable Maximum Flood (PMF) (the largest flood that could conceivably occur) and proposed an in-stream stormwater detention strategy. However given this approach is likely to increase velocities and the existing soil is erodible and sensitive to high velocities a traditional off line approach to storage has been adopted. The 1%AEP event is used for purposes such as the setting of design standards for new dwellings and the PMF is used for emergency management purposes. The study also reviewed the potential Flood hazard which is a function of flood depth and velocity and it is used to aid in evaluating areas where floodwaters pose a greater risk to life and property.

The estimated areas of inundation for the 1% AEP and the PMF are provided in Figure 6.

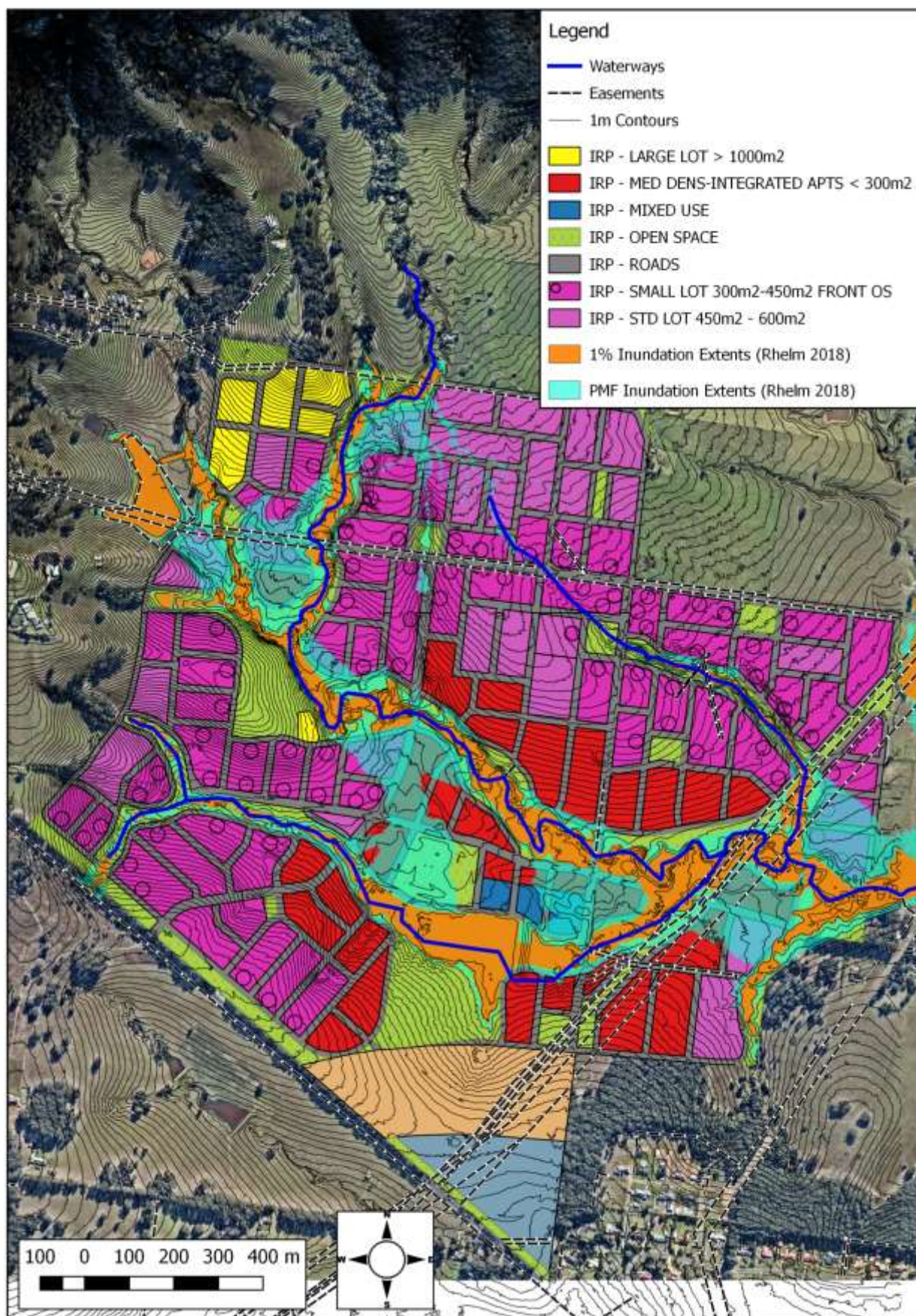


Figure 6 - Flood Extents (Data Source: Rhelm 2018)

The flood modelling highlights that the 1% AEP flood is contained within the environmental conservation areas and is not expected to impact the proposed development area. During the PMF flow will break out and merge inundating the central region of the development. Some properties at the western and eastern end of the development will also be inundated.

The flood modelling highlights that the 1% AEP flood hazard is intermediate to high within the lower sections of the main flows paths however it is generally low along the areas of inundation. The high hazard area increases during the PMF.

Flood plans and additional information can be obtained in the Rhelm 2018 Flood Study and Riparian Lands Review.

As per the SLEP 2014, any new development must:

- Be compatible with the flood hazard of the land; and
- Not significantly adversely affect flood behavior resulting in detrimental increases in the potential flood affectation of other development or properties, and
- Incorporate appropriate measures to manage risk to life from flood, and
- Not significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and
- Not result in unsustainable social and economic costs to the community as a consequence of flooding, and
- Not affect the safe occupation or evacuation of the land.

Clause 7.3 of the SLEP (2014) recommends the Flood Planning Level (FPL) be adopted as the 1% AEP flood level plus 0.5m freeboard. The Rhelm mapping indicates the proposed development area of the URA is higher than the 1% AEP and it is assumed that the 0.5m freeboard can be achieved.

Any filling above the 1% AEP flood level might impact larger, less frequent, events depending on the location of the filling. Detailed flood modelling of any proposed filling would be required to confirm that it does not impact any existing flood levels for adjacent properties for all flood events up to the Probable Maximum Flood (PMF).

Apart from filling low-lying areas, the hydrological regime of the catchment could also be impacted due to changes to land use through an increase in imperviousness and density of development. Potential impacts to local flows and their potential mitigation measures are presented in Section 6.

The URA includes areas that are outside of the Flood Planning Area but are within the Probable Maximum Flood (PMF) extent. As such the DCP Chapter G9: Development on Flood Prone Land is applicable and should be included as a future design reference.

3.6 Drainage

The study area varies from around RL 79m AHD in the northern section to RL16m AHD in the east near Princes Highway. Slope gradients vary from up to approximately 20% in the western upper areas to 1% in the lower areas to the east. The development area is positioned high within the catchment where various steep Category 3 watercourses are present in the western upper areas and Category 2 watercourses exist through the middle areas of the development. All development areas drain towards Abernethys Creek.

3.7 Climate

The nearest rainfall station to the URA is the Nowra RAN Air Automatic Weather Station (AWS), Station Number 068072 which has been in operation since 2000. The mean annual rainfall is 939.0mm with no distinct wet season. Pan evaporation is relatively high and is approximately 1,670 mm/year. The average monthly rainfall statistics are presented in Table 5 and Figure 7.

Table 5 - Mean Monthly Rainfall - Nowra RAN AWS - Site number: 068072

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
74.9	145.8	116.9	59.7	55.4	108.8	64.7	80.7	41	65.5	81.9	73.7	939

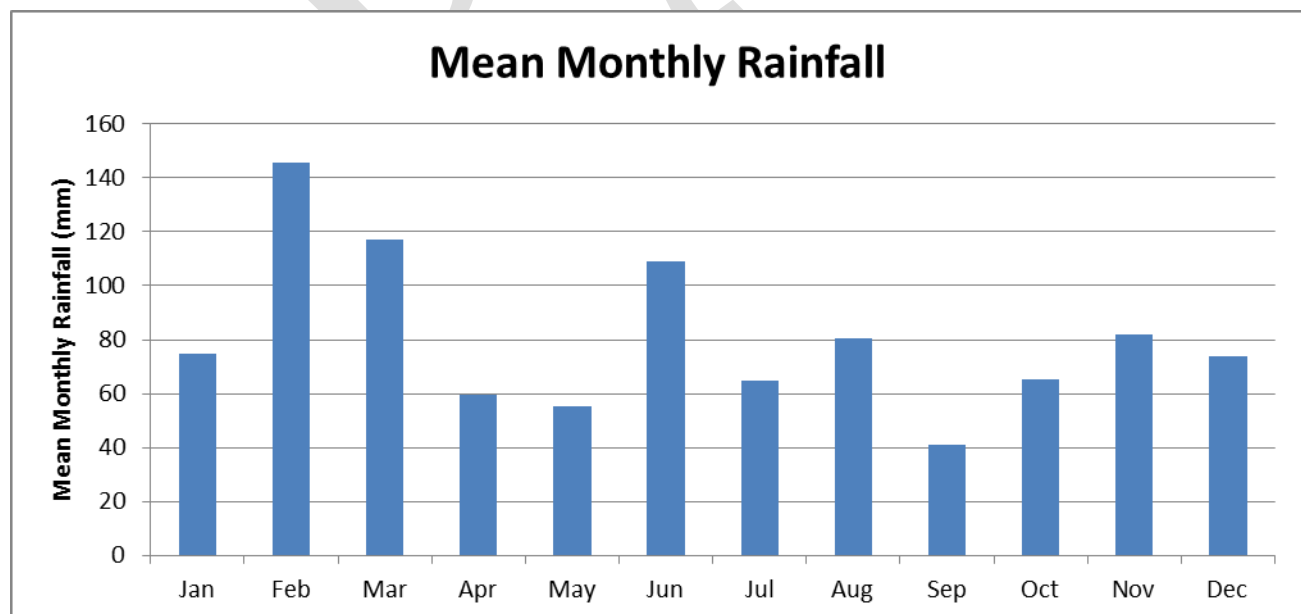


Figure 7 - Mean Monthly Rainfall

4 Stormwater Management

The URA requires a stormwater management system that can convey nuisance stormwater runoff away from habitable areas in a sustainable manner and that complies with Council's Chapter G2 in the DCP 2014. Key outcomes include:

- Manage stormwater flow paths and systems to ensure the safety of people and property.
- Protect and enhance natural watercourses and their associated ecosystems and ecological processes.
- Maintain, protect and/or rehabilitate modified watercourses and their associated ecosystems and ecological processes towards a natural state.
- Mitigate the impacts of development on water quality and quantity.
- Encourage the reuse of stormwater.
- Integrate water cycle management measures into the landscape and urban design to maximise amenity.
- Minimise soil erosion and sedimentation resulting from site-disturbing activities.
- Minimise the potential impacts of development and other associated activities on the aesthetic, recreational and ecological values of receiving waters.
- Ensure the principles of ecologically sustainable development are applied in consideration of economic, social and environmental values in water cycle management.
- Ensure stormwater systems and infrastructure are designed, installed and maintained so as not to increase the risk to life or safety or people.
- Provide Green and Golden Bell Frog (GGBF) friendly stormwater detention ponds in areas where GGBF are present.

Council's key design objectives are listed in the sections below. It is expected that the URA will comply with all listed controls.

4.1 Stormwater Quantity Controls

Hydrology controls required to be met are listed in Table 6 with reference to Council's Chapter G2: *Sustainable Stormwater Management and Erosion/Sediment Control*.

Table 6 - Stormwater Quantity Controls

Item	Chapter G2 Section
Minor stormwater system – residential areas - 5 year ARI Minor stormwater system – mixed residential/commercial areas - 10 year ARI Major stormwater system - 100 year ARI Includes trunk stormwater systems e.g. open channels, large conduits and overland flow paths. Must ensure a velocity depth product of less than $0.3\text{m}^2/\text{s}$ for a 100 year storm event.	5.1.1
Climate change impacts such as changes to rainfall intensities are incorporated into system design as per relevant policies and/or Australian Rainfall and Runoff (AR&R) Guidelines	5.1.3
OSD is to be sized to match pre-development peak flow rates for the 5, 20 and 100 year ARI rain events. 50% of any retention volume can contribute towards the OSD volume required for the development, provided the systems are interconnected.	5.1.4

Note that Australian Rainfall & Runoff 2016 contains additional clauses for flood management but they have not been adopted as part of this study apart from those specified above.

4.2 Stormwater Reuse Controls

Council promotes the reuse of stormwater through the controls as listed in Table 7.

Table 7 - Stormwater Reuse Controls

Item	Chapter G2 Section
Residential buildings are encouraged to install rainwater tanks to meet a portion of supply such as outdoor use, toilets, laundry. Stormwater use within public open space (irrigation, street cleaning, public amenities) is encouraged.	5.2.2

4.3 Stormwater Quality and Waterway Protection Controls

Council has specified controls to encourage a decentralised approach to stormwater management that considers the natural hydrological and ecological processes of the surrounding environment. This may include onsite collection, treatment and utilisation of water flows as part of an integrated treatment train provided either in addition to or, in lieu of, conventional stormwater treatment measures. Refer to Table 8.

Table 8 - Stormwater Quality and Waterway Protection Controls

Item	Chapter G2 Section
Develop an erosion and sediment control plan or soil and water management plan.	5.2.1
Stormwater retention – provide adequate retention storage volume where there is an increase in impervious surface area.	5.2.2
Pollutant load reductions: Gross pollutants – capture all litter greater than 40mm for flows up to the 4 Exceedances per Year (EY) event. Total Suspended Solids – 80% Total Phosphorus – 45% Total Nitrogen – 45% The 1.5 year ARI pre-development peak discharge must be maintained. The duration of stream forming flows must be no greater than a stream erosion index of 2.	5.2.4 <i>The adopted pollutant load reduction targets are the revised MUSIC targets proposed for Chapter G2 of the DCP</i>

5 Stormwater Quantity Modelling

The proposed change in land use will increase the level of imperviousness, which will increase stormwater peak flows and volumes. A DRAINS model was set-up using the ILSAX hydrological model to determine the total pre-development and post development flows from the URA. The model simulates all storm events ranging from 1 year ARI to 100 year ARI using the following parameters:

- Paved (impervious) area depression storage (mm) = 1
- Supplementary area depression storage (mm) = 1
- Grassed (pervious) area depression storage (mm) = 5
- Soil Type = 3
- AMC (Antecedent Moisture Condition) = 3
- Bureau of Meteorology 2016 rainfall depths (current at release of report)
- Australian Rainfall and Runoff 2019 temporal patterns (current at release of report)
- Sub-catchment areas
- Sub-catchment slopes

5.1 Existing Flows

Sub-catchment areas were determined from existing contours and are tabulated below (Table 9), together with key catchment information such as catchment slope and expected Time of Concentration. The sub-catchment break-up for the existing land use is provided in Figure 8.

Table 9 - Existing Sub-Catchment Area Characteristics

Sub-Catchment	Area (ha)	% Impervious	Catchment slope (%)	Adopted Time of Concentration (mins)
1	14.6	4.6%	3.7%	25.7
2	15.3	0.3%	3.7%	25.2
3	7.5	0.0%	6.9%	20.6
4	8.6	0.0%	6.7%	21.3
5	13.8	1.0%	4.5%	24.6
6	8.5	1.5%	3.8%	23.0
7	17.2	4.2%	4.6%	23.6
8	12.4	0.0%	4.5%	23.3
9	14.4	3.6%	8.2%	20.5
10	5.3	2.9%	4.3%	18.9
11	2.1	0.8%	2.3%	16.2
12	8.5	2.9%	7.4%	19.0
13	8.1	5.2%	2.3%	21.9
14	8.0	5.6%	1.9%	21.2
15	7.7	0.0%	3.7%	22.2
16	11.6	0.0%	4.9%	21.9
17	21.7	3.6%	7.6%	24.8
18	32.1	5.1%	3.6%	31.5
19	3.2	0.8%	2.9%	17.5
20	24.6	2.8%	4.7%	29.1
21	5.8	3.4%	1.9%	20.0
22	0.8	0.0%	1.6%	17.9
23	83.3	0.1%	26.4%	32.2
24	4.8	1.5%	4.5%	21.0
25	8.2	7.6%	4.1%	21.4
26	26.9	0.5%	16.3%	22.8
27	51.4	1.3%	22.6%	27.7
28	5.3	1.2%	2.6%	19.6
29	14.5	2.1%	5.2%	24.2
30	3.4	0.9%	10.6%	13.4
31	7.8	0.0%	7.7%	18.8
TOTAL	457.29			

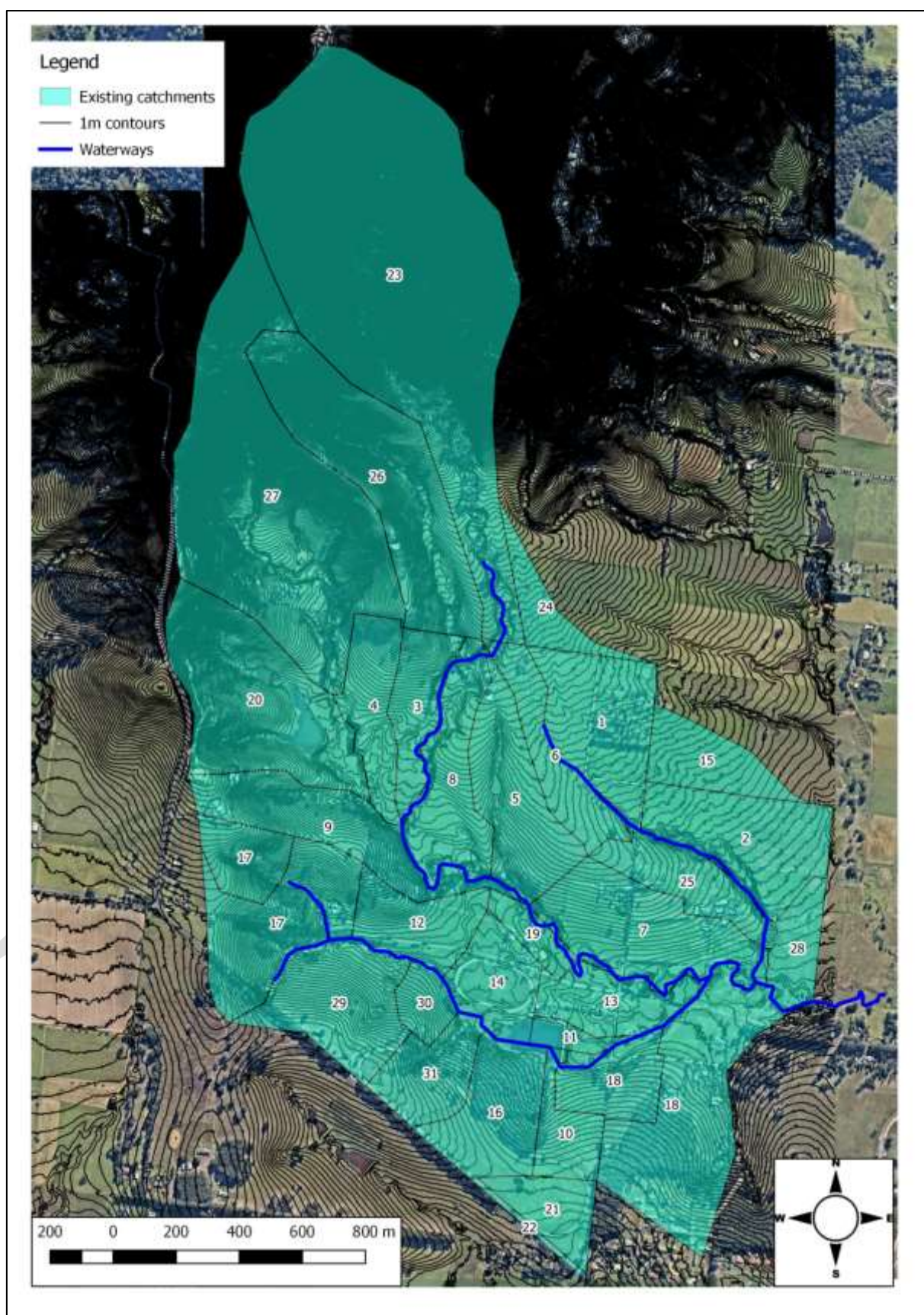


Figure 8 - Existing Catchments

The model has two discharge locations. The main one is Abernethys Creek which discharges eastward downstream of sub-catchment 28. The other is the discharge from sub-catchments 21 and 22 which drain towards the south.

Table 10 - Existing Catchment Peak Flows

Sub-catchment	Flow (m3/s)		
	0.2EY AEP (5 year)	5% AEP (20 year)	1% AEP (100 year)
Discharge Point East	28.9	47.3	74.3
Discharge Point South	0.662	1.17	1.92

These flows were compared against the Australian Rainfall and Runoff Regional Flood Frequency Estimate to provide confidence in the DRAINS model results. The RFFE estimated the following peak flows for the existing catchment at the eastern discharge point (Abernethys Creek).

Table 11 - RFFE - Discharge Point East

Estimated Flood Quantiles	Flow (m3/s)		
	0.2EY AEP (5 year)	5% AEP (20 year)	1% AEP (100 year)
Expected Quantiles	19.4	43.6	88.1
5% Confidence Limit	7.06	15.8	30.9
95% Confidence Limit	53.2	120	254

The DRAINS peak flows are within the expected flow range predicted by the RFFE. The DRAINS 5% AEP (20 year) peak flow is within 10% of the predicted RFFE flows. The DRAINS 0.2 EY AEP (5 year) peak flow is around 33% higher and the 1% AEP (100 year) peak flow is around 19% lower than the RFFE expected flows. Although the absolute peak flows estimated by DRAINS for these two storm events doesn't match the estimated RFFE flows, the expected impact from development (i.e. increase in peak flows) is expected to be accurate as the same model assumptions are used in the existing and developed models. A summary of the RFFE is provided in Appendix A.

It is worth noting that the detailed flood assessment by Rhelm estimated the 1% AEP peak flow to be 45m³/s at the downstream boundary (discharge point east) which is around 39% lower than the DRAINS estimate. It is expected that this is due to the different hydrological rainfall-runoff models used to calculate flow hydrographs which result in the different models calculating different peak flows. As there is no data to calibrate either model it is difficult to confirm the accuracy of either model and the discrepancy can be further investigated during concept design.

5.2 Developed Flows

The developed sub-catchments were identified from the indicative layout plan are tabulated below (Table 12) and shown in Figure 9.

Table 12 - Developed Sub-Catchment Areas

Catchment / Pit Name	Area (ha)	Roof - Paved (ha)	Total Mixed Area (ha)	% Paved / Impervious	% Grass / Pervious	Time of Concentration (mins)
Catch_1	14.52	4.94	9.57	60.3%	39.7%	14.4
Catch_2	12.70	4.75	7.95	68.5%	31.5%	13.4
Catch_2 Open Space	2.24	0	2.24	25.0%	75.0%	15.0
Catch_3	5.57	1.56	4.01	69.9%	30.1%	11.8
Catch_4	6.35	1.74	4.60	65.2%	34.8%	12.0
Catch_3&4 Open Space	4.12	0.000	4.12	25.0%	75.0%	15.0
Catch_5	12.90	5.35	7.55	68.5%	31.5%	14.1
Catch_5 Open Space	0.93	0	0.93	25.0%	75.0%	15.0
Catch_6	8.55	2.93	5.63	56.0%	44.0%	14.6
Catch_7	12.06	6.12	5.94	80.6%	19.4%	13.3
Catch_7 Open Space	5.15	0	5.15	25.0%	75.0%	15.0
Catch_8	8.37	3.26	5.11	66.2%	33.8%	12.9
Catch_8 Open Space	4.03	0	4.03	25.0%	75.0%	15.0
Catch_9	3.73	1.296	2.43	70.2%	29.8%	7.8
Catch_9E	5.53	0.000	5.53	0.0%	100.0%	20.5
Catch_9_Open Space	5.10	0.000	5.10	25.0%	75.0%	15.0
Catch_10	5.26	0.16	5.10	38.5%	61.5%	8.7
Catch_11	2.09	0.00	2.09	36.8%	63.2%	15.0
Catch_12 (+ 17B)	14.12	4.27	9.85	58.7%	41.3%	11.9
Catch_13	5.25	1.32	3.93	87.8%	12.2%	10.0
Catch_13 Open Space	2.81	0	2.81	25.0%	75.0%	15.0
Catch_14 Open Space	4.15	0	4.15	25.0%	75.0%	15.0
Catch_14	3.99	1.88	2.11	89.1%	10.9%	8.7
Catch15	7.69	0.00	7.69	0.0%	100.0%	22.2
Catch_16	6.31	0.24	6.07	29.7%	70.3%	10.0
Catch_16 Open Space	5.30	0	5.30	25.0%	75.0%	15.0
17E (100)	5.81	0.21	5.60	0.0%	100.0%	24.8
Catch_17 (B)	10.27	1.73	8.54	27.4%	72.6%	8.8
Catch_18A	3.13	1.42	1.71	40.4%	59.6%	10.0
Catch_18	12.70	5.57	7.14	77.2%	22.8%	12.6
Catch_18E	16.58	0	16.58	25.0%	75.0%	15.0
Catch_19	1.82	0.94	0.88	86.5%	13.5%	8.8
Catch_19 Open Space	1.35	0	1.35	25.0%	75.0%	15.0
Catch_20	1.97	0.576	1.40	65.9%	34.1%	6.7

Catchment / Pit Name	Area (ha)	Roof - Paved (ha)	Total Mixed Area (ha)	% Paved / Impervious	% Grass / Pervious	Time of Concentration (mins)
Catch_20E	22.63	0.000	22.63	3.5%	96.5%	31.5
Catch_21	5.78	2.91	2.87	76.6%	23.4%	8.9
Catch_22	0.86	0.00	0.86	28.4%	71.6%	5.0
Catch_23	83.27	0.08	83.18	0.0%	100.0%	32.2
Catch_24	4.79	0.07	4.72	0.0%	100.0%	21
Catch_25	6.70	3.00	3.70	58.7%	41.3%	10.6
Catch_25 Open Space	1.15	0	1.15	25.0%	75.0%	15.0
Catch_26	26.89	0.13	26.76	0.0%	100.0%	22.8
Catch_27	51.41	0.67	50.74	0.0%	100.0%	27.7
Catch_28	4.59	1.80	2.79	68.1%	31.9%	10.3
Catch_28 Open Space	0.65	0	0.65	25.0%	75.0%	15.0
Catch_29	11.07	4.51	6.56	65.6%	34.4%	10.7
Catch_29 Open Space	3.56	0	3.56	25.0%	75.0%	15.0
Catch_30	3.05	1.76	1.29	82.7%	17.3%	7.8
Catch_30 Open Space	0.38	0	0.38	25.0%	75.0%	15.0
Catch_31	6.79	3.18	3.61	76.6%	23.4%	9.2
Catch_31 Open Space	1.00	0	1.00	25.0%	75.0%	15.0
TOTAL	457.04					

The roof area and % paved/imperviousness was calculated based on the impervious area provided in Chapter G2 of Shoalhaven DCP as provided in Table 13.

Table 13 - Developed Sub-Catchment Area Assumptions

Land Use	Impervious Area (%) (based on G2)	Average Allotment Area (m2)	House densities (Dwellings / ha)	Nominal Roof Area (m2)
Large Lot Residential	60%	1000	10	300
Standard Lot Residential	70%	500	20	300
Small Lot Residential	80%	400	25	300
Medium Density / Integrated Residential Housing	80%	250	40.0	250
Public Open Space	25%	10000	1.0	0
Sealed Roads	100%			0
Mixed Use	80%	1000	10.0	0
Business Park	90%	1000	10.0	700
Rural Uses	30%	10000	1.0	500

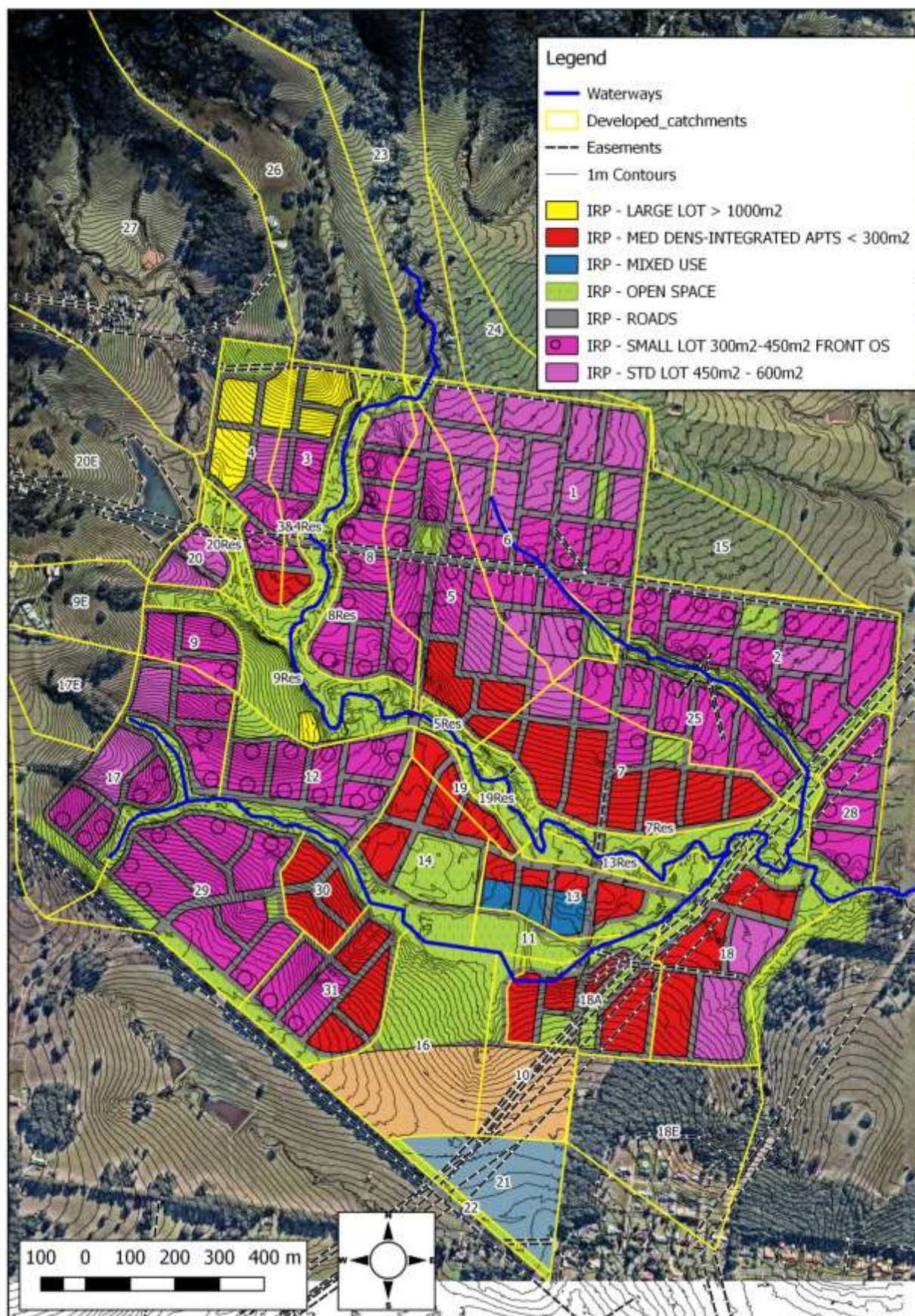


Figure 9 – Estimated Developed Catchments

The developed DRAINS model included additional storage from rainwater tanks (2kL at each household as described in Section 7.3), extended detention at some bio-filtration basins and the wetlands and their associated sediment forebays. Further discussion on WSUD elements is provided in Section 6. The DRAINS model predicted the following peak flows at each discharge point after development with no mitigation.

Table 14 - Developed Catchment Peak Flows

Sub-catchment	Flow Event		
	0.2EY AEP (5 year)	5% AEP (20 year)	1% AEP (100 year)
Discharge Point East	34.2	57.3	90.9
Discharge Point South	1.55	2.21	3.22

The model indicates that peak flows at both discharge points have increased and require additional On-site Detention as shown by the table below.

Table 15 - Impact to Peak Flows from Proposed Development

Sub-catchment	Flow Event		
	0.2EY AEP (5 year)	5% AEP (20 year)	1% AEP (100 year)
Discharge Point East	18.34%	21.14%	22.34%
Discharge Point South	134.14%	88.89%	67.71%

The increase in peak flows for the eastern discharge point appears low as the modelling includes the upstream catchment that will remain undisturbed. When this area is removed the increase in peak flows will increase as expected in the table below.

Table 16 - Impact to Peak Flows from Proposed Development Without Upstream Catchment Areas

Sub-catchment	Flow Event		
	0.2EY AEP (5 year)	5% AEP (20 year)	1% AEP (100 year)
Existing	16.7	28.4	47.4
Developed	33.1	52.0	77.1
Discharge Point East	98.20%	83.10%	62.66%

5.3 On-site Detention

The DRAINS model has shown that additional onsite detention is required to mitigate the change in imperviousness associated with the URA. Various storage sizes were modelled until the peak discharges were no greater than the predicted existing peak flows. The required onsite detention storages for each discharge location and the change in peak flows is provided in the tables below. These storage volumes are in excess of the 2 kL rainwater tank allowance for each property. The values in the tables below include the extended detention at some bio-filtration basins and the wetland and their associated sediment forebays. The detention basin was modelled assuming the permanent pool was not available for on-site storage (i.e. it is full at the start of the rain event) with an extended detention of 0.4m above the pool to a spillway.

The actual storage volumes adopted by future development may change slightly depending on the outlet configuration (i.e. outlet pipe, overflow weir size etc.), however it is expected that the storage would be similar to the volumes listed below.

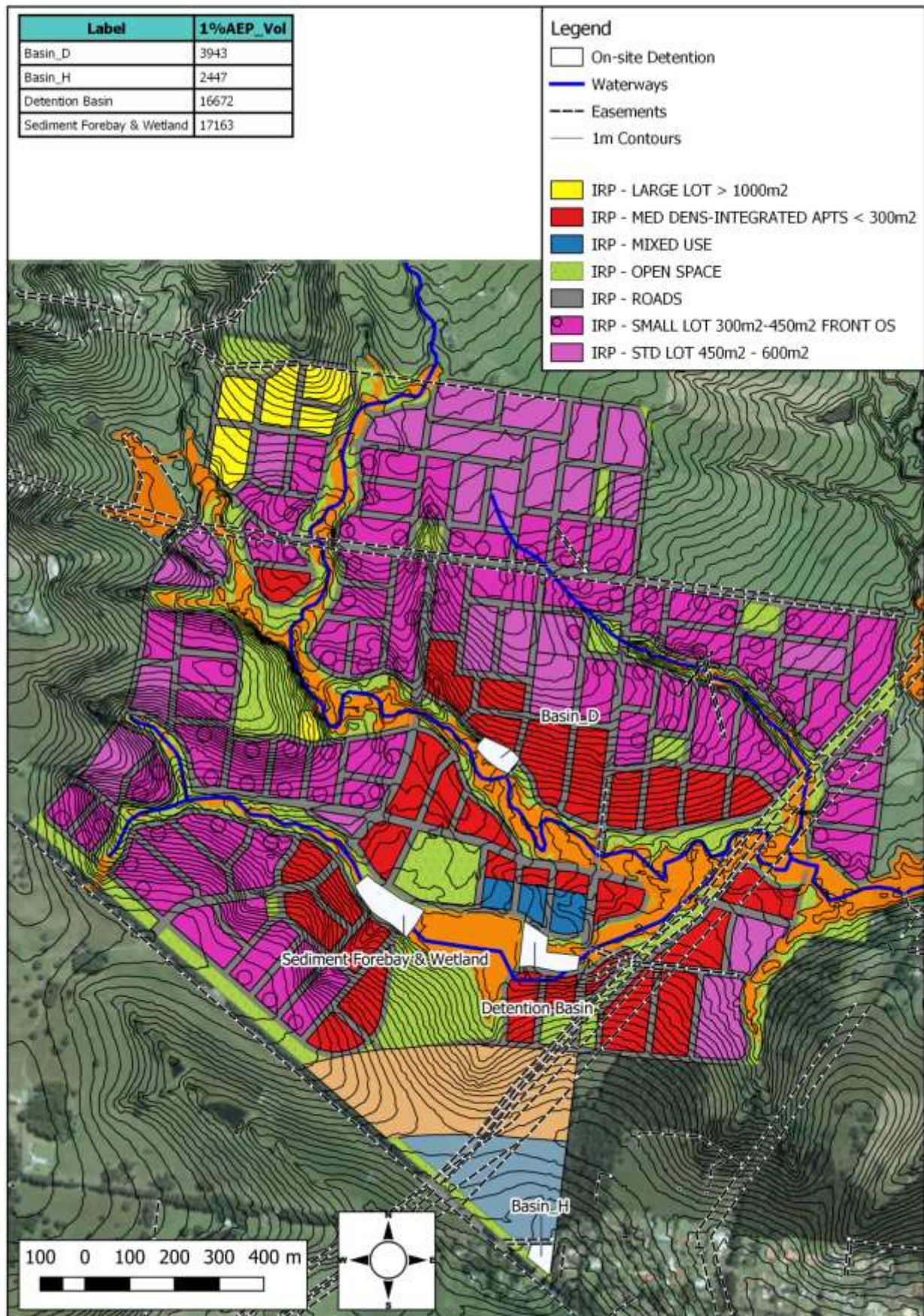
Table 17 - On-site Detention Volumes - 1% AEP Event

1% AEP Flows	Discharge Point East	Discharge Point South
Pre-Development Flows (m3/s)	74.3	1.92
Post-Development Flows (m3/s)	70.2	1.36
Total Change in Peak Flow (m3/s)	-4.1	-0.56
Basin Storage Required (m3)	37,776.9	2,446.7

The location of the basins is provided in Figure 10 and their relative sizing is provided in Table 18.

Table 18 - On-site Detention Volumes

Basin	Storage Volume (m3)		
	1% AEP	5% AEP	0.2Ey AEP
Sediment Forebay of Wetland	5,865.39	4,246.95	3,344.72
Wetland	11,297.08	9,018.09	7,255.03
Detention Basin	16,671.46	13,622.72	10,863.77
Basin D – (bio 5&8)	3,943.00	2,601.31	1,799.73
Total - East	37,776.93	29,489.07	23,263.25
Basin H – (bio 21)	2,446.67	2,039.50	1,318.31
Total - South	2,446.67	2,039.50	1,318.31



A summary of the pre and post development flows for the 5% AEP and the 0.2EY AEP are provided below.

Table 19 - On-site Detention Volumes – 5% AEP (20 year) Event

5% AEP (5 year) Flows	Discharge Point East	Discharge Point South
Pre-Development Flows (m3/s)	47.3	1.17
Post-Development Flows (m3/s)	47.3	0.542
Total Change in Peak Flow (m3/s)	0.0	-0.628
Basin Storage Required (m3)	29,489.1	2,039.5

Table 20 - On-site Detention Volumes – 18.13% AEP (5 year) Event

0.2EY AEP (5 year) Flows	Discharge Point East	Discharge Point South
Pre-Development Flows (m3/s)	28.9	0.662
Post-Development Flows (m3/s)	27.4	0.351
Total Change in Peak Flow (m3/s)	-1.5	-0.311
Basin Storage Required (m3)	23,263.3	1,318.3

The model results indicate that the peak flows from development can be attenuated with the nominated storage volumes for all modelled events.

The proposed on-line detention basin will require an emergency spillway to control overflows in very rare and extreme events. As there is a proposed road immediately downstream of the basin, consideration will be required on how to integrate the spillway with the road and maintain access/limit damage from overflows.

6 Selection of WSUD Measures

6.1 Introduction

The selection of appropriate WSUD measures requires an understanding of a range of issues to ensure the appropriate measures are adopted. In its simplest form, the selection of WSUD requires an understanding of the types and loads of pollutants and what measures might be effective in reducing the targeted loads. The key issues impacting this include an understanding of the:

- proposed land use of the catchment
- expected soil types and potential erodibility
- catchment topography
- major flow paths and areas of flood inundation
- ecological buffer areas
- safety concerns
- public expectations / concerns
- potential groundwater influences
- desire for centralised or de-centralised systems
- construction, operational and maintenance costs
- experience of maintenance staff
- potential additional benefits such as ecological, aesthetic, social amenity, alternate water supply/reuse etc.
- legislative requirements.

6.2 Pollutants of concern

The pollutant concentrations for typical urban environments are generated from erosion of soils, fertilization of vegetation, vehicle movement and wear, increased runoff etc. They range from gross pollutants to particulate and soluble contaminants. They include:

- gross pollutants and litter
- total suspended solids
- nutrients (phosphorous and nitrogen)
- biological oxygen demand and chemical oxygen demand
- pesticides and herbicides
- heavy metals
- hydrocarbons

Some of these pollutants are not easily modelled using MUSIC stormwater quality modelling but it is widely accepted that if the nutrient and total suspended solids loads are reduced any associated pollutants of concern would also be reduced.

6.3 Opportunities and Constraints to Urban Development

Table 21 presents the opportunities and constraints to urban development identified for the URA.

Table 21 - Opportunities and Constraints

Item	Opportunity	Constraint
Land use	Diverse range of land uses from large lot to medium density integrated housing. A number of open spaces are included which will provide room for overland flow paths and WSUD treatments.	Small lot and integrated housing will have very little space for disconnection of impervious surface and will rely more on open space networks or regional scale systems. Large lot areas may be more suitable to allotment style treatments
Soil	The soil landscape has overall only moderate limitations to urban development.	- The soils vary from a loam with fine sandy topsoil to silts and clays. - The soils can suffer moderate to severe stream bank erosion. - The soils are moderately erodibility. - The soils are generally fine grained. - soils are infertile
Topography	Gently sloped 1%-5% in most areas. Three main flow paths through the URA.	Steeper sections to the south and east of the area of up to 16%.
Major Flow Paths and Flooding	The site appears to be higher than the 1% AEP Flood Planning Level (FPL). The major overland flow paths have been identified and locked away from future development.	Two of the flow paths join in the Probable Maximum Flood (PMF) inundating the central region of the site. Some properties at the eastern end of the development will also be inundated.
Ecological Buffers	The habitat corridor is zoned E2 environmental conservation and is protected from urban development.	Under SLEP 2014, a small part of the URA is mapped for terrestrial biodiversity (habitat corridor).
Safety Concerns		Any permanent ponded water bodies must be safe and have fencing to prevent access or include appropriate batter slopes.

This page left blank

6.4 WSUD Selection

The selection of appropriate WSUD elements will depend on the opportunities and constraints of the individual site as listed in Table 22. Potential WSUD elements and their relevance to catchment characteristics are listed in the following tables.

Table 22 – Scale and Effectiveness of WSUD Measures (Source HW, 2006)

WSUD Measure	Allotment Scale	Street Scale	Precinct or Regional scale	Water Quality Treatment	Peak Flow Attenuation *	Reduction in Runoff Volume *
Rainwater tanks	✓			L	M	M
Gross pollutants Traps		✓		L	L	L
Swales and buffer strips		✓		M	L	L
Biofiltration swales		✓	✓	H	M	L
Sedimentation basins			✓	M	M	L
Biofiltration basins	✓	✓	✓	H	M	L
Constructed wetlands		✓	✓	H	H	L
Infiltration measures	✓	✓		H	H	H
Sand filters	✓	✓		M	L	L
Aquifer storage and recovery			✓	H	H	H

H - High, M - Medium, L - Low

* Frequent Events Only

Table 23 – Site Constraints for WSUD Measures (Source HW, 2006)

WSUD Measure	Steep site	Shallow bedrock	Low permeability soil	High permeability soil	High sediment input	Land availability	Acid Sulfate Soils
Gross Pollutant Traps	D	D	✓	✓	D	✓	D
Swales and buffer strips	C	D	✓	✓	D	C	D
Biofiltration swales	C	C	✓	✓	D	C	C
Sedimentation basins	C	✓	✓	✓	✓	C	✓
Biofiltration basins	C	D	✓	✓	C	C	D
Constructed wetlands	C	D	✓	D	D	C	C
Infiltration measures	C	C	C	✓	C	C	C
Sand filters	C	✓	✓	✓	C	✓	✓
Aquifer storage and recovery	C	C	C	✓	C	C	C

C - Constraint may preclude use, D - Constraint may be overcome through appropriate design, ✓ Generally not a constraint

Table 24 – Target Particle Size Range of WSUD Measures (Source Lloyd et al, 2002)

Particle Size Gradings	Treatment Measures	Hydraulic Loading $Q_{des}/A_{facility}$
Gross solids > 5000µm	Gross Pollutant Traps	1,000,000 m/yr 100,000 m/yr
Coarse to medium-sized particulates 5000µm - 125µm	Sediment Basins (Wet & Dry)	50,000 m/yr 5,000 m/yr
Fine particulates 125µm - 10µm	Grass Swales & Filter Strips	2,500 m/yr 1,000 m/yr
Very fine colloidal particulates 10µm – 0.45µm	Surface Flow Wetlands	500 m/yr 50 m/yr
Dissolved particulates < 0.45µm	Infiltration Systems Sub Surface Flow Wetlands	10 m/yr

Based on the opportunities and constraints, it is recommended that the following WSUD treatment measures be considered.

- Rainwater tanks;
- Gross Pollutant Traps;
- Sediment basins (during construction); and
- Biofiltration basins

It is expected that any on-site detention basins would also act as sediment basins and assist with improving water quality.

The adoption of rainwater tanks will be decentralised, (i.e. on every allotment); however the remaining treatment measures will be regionalized to allow a more efficient treatment system with fewer treatment measures within easily accessible areas.

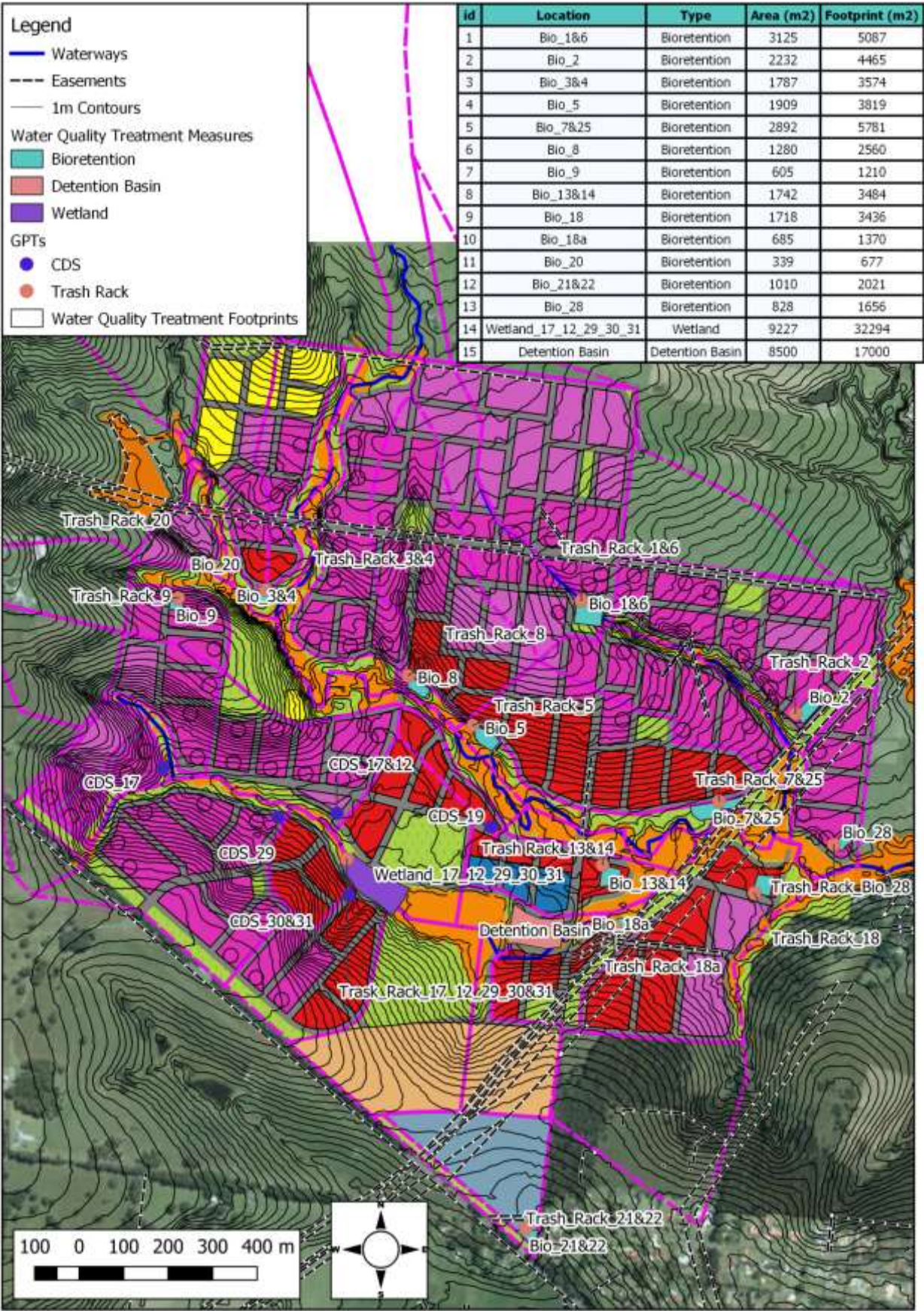
It has been assumed that each new dwelling would be fitted with a rainwater tank to capture roof runoff. Each tank would:

- i. Have a capacity of 4,000 L¹(minimum).
- ii. Have the top 2,000 L of the tank(s) dedicated to on-site detention.
- iii. Have a first-flush device.
- iv. Be screened to prevent the entry of leaves, twigs and mosquitos.
- v. Be plumbed to toilet and laundry, and at least one outdoor tap.
- vi. Overflow to a nearby kerb and gutter.
- vii. Be topped up from mains supply and that would require a back-flow prevention valve.

The proposed layout of adopted WSUD measures is shown in Figure 11.

We have included only a limited length of vegetated swales (150m) as it was assumed that kerb and channel would be preferred. However, the use of vegetated swales where possible would be encouraged. The swales would provide additional water quality treatment through slowing down velocities, encouraging sedimentation, filtering and encourage infiltration.

¹ The State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004 requires a rainwater tank of between 3,000L and 5,000L hence an average total volume 4,000L was adopted for this study. A larger BASIX tank volume may apply to some areas of the development and this could result in a small reduction in the footprint of some stormwater treatment devices. This can be investigated further during a later design stage.



7 Stormwater Quality Modelling

Pre and post development sediment and nutrient loads were modelled using MUSIC (Model for Urban Stormwater Improvement Conceptualisation), developed by the CRC for Catchment Hydrology (now eWater).

MUSIC contains algorithms based on the known stormwater runoff, pollutant generation from typical land uses and the performance characteristics of common stormwater quality treatment measures. These data are derived from research undertaken by eWater and others in Australia and overseas. To comply with Council's DCP, the models have been developed using MUSIC default parameters from the 2010 DRAFT NSW MUSIC Modelling Guidelines developed by the Sydney Metropolitan Catchment Management Authority. Statistics are produced in MUSIC for the following parameters:

- Flow (ML/yr)
- TSS - Total Suspended Solids (kg/yr)
- TP - Total Phosphorus (kg/yr)
- TN - Total Nitrogen (kg/yr)
- Gross Pollutants (kg/yr).

The MUSIC model does not cater for hydrocarbons or heavy metals. However, it is assumed if the total suspended solids are reduced, then any associated/attached pollutants will also be reduced.

7.1 Climate Data Selection

Creation of a MUSIC catchment file requires an associated meteorological data file. CMA (2010) recommends using data obtained from the Bureau of Meteorology's pluviograph rainfall station at Nowra for the period 1964 to 1970 (Rainfall Station 68076 - Nowra RAN Air). However, that data has a mean annual rainfall value of just 874 mm and so is not suitable². Therefore, Nowra data from 1970 to 1975 was used as that has a higher mean annual rainfall (1,191 mm). Basic rainfall and evapotranspiration statistics are in Table 25 and the time-series graph is in Figure 12.

² Nowra's mean annual rainfall is 901.5 mm

Table 25 - Rainfall and PET statistics adopted

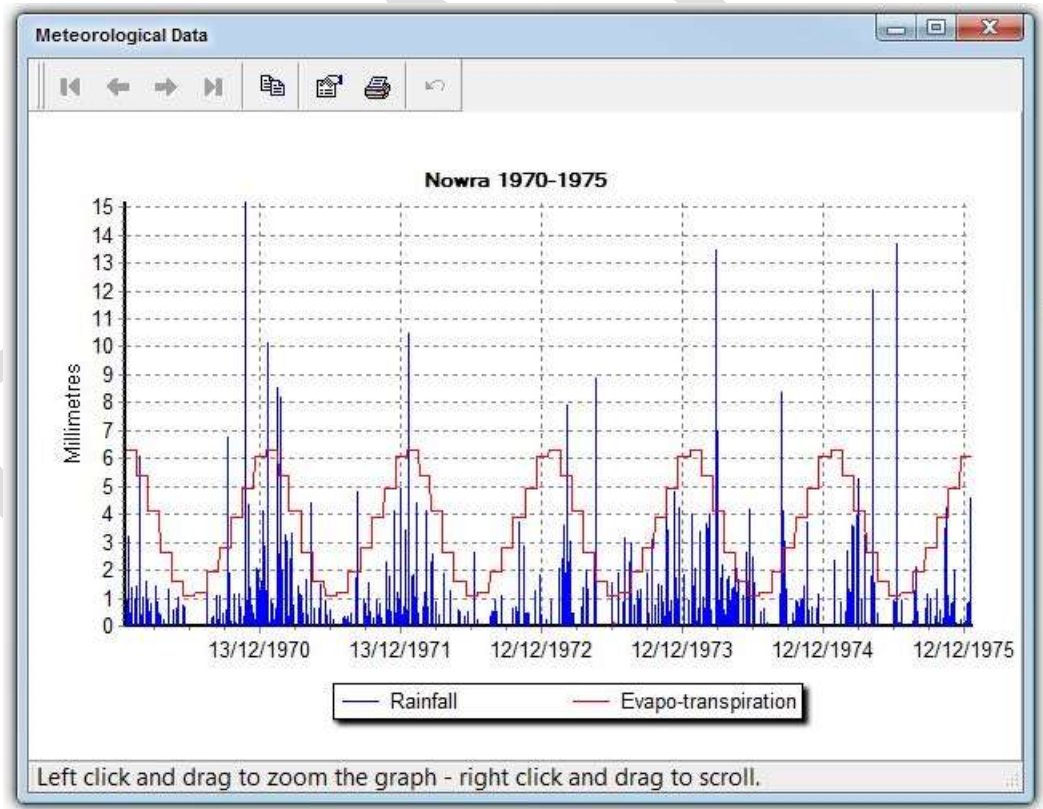
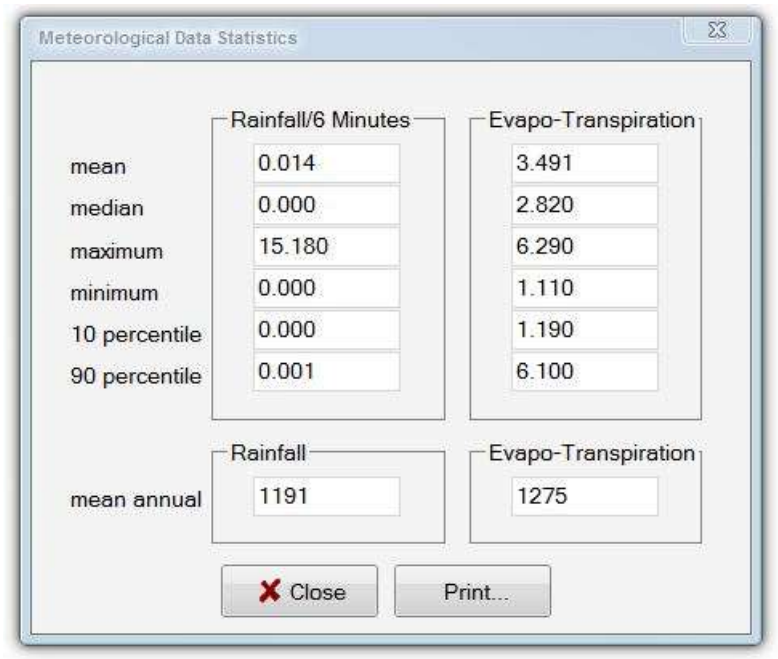


Figure 12 - Rainfall and PET Statistics

7.2 MUSIC Data

The DRAFT MUSIC modelling guideline states all urban residential lots and urban parklands are to be modelled as residential land use. There are other categories for sealed roads and roofs, both of which will be defined separately in the MUSIC model. The guidelines also include a category for rural residential land but, for this URA, the large lots are not considered big enough to meet the description and so the normal residential pollutant and runoff parameters have been adopted but, the level of imperviousness was reduced appropriately. The following land uses have been adopted in the MUSIC model:

- Large lot residential
- Standard lot residential
- Small lot residential
- Medium density / integrated residential housing
- Open space (reserves)
- Sealed Roads

The adopted level of imperviousness for developed land uses is presented in Table 26.

Table 26 - Determination of % Imperviousness used in MUSIC

Density	Lots/ha	% Impervious (non-roof)
Large Lot Residential	10	7%
Standard Lot Residential	20	25%
Small Lot Residential	25	60%
Medium Density / Integrated Residential Housing	40.0	100%
Public Open Space	-	0%
Sealed Road Corridors	0	60%
Mixed Use	10	33%

Table 27 summarises the adopted stormflow concentration parameters for the various land uses.

Table 27 - Storm flow concentration calibrations used in MUSIC

	TSS mean (log mean)	TSS std dev (log std dev)	TP mean (log mean)	TP std dev (log std dev)	TN mean (log mean)	TN std dev (log std dev)
Residential land	141 (2.15)	2.1 (0.32)	0.25 (-0.60)	1.8 (0.25)	2 (0.30)	1.55 (0.19)
Sealed road	269 (2.43)	2.1 (0.32)	0.5 (-0.30)	1.8 (0.25)	2.19 (0.34)	1.55 (0.19)
Roof	20 (1.30)	2.1 (0.32)	0.13 (-0.89)	1.8 (0.25)	2 (0.3)	1.55 (0.19)

The pervious area characteristics have been selected based on the soil characteristics (loam – sandy/loam) of the site and are in Table 28. They are based on the method described in Section 3.6.4 of CMA (2010).

Table 28 - Pervious area calibrations used in MUSIC

Parameter	Residential	Roof	Sealed Roads
Rainfall Threshold (mm)	1.5	0.3	1.5
Soil storage capacity (mm)	120	N/A	N/A
Initial storage (% of capacity)	25	N/A	N/A
Field capacity (mm)	87	N/A	N/A
Infiltration capacity coefficient (mm/d)	250	N/A	N/A
Infiltration capacity exponent	1.3	N/A	N/A
Groundwater initial depth (mm)	10	N/A	N/A
Daily recharge rate (%)	60	N/A	N/A
Daily base flow rate (%)	45	N/A	N/A
Daily deep seepage rate (%)	0	N/A	N/A

7.3 Other Assumptions

For the purpose of modelling we have assumed:

- Each new lot will be developed with a house having a roof area of around 300m² and 80% of the roof area will drain to a rainwater tank.
- The remaining land on each lot has an impervious area sufficient to ensure that the total level of imperviousness equals the DCP requirement.
- Each new home would have a 4 kL rainwater tank with 2 kL of that dedicated to domestic use. The other 2 kL is available for on-site detention. The anticipated demands on that 2 kL are:
 - Indoor use at 470 L/day per house (based on a four-bedroom home – toilet and laundry use (SCA, 2012).
- The bio-filtration filter media will be 500mm deep (excluding the drainage layer), having an initial hydraulic conductivity of 200mm/hr, and an extended detention depth of 0.3m. The bio-filtration basins will be constructed offline with a high flow bypass equal to the peak flow from the 1 EY event.
- Vegetated swales have generally not been modelled (only 150m in catchments 10 and 16). However, if they are to be adopted it is assumed they would be used in open spaces and large lots where possible and have a minimum base width of 1m, side slopes no steeper than 1 in 4, a depth of at least 500mm deep, and vegetation height of around 250mm. They are to have longitudinal grades between 0.5% and 4%.
- The bio-filtration basins should include a coarse sediment forebay to cater for an expected sediment load of approximately 0.6m³/ha/year. It is anticipated that the

volume of the forebay would be sufficient so that maintenance is restricted to a quarterly basis.

- Each biofiltration basin includes an upstream Gross Pollutant Trap (GPT) or trash rack that is expected to capture gross pollutants and any associated pollutants such as coarse sediment in accordance with DCP G2. The GPT can be combined with the coarse sediment forebay if it is capable of retaining coarse sediment.

The adopted approximate areas and volumes for the bio-filtration water quality treatments are below in Table 29.

Table 29 - Adopted Bio-filter Treatment Area

WSUD Element	Bio-Filter Area (m²)	Bio-filter Pond Area (m²)	Sediment Forebay Area (m²)	Total Bio-filtration Area (m²)
Bio-filtration 1 & 6	2390	2525.0	600.0	3125.0
Bio-filtration 2	1690	1804.0	428.0	2232.0
Bio-filtration 3 & 4	1334	1437.0	350.0	1787.0
Bio-filtration 5	1460	1567.0	342.0	1909.0
Bio-filtration 7 & 25	2259	2392.0	500.0	2892.0
Bio-filtration 8	923	1009.0	271.0	1280.0
Bio-filtration 9	418	475.0	130.0	605.0
Bio-filtration 13&14	1300	1400.0	342.0	1742.0
Bio-filtration 18	1280	1382.0	336.0	1718.0
Bio-filtration 18A	492	556.0	129.0	685.0
Bio-filtration 20	220	264.0	75.0	339.0
Bio-filtration 21	722	798.0	212.0	1010.0
Bio-filtration 28	587	656.0	172.0	828.0

The detention basin was modelled in MUSIC with the following properties:

- Basin area:- 8,500m²
- Extended detention depth:- 0.4.

The wetland was modelled with the following properties:

- Inlet pond volume:- 4,000m³
- Surface area:- 6,150m²
- Permanent Pool Volume:-1,230m³
- Extended detention depth:- 0.4
- Nominal water depth above the macrophyte zone:- 100mm-400mm.

7.4 Modelling Results

The MUSIC model was run to estimate annual pollutant loads and expected reductions for the key stormwater pollutants; the results are given in Table 30.

Table 30 - MUSIC Results³

	Sources (Unmitigated Loads)	Residual Load (After Treatment)	% Reduction
Flow (ML/yr)	1.97E+03	1.77E+03	10.2
Total Suspended Solids (kg/yr)	3.29E+05	6.450E+04	80.4
Total Phosphorus (kg/yr)	634	234	62.9
Total Nitrogen (kg/yr)	4.27E+03	2.35E+03	45
Gross Pollutants (kg/yr)	3.93E+04	36.7	99.9

The required target pollutant removals of 80% for Total Suspended Solids, 45% for Total Phosphorus and 45% for Total Nitrogen have all been met.

7.5 Wetland Water Levels

As part of the MUSIC modelling, a review of the wetland storage and water fluctuations was undertaken. The MUSIC model results were extracted to provide the daily water storage volume and relative water level in the wetland macrophyte zone. The wetland has been modelled with an average surface area of 6,150m² and a permanent pool volume of 2,500m³, with a nominal average depth of 0.4m.

The Melbourne Water Wetland Design Manual provides the following guidance on the water levels required to sustain wetland plants within the macrophyte zone.

The expected wetland inundation regime must be analysed to determine whether there is a potential risk to the long term health of the emergent macrophytes. The effective water depth (permanent pool depth plus EDD) must not exceed half the average plant height for more than 20% of the time. This must be demonstrated during design using an inundation frequency analysis.

The expected nominal water depth across the macrophyte zone is 100mm to 400mm for the shallow and deep marsh zones. The expected average plant height is at least 1.0m, therefore the allowable water level rise of 0.5m (half the plant height) should not be exceeded more than 20% of the time. A review the data indicates that this level is only exceeded less than 1% of the time.

A plot of the wetland storage and water level fluctuations is provided in Figure 13 and the wetland outflow and water level fluctuations are provided as Figure 14.

³ SEEC internal reference = 17000346-Run 12

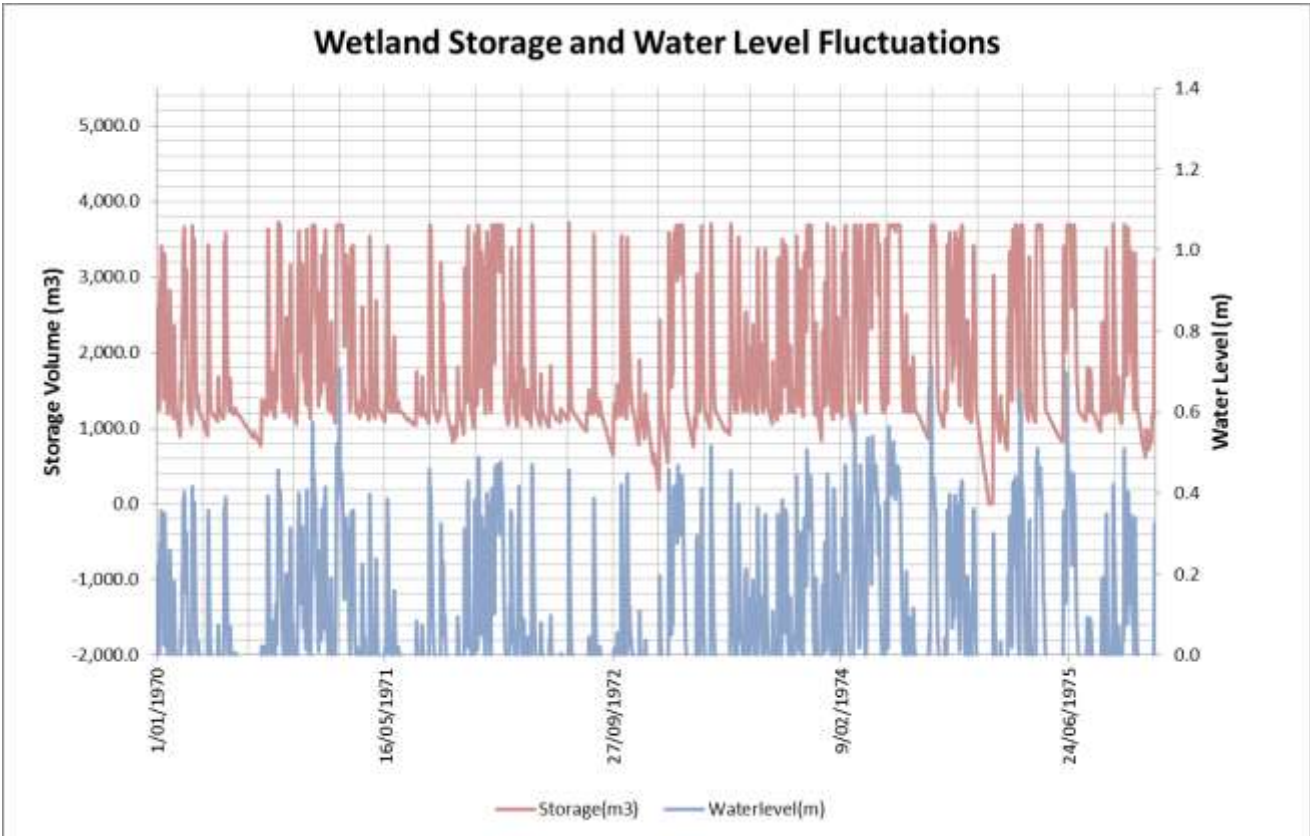


Figure 13 - Wetland Storage and Water Level Fluctuations

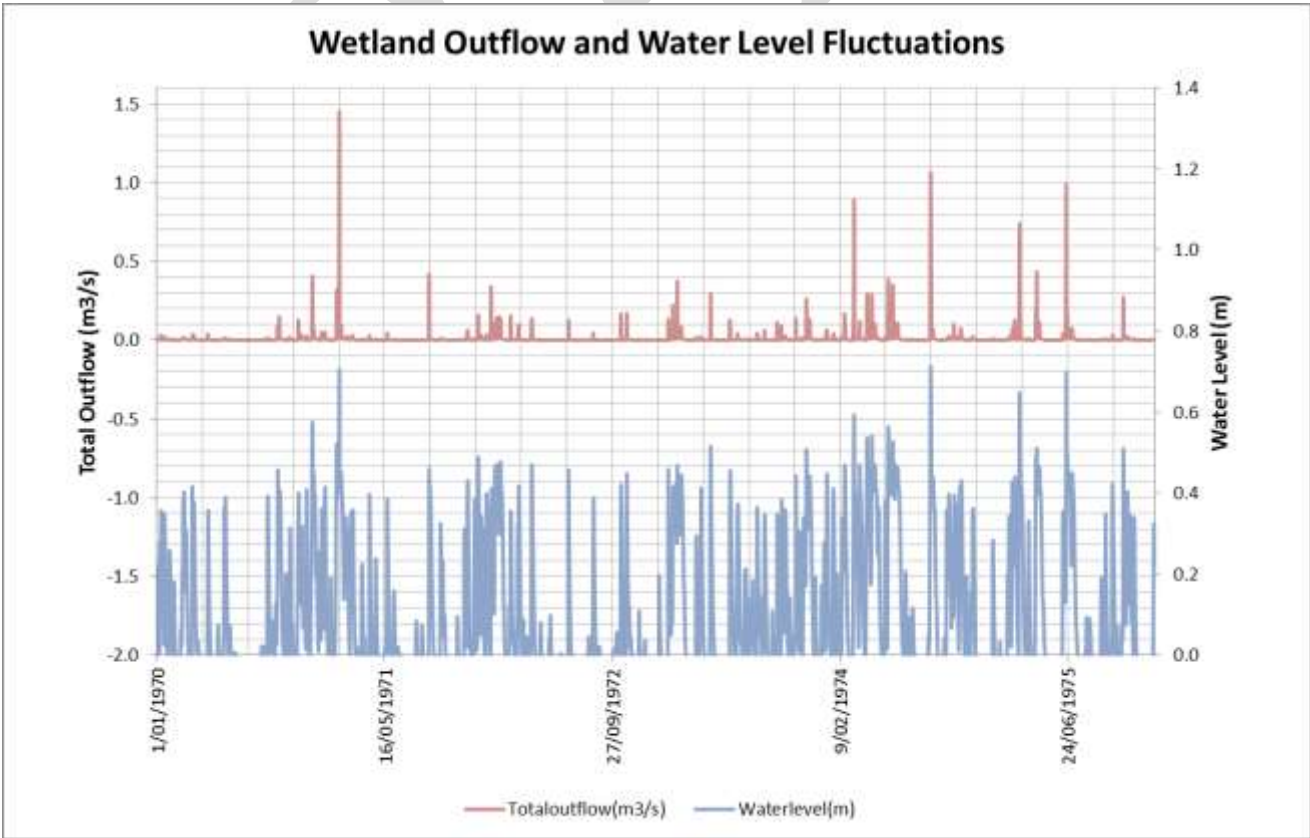


Figure 14 - Wetland Outflow and Water Level Fluctuations

Further analysis of the results indicates that water is predicted to reach the macrophyte zone 56% of the time i.e. the macrophyte zone will be dry approximately 44% of the time. Water will reach the median elevation of the macrophyte pond i.e. 50% inundation of the macrophyte zone around 34% of the time and the macrophyte zone will be fully inundated around 24% of the time. The model predicts that the nominal water level of 100mm above the highest elevation of the macrophyte zone will be reached or exceed around 17% of the time.

This information (and any updated information from the detailed design) should be provided to an ecologist/landscape designer to ensure that the correct species of wetland plants are adopted for the predicted water level changes.

8 Life Cycle Costs

All cost estimates are based on available information as documented below. Although SEEC has taken care in the selection and use of the cost estimate formulas and rates, it should be noted the estimates are for planning purposes only and actual costs will vary. SEEC has relied on the available information and has not verified the cost inputs as part of this study. The expected costs of applying WSUD can be classified as acquisition, operational and renewal costs. They can be direct financial costs, indirect financial costs or non-market costs. The following case study provides the following examples.

Table 31 - WSUD costs as identified by the Water by Design Business Case

Item	Description	Distribution
<i>Direct financial</i>		
Total life cycle	The sum of an assets costs over its life span with future costs discounted to a base date. Includes acquisition, annual maintenance, operational, renewal and decommissioning costs	Developers, local government and households
Acquisition	Capital costs of construction and establishment including design, site assessment and acquisition	Developers and householders
Annual maintenance	Maintenance during the first two years	Developers, local government or private ownerships
Operation	Running costs e.g. rainwater tank pumps	Local government and households
Renewal	Resetting or rebuilding the WSUD asset once the design life has been reached	Local government and households
Decommission	Decommission if required at the end of the design life	Local government and households
<i>Indirect financial</i>		
Reduction in area for other users	Lost opportunity to use land for other purposes	Developers and ultimately households
Environmental costs	Associated with obtaining raw materials, construction and maintenance	Community
Training and educational costs	Capacity building within government and the development industry	State and local government, developers and households
"Hidden costs" of development	Environmental monitoring, delays in gaining development approvals, environmental permits, insurance etc	Developers
Exposure to risk	An organisations exposure to financial risk if the WSUD asset should fails	Local governments and the development industry
<i>Non-market</i>		
Maintenance burden for residents	Maintenance burden for residents and landowners where WSUD is in private property	Community
Nuisance flooding perception	Inconvenience associated with temporary nuisance flooding associated with some WSUD elements (e.g. biofiltration requires temporary ponding within the asset)	Community
Community health and safety	Impact on the health and well-being of nearby residents who may be affected by potential nuisances such as mosquitos.	Community

Three documents were used to estimate the costs of WSUD infrastructure:

- Water Sensitive Urban Design Life Cycle Costing data (Melbourne Water online guideline)
- Structural Stormwater Quality BMP Cost / Size Relationship Information from the Literature, Andre Taylor (May 2005).
- Adoption Guidelines for Stormwater Biofiltration Systems Cities as Water Supply Catchments – Sustainable Technologies, CRC For Water Sensitive Cities (2015)

A review of the above literature provided a table of equations for the planning, design, establishment, and construction of WSUD assets. Routine maintenance costs and the costs of major renewal periods were also included. Referring to Table 31, the following rules were applied to estimate costs:

- where applicable the formula was applied to estimate cost (e.g. wetlands and sedimentation basins);
- the costs of the larger bio-filtration basins around 500m² were increased to \$70/m² and basins >1,000m² were increased to \$45/m² from the 2016 literature to be more in line with the latest cost estimates found in MUSIC;
- establishment costs were based on 5 times the average of the routine maintenance cost and reflects 1 to 2 years of maintenance;
- capital costs in Table 32 are the sum of all plan design construct and establishment costs of all WSUD elements within the URA;
- maintenance costs were of bio-filtration basins were increased to \$10/m² to be more in line with the latest cost estimates from MUSIC;
- on-site detention basins and rainwater tanks have not been included in the cost estimates;
- land acquisition costs are not included in the cost estimates; and
- any pump out, removal of unsuitable/contaminated material from an existing dam/detention basin have not been included.

Table 32 - Cost summary

Asset Type	Plan, Design and Construct	Establishment	Ongoing Routine Maintenance	Ongoing Renewal Maintenance
Wetlands	$1911 \cdot A^{0.6435}$ (\$/asset); Small (500 m ²) = \$210 /m ² Med (5,000 m ²) = \$90 / m ² Large (50,000 m ²) = \$40 /m ²	2 to 5 x routine cost	$1289.7 \cdot A^{-0.794}$ (\$/m²/yr); Small (< 500 m ²) = \$9 to \$10 /m ² /yr Med (5,000 m ²) = \$1.5 /m ² /yr Large (> 50,000 m ²) = \$0.2 /m ² /yr	NA
Sedimentation basins	$685.1 \cdot A^{0.7893}$ (\$/asset); Small (250 m ²) = \$215 /m ² Med (500 m ²) = \$185 /m ² Large (1,500 m ²) = \$145 /m ²	2 to 5 x routine cost	Small (< 250 m ²) = up to \$18/m ² Small (250 m ²) = \$12 /yr/m ² Med (500 m ²) = \$5 /yr/m ² Large (> 1,500 m ²) = \$2 /yr/m ²	Sediment removal and disposal: Dry waste = \$250 /m ³ Liquid waste = \$1,300 /m ³
Biofiltration basin	Construction only: Small (100 m ²) = \$800 /m ² Med (300 m ²) = \$250 /m ² Large (500 m ²) = \$70 /m ² Extra large (> 1000 m ²) = \$45 / m ²	2 to 5 x routine cost	Based on in-house estimates / case studies: \$3 to \$5 /yr/m ² (400 to 700 m ²)	Sediment removal and disposal = ID Minor reset = ID
Grassed swale and buffer strip	Construction only: Seeded = \$8 to 18 /m ² and up to \$25 /m ² (with subsoil drain) Turfed = \$13 to \$22/m ² and up to \$35/m ² (with subsoil drain) Established or native grass = up to \$62/m ²	2 to 5 x routine cost	\$1 to \$3 /m ² /yr *Estimates based on range of industry values	Sediment removal and disposal = ID Reset / returf = ID
Vegetated / biofiltration swale	Construction only: \$130 to \$170 /m ²	2 to 5 x routine cost	\$2 to \$6 /m ² /yr *Estimates based on range of industry values	Sediment removal and disposal = ID Reset (replace filter / vegetation) = ID

ID = Insufficient Data

This page left blank

DRAFT

Table 33 - Combined estimated costs for WSUD in Moss Vale Road North URA

WSUD Element	Area or Length (m²)	Capital Cost Incl Establishment	Yearly Maintenance
Gross Pollutant Traps	19	\$ 360,000	\$ 172,000
Bio-retention Basins (filter area)	15,100	\$ 1,600,000	\$ 151,000
Wetlands	8,150	\$ 720,000	\$ 17,000
Sediment Basins	8,500	\$ 1,320,000.00	\$ 17,000
Sub-Total Cost		\$4,000,000	\$357,000
Contingency – 40%		\$1,600,000	\$142,800
Total Cost		\$5,600,000	\$499,800

It should be noted that an appropriate contingency of 30-50% should be applied to the cost estimate in Table 33 given the preliminary nature of the conceptual design. The table includes a 40% contingency.

9 Operation and Maintenance

The performance of stormwater systems, particularly WSUD elements that are vegetated require maintenance activities to ensure they operate as designed. Poorly maintained WSUD assets can result in:

- failure to achieve the desired objectives
- poor amenity
- healthy and safety concerns such as mosquitos or offensive odours
- reduced value of the asset.

The design of each element must include an assessment of required maintenance activities. Suitable access and clearances to undertake maintenance activities is required to be provided as is a checklist of required maintenance activities and frequency. Typical maintenance activities could include:

- removing silt
- removing litter and debris
- weed control
- replanting vegetation
- mowing grass
- draining and removal of sediment
- cleaning and renewing filter media
- regular inspections.

Regular inspections are required to assess performance and damage after storm events and to guide required maintenance activities. Recommended frequency of inspection and regular maintenance for various stormwater elements are provided in Table 34. Assets should be inspected more frequently during establishment and after major storm events.

Table 34 - Recommended frequency of inspections and regular maintenance

Asset Type	Frequency of inspections - Temperate Climate
Swales	4 months (turf swales will require more frequent mowing)
Biofiltration systems / rain gardens	3 months
Constructed wetlands	3 months
Sediment basins	3 months
Proprietary products (e.g. GPTs)	As directed by the manufacturer

(Source: Water By Design 2012)

Water By Design - *Maintaining Vegetated Stormwater Assets* should be referenced for further advice. However, an example of typical maintenance and inspection checklist for a biofiltration basin is provided below.

- Surrounds – review safety fencing, signage, bollards, access etc. for damage or risk to public safety
- Inlet – review erosion or subsidence/settlement around the inlet, any damage to structures, sediment/litter or debris
- Sediment forebay – erosion or build-up of sediment/litter that may prevent flow through the system
- Batter slopes and base invert – erosion/short circuiting of concentrated flows, surface crusting, development of depressions or mounds, ponded water not draining freely through the filter media, litter, unusual odours or colours, state of vegetation, algal or moss growth, inspection openings / underdrain clean out points, weeds.
- Outlet – erosion, damaged structures, sediment/litter/debris/vegetation, outlet is free draining

All stormwater assets should be referenced to Council's GIS system to ensure their location is known, and the frequency of routine maintenance activities documented in a maintenance plan. Maintenance is also required for traditional stormwater assets to ensure that they can continue to convey the desired peak stormwater flows.

10 Erosion and Sediment Control

With regard to Erosion and Sediment Control Design:

- The estimated rainfall erosivity (R-factor) is 5,080 (high)
- The soil erodability (K-Factor) is 0.038 (moderate)
- Slope gradients vary from about 5% to 10%
- The URA will have a high erosion hazard (Figure 4.6 in Landcom, 2004)
- The Revised Universal Soil Loss Equation (RUSLE) estimates the soil loss at this site would be:
 - 298 t/ha/yr (Soil Loss Class 3, Moderate) on a 5 percent slope⁴
 - 704 t/ha/yr (Soil Loss Class 5, High) on a 10 percent slope

Erosion and sediment control plans (ESCP) would be developed for each stage of the subdivision works and would incorporate the following generic principles (Landcom, 2004):

- i. The upslope catchment length of exposed soil areas would be kept below 80 m. Any slope length exceeding 80 m would have a berm installed to intercept flow.
- ii. Construction traffic access is to be limited to the minimum required for efficient construction. Areas not essential for construction purposes are to be protected from traffic entry through the use of barrier and/or sediment fencing.
- iii. Disturbed lands will be progressively and rapidly rehabilitated, rather than leaving it to the end of works.
- iv. Diversion berms would be used to divert “clean” runoff from upslope of any construction areas away. Discharges are to be either onto a stabilised, well-vegetated area or into the existing stormwater system.
- v. Dust Control Measures would be implemented during earthworks. This would include re-using water from sediment basins and spaying exposed areas via water cart.
- vi. Total Capture (Type F/D) sediment basins would be used at the end of catchments to trap dirty water runoff, so that it may be treated before release. The sediment basins would be designed for the 80th percentile 5-day rainfall depth which is 31.8mm and a volumetric coefficient of runoff of 0.51.

The requirements of an ESCP would be implemented until at least 90 percent of the work areas were stabilised with vegetated or hard surfaces.

⁴ Based on slope length 80 m, P-factor of 1.3, C-factor of 1.

11 Staging

Staging of the proposed URA from a stormwater perspective needs to be considered to ensure:

- Stormwater infrastructure is constructed in an order that supports the expected development stages;
- Under-utilised and inefficient infrastructure is minimised during the establishment of the development; and
- Damage of assets with sediment laden water during future construction activities is minimised (e.g. clogging biofiltration basins).

Of particular concern is the staging of water quality treatment assets that are typically located in the downstream reaches of a developing catchment. Housing construction and bulk earthworks of future stages have the potential to generate large volumes of sediment that can smother water quality treatment measures and prevent them from functioning properly.

Staging of the stormwater assets (pit and pipe network) throughout the URA will be based on the construction sequence of the various development stages. It is expected that development will be staged such that allotments closer to existing infrastructure (roads, services etc.) would be constructed first and could be either upstream or downstream in the catchment.

Development at the downstream portion will allow outlets (pipe outfalls, rock protection, basins etc.) to be constructed early but the infrastructure will be under utilised until the URA is fully developed. This will result in high initial costs and may require additional maintenance and potential remediation of assets once the entire URA is developed.

Alternatively, starting construction at the upstream end of the URA will allow smaller pipe networks to be constructed saving initial costs but temporary downstream channels, basins etc. will be required to direct stormwater through the URA and ensure that peak flows are not increased in downstream receiving environments. This may require several temporary basins, erosion control measures that must be continually relocated throughout the life of the development. Ultimately, the staging of the stormwater system must match the developers' other construction requirements but the impact to the stormwater network should be considered when developing a staging plan.

Staging of the development will impact the type and level of erosion and sediment controls. Earthworks should be staged to limit the exposure of soil that can be washed from the URA into stormwater infrastructure and downstream waterways. Multi-stage Erosion and Sediment Control Plans that reflect each construction stage will be required.

It is recommended to combine the function of construction and operational water quality basins to limit excavation volumes, potential additional clearing extents and costs. Water quality basins can be constructed initially as sediment basins during the bulk earthworks stages then converted to WSUD elements such as bio-filtration basins after bulk

earthworks stages. Sediment basins will need to be pumped out and de-silted before they can be converted to WSUD elements.

WSUD elements are typically completed by the developer prior to the allotments being sold and the construction of houses. Builders can generate large sediment volumes that will be washed into the WSUD elements via the stormwater network for up to several years after the initial construction of the water quality infrastructure. Sediment can limit the performance of WSUD elements by smothering vegetation, blocking filter media, reducing water clarity, prematurely filling sediment stores etc. Excessive sediment can limit the capacity of conveyance paths, increase the risk of localised flooding and reduce the general amenity.

It is recommended that:

- Staging is intended to be implemented with multiple upstream owners via a contributions plan developed for the URA so the construction and funding of the larger combined WQ/OSD basins can be staged as development comes on line i.e. the full footprint does not need to be constructed upfront.
- No WSUD elements be on line until all bulk earthworks have been completed
- No WSUD elements to be on-line until the catchment is at least 90% developed, unless additional measures are implemented.
- The on line detention basin be constructed within the dry season and that no upstream development occur until it is in place.

Additional measures may include:

- Using water quality basins as sediment basins until all development is completed;
- Use temporary coverings/linings over bio-filtration media until all development is completed e.g. turf or geotextile over bio-filtration media;
- Additional erosion controls within the upstream catchment; and
- Additional sediment controls upstream of WSUD elements to cater for excessive sediment loads.

12 Development Controls

The following development controls are recommended to encourage the proposed URA to meet the objectives of Councils development planning policy.

12.1 Objectives

- i. Manage stormwater flow paths and systems to ensure the safety of people and property
- ii. Maintain, protect and/or rehabilitate modified watercourses and their associated ecosystems and ecological processes towards a natural state.
- iii. Mitigate the impacts of development on water quality and quantity.
- iv. Encourage the reuse of stormwater.
- v. Minimise soil erosion and sedimentation resulting from site disturbing activities.

12.2 Controls

- i. Stormwater management is to be designed and implemented within the URA.
- ii. Stormwater is to be managed primarily through the street network and is to be designed in accordance with Shoalhaven City Council's Engineering Design Specifications and the Development Control Plan 2014 – Chapter G2: Sustainable Stormwater Management and Erosion/Sediment Control in relation to management of stormwater flows and quality.
- iii. Management of 'minor' flows using piped systems for the 18.13% AEP (5 year) (residential land use) and 10% AEP (10 year) (mixed residential/commercial, commercial land use) shall be in accordance with Shoalhaven City Council's Engineering Design Specifications and the Development Control Plan 2014. Management measures shall be designed to:
 - control stormwater to minimise localised flooding and reduce nuisance flows;
 - provide sufficient on-site storage to match pre-developed peak flow rates for the 50% AEP (1.5 year), 18.13% AEP (5 year) and 5% AEP (20 year) rain events;
 - ensure that the duration of stream forming flows must be no greater than two-times the pre-development duration of stream forming flows at the site discharge point;
 - encourage the installation of rainwater tanks on residential dwellings to meet a portion of supply such as outdoor use, toilets, laundry;
 - provide an erosion and sediment control plan or soil and water management plan for each stage of works;
 - capture and retain a high level of urban water run-off pollutants to protect local watercourses;
 - include sufficient Water Sensitive Urban Design (WSUD) elements to achieve the water quality targets listed in the table below.

Table 35 –Required WSUD Pollutant Reduction Targets

Pollutant	Reduction
Gross pollutants	Capture all litter greater than 40mm for flows up to the 4 EY event
Total Suspended Solids	80%
Total Phosphorus	45%
Total Nitrogen	45%

- i. Management of 'major' flows using dedicated overland flow paths such as open space areas, roads and riparian corridors for all flows in excess of the pipe drainage system capacity and above the 18.13% AEP (5 year) shall be in accordance with Shoalhaven City Council's Engineering Design Specifications. Management measures shall be designed to:
- Prevent both short term and long term inundation of habitable dwellings;
 - Control localised flooding from storm events to maintain access to lots, maintain the stability of the land form and to control erosion;
 - Habitable floor levels to have a minimum of 0.5m freeboard above the 1% AEP (100 year) flood level;
 - Ensure that any proposed filing does not cause unacceptable afflux to adjacent properties for all events up to and including the Probable Maximum Flood;
 - Provide for the orderly and safe evacuation of people away from rising floodwaters;
 - Provide sufficient on-site storage to match pre-developed peak flow rates for the 1% AEP (100 year) rain event. This will be achieved using detention storage within water quality features and detention basins;
 - Ensure a velocity depth product of less than 0.3m²/s for a 1% AEP (100 year) storm event
 - Provide management measures for minor and major flows (including WSUD elements) must not result in obstruction / redirection of flooding to areas that are not expected to be inundated i.e. habitable areas. In addition, high hazard floodway areas are to be kept free of fill and/or obstructions at all times.

13 Summary

The proposed URA is expected to support around 2,916 properties ranging in size from less than 300m² to 1,000 m². The expected increase in imperviousness will increase the peak flow, volume, frequency and level of stormwater pollution entering local waterways unless adequate stormwater management practices are adopted.

Stormwater modelling indicates that on-site detention and the adoption of a number of WSUD elements including GPTs, wetlands and bio-filtration basins can mitigate the impacts of the proposed development. It is suggested that the future development adopts the controls identified in **Section 12** (or similar to achieve the same outcomes).

The required WSUD elements to achieve compliance are listed in Table 36. A plan of the proposed measures is presented in Figure 11.

Table 36 – Summary of Required WSUD Measures

Gross Pollutant Traps	Bio-Filtration – Filter Area (m ²)	Constructed Wetlands (m ²)	Rainwater Tanks - No	1% AEP event On-site Detention (m ³) *
14	15,100	8,150	2,916	40,224

* Includes the storage volumes provided by the wetlands and sediment/detention basins.

The proposed WSUD elements are expected to be located within the nominated URA due to constraints outside the URA. However, the location of WSUD elements immediately outside the URA may be possible if the following limitations can be addressed:

- The topography is suitable for the proposed infrastructure
- Soil and groundwater conditions do not limit constructability
- The location provides appropriate access for inspection and maintenance of the proposed infrastructure
- Opportunities to be combined with an adjacent WSUD element
- Water discharged from the URA does not adversely impact the waterway reach between the URA and the offsite WSUD element
- Any WSUD elements are increased in size to cater for the additional catchment.

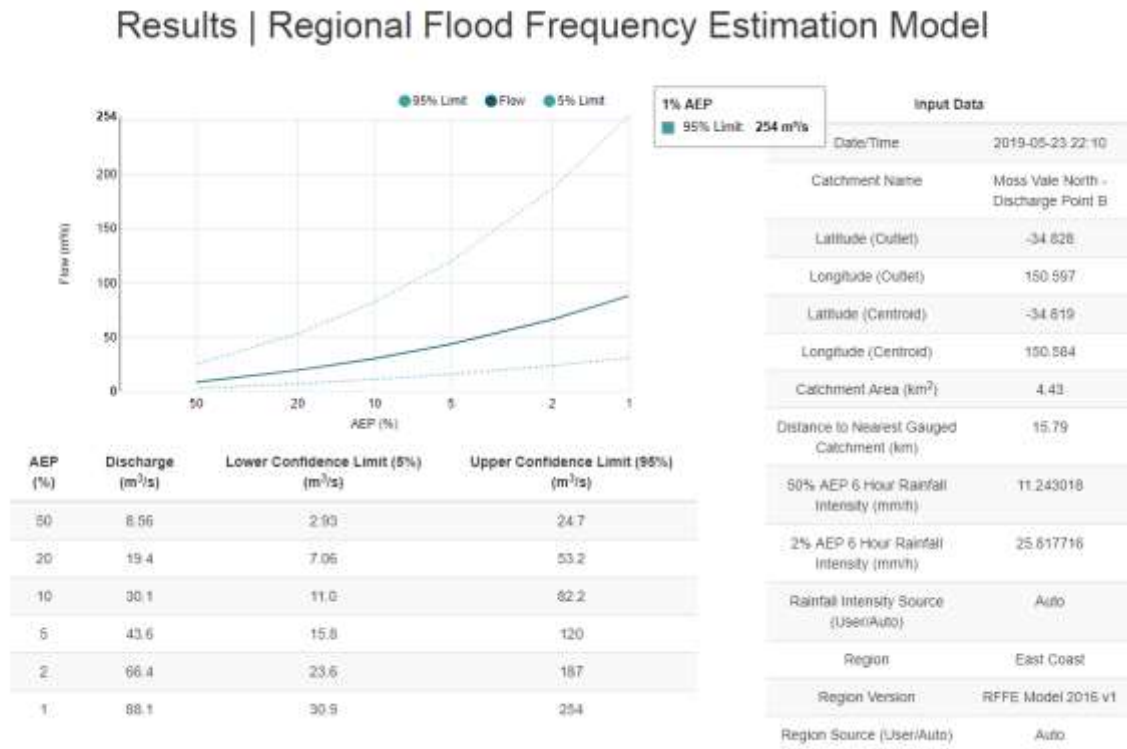
The design should follow current best practice to ensure effective operation and allow ease of maintenance.

14 References

- Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), (2016), *Australian Rainfall and Runoff: A Guide to Flood Estimation*, © Commonwealth of Australia (Geoscience Australia).
- CMA, (2010), *Draft NSW MUSIC Modelling Guidelines*. Sydney Metropolitan Catchment Management Authority.
- Healthy Waterways, (2006), *WATER SENSITIVE URBAN DESIGN - Technical design Guidelines for South East Queensland*, Brisbane QLD.
- Landcom, (2004), *Managing Urban Stormwater: Soils and Construction Volume 1* (the “Blue Book”), NSW.
- Lloyd et al, (2002), *WATER SENSITIVE URBAN DESIGN - A stormwater management perspective*, CRC for Catchment Hydrology, Melbourne Victoria.
- NSW Government, (2017), Shoalhaven Local Environmental Plan 2014, <https://www.legislation.nsw.gov.au/#/view/EPI/2014/179>
- Rhelm, (2018), *Moss Vale Road North Urban Release Area – Masterplan and DCP – Flood Study and Riparian Lands Review*, Sydney NSW.
- Sydney Catchment Authority, (2012) - *Using MUSIC in Sydney’s Drinking Water Catchment*. Sydney Catchment Authority, Penrith NSW.
- State of NSW and Office of Environment and Heritage, (2017), eSPADE, <http://www.environment.nsw.gov.au/eSpade2WebApp>
- Shoalhaven City Council, (2020), *Shoalhaven Development Control Plan 2020. Chapter G2: Sustainable Stormwater Management and Erosion/Sediment Control*.
- Shoalhaven City Council, (2014), *Shoalhaven Development Control Plan 2014. Chapter G9: Development on Flood Prone Land*.
- Water by Design, (2012), *Maintaining Vegetated Stormwater Assets (Version 1)*. Healthy Waterways Ltd, Brisbane.

Appendices

Appendix A – Regional Flood Frequency Estimation



RESULTS FROM ARR RFFE 2015 MODEL

Datetime: 2019-05-23 22:10

Region name: East Coast

Region code: 1

Site name: Moss Vale North - Discharge Point East

Latitude at catchment outlet (degree) = -34.828

Longitude at catchment outlet (degree) = 150.597

Latitude at catchment centroid (degree) = -34.819

Longitude at catchment centroid (degree) = 150.584

Distance of the nearest gauged catchment in the database (km) = 15.79

Catchment area (sq km) = 4.43

Design rainfall intensity, 1 in 2 AEP and 6 hr duration (mm/h): 11.243018

Design rainfall intensity, 1 in 50 AEP and 6 hr duration (mm/h): 25.817716

Shape factor of the ungauged catchment: 0.74

ESTIMATED FLOOD QUANTILES:

AEP (%)	Expected quantiles (m ³ /s)	5% CL m ³ /s	95% CL m ³ /s
50	8.56	2.93	24.7
20	19.4	7.06	53.2
10	30.1	11.0	82.2
5	43.6	15.8	120
2	66.4	23.6	187
1	88.1	30.9	254

DATA FOR FITTING MULTI-NORMAL DISTRIBUTION FOR BUILDING CONFIDENCE LIMITS:

- 1 Mean (loge flow) = 2.165
- 2 St dev (loge flow) = 0.896
- 3 Skew (loge flow) = 0.091

Moments and correlations:

No	Most probable	Std dev	Correlation		
1	2.165	0.646	1.000		
2	0.896	0.162	-0.330	1.000	
3	0.091	0.027	0.170	-0.280	1.000

This is the end of output file.

Appendix B – WSUD Cost Benefit framework: medium to high density residential developments (Water By Design, 2010)



Alan Hoban



Shaun Leinster



Shaun Leinster

Example of bioretention systems in medium to high density residential development

LIKELY COSTS FOR TYPICAL DEVELOPMENTS		LIKELY BENEFITS FOR TYPICAL DEVELOPMENTS	
Major quantifiable costs (estimated)		Major quantifiable potential benefits (estimated)	
Acquisition (capital + design costs (Note: included in life cycle cost): \$350-\$1,200/lot (average = \$775/lot) \$29,680-\$46,180/ha (average = \$37,930/ha). Annual maintenance costs (Note: included in life cycle cost): \$3-\$40/lot (average = \$22/lot) \$260-\$520/ha (average = \$390/ha). Life cycle costs (acquisition + maintenance + renewal + decommission): \$345-\$1,670/lot (average = \$1,110/lot) \$40,135-\$71,720/ha (average = \$55,930/ha). Annualised life cycle costs (acquisition + maintenance + renewal + decommission): \$15-\$65/lot (average = \$45/lot) \$1,615-\$2,870/ha (average = \$2,240/ha).		Value of the reduction in TN loads in stormwater: The equivalent wastewater treatment cost to remove annual TN loads: \$2,470-\$5,930/ha/yr (average = \$4,200/ha/yr) 150%-205% of the annualised life cycle cost of the WSUD treatment train (average = 185%). Potentially avoided costs associated with downstream waterway rehabilitation and maintenance: \$8,000-\$60,000/ha (life cycle cost) of development (average = \$34,000/ha of development (value estimated using a low-density residential development case study)) 20%-85% of the life cycle cost of the WSUD treatment train (average = 60%). Potential increased property values (premium): Medium density: \$35,000-\$70,000/ha (average = \$52,500/ha) 120%-150% of the acquisition cost of the WSUD treatment train (average = 135%). High density: \$175,000-\$350,000/ha (average = \$262,500/ha) 480%-700% of the acquisition cost of the WSUD treatment train (average = 520%). Potential development costs that are avoided (applicable only on flat sites, i.e. <5%): \$36,000/ha 95% of the average capital cost of the WSUD treatment train.	
		Major unquantifiable potential benefits	
		Contribution to protecting the numerous values associated with healthy downstream waterways: - ecosystem services - recreational and commercial fishing - tourism - seafood industry - option, existence and bequest values. The monetary value of many of these unquantified benefits is very high (see Table 4.2), but the relationship between the application of WSUD in a catchment and the maintenance of these values in downstream waterways has not been quantified.	
Minor potential costs:		Minor potential benefits	
- Additional development assessment, compliance checking and enforcement costs associated with WSUD assets (relatively minor and reducing over time as WSUD becomes mainstream practice). - Potential increase in maintenance tasks for residents (for at source or streetscape WSUD). - Environmental costs associated with sourcing materials for the WSUD measures (e.g. biofiltration media).		- Increased rate of sales and amenity associated with developments with landscaped WSUD features, such as streetscape bioretention systems (see Lloyd et al., 2002). - Shading and urban cooling (potentially reducing energy consumption). - Some direct and indirect aspects of implementing WSUD will result in changes to the configuration of development that could enhance open space. - Education and research.	

Conclusions regarding the relative magnitude of likely costs and benefits:

Considering all the costs and all the potential benefits of applying WSUD to achieve the proposed stormwater management design objectives, it is concluded that the **benefits are likely to outweigh the costs for typical medium to high-density residential development in Queensland.**

The estimated acquisition costs of applying WSUD within medium- to high-density residential developments equate to an average cost of approximately \$775 per dwelling. This value is equivalent to 0.2% of a unit or townhouse worth \$350,000. This cost will usually be passed onto the homeowner, so it should not significantly impact the profitability of development.

The estimated annual maintenance costs are an average of \$22/year. Where councils undertake the maintenance of WSUD assets in public areas, this cost is likely to be passed onto homeowners via rates.

Considering just the quantifiable benefits, on average, the value of TN reduction is worth more than the total life cycle cost of WSUD measures. The potentially avoided waterway rehabilitation costs (expressed as life cycle cost) are worth around 67% of the life cycle cost of WSUD and the potential property premiums are worth around 90% of the acquisition cost of WSUD. Considering the quantifiable benefits in a lumped group, the *potential quantifiable benefits are likely to outweigh the costs.*

Draft Supporting Document 2: Landscape Specifications

Contents

1	Introduction	3
2	MVRN URA Landscape Principles.....	3
3	Major Entry Treatments	3
4	Streetscape Planting.....	5
4.1	Collector Road – Tier 1 & Tier 2	6
4.2	Local and Retail Streets.....	7
4.3	Access Street – Tier 1 & Tier 2.....	8
4.4	Riparian Street.....	9
4.5	Rear Laneway.....	9
5	Open Space and Riparian Corridor Networks.....	10
5.1	Riparian corridor and open space areas adjacent to and within the riparian corridor network.....	11
5.2	Large Parks	14
5.3	Small Parks.....	15
6	Village Centre	15
7	Furniture, Materials, Finishes and Colours	17
7.1	Furniture - Village Centre, Parks and Riparian Corridor Areas	18
7.2	Footpaths and Slabs.....	22
7.3	Public Art and Wayfinding/Interpretative Signage.....	24
8	References	24

Tables

Table 1: Primary and Secondary Gateway - Tree and Understory Plant List.....	4
Table 2: Recommended Tree Offset and Spacing.....	6
Table 3: Collector Road Tree and Understory Plant List.....	6
Table 4: Local and Retail Street Tree and Understory Plant List	7
Table 5: Access Street Tree Plant List.....	8
Table 6: Riparian Street Tree Plant List.....	9
Table 7: Rear Laneway Tree Plant List.....	10
Table 8: Riparian Planting List - Riverflat Eucalyptus Forest on Coastal Floodplains.....	12

Table 9: Riparian Planting List - Freshwater Wetlands on Coastal Floodplains.....	13
Table 10: Village Centre Tree Plant List	16
Table 11: Furniture Specifications	18
Table 12: Footpath and Slab Specifications.....	23

1 Introduction

The purpose of the Landscape Specifications is to guide the landscape outcomes of the Moss Vale Road North Urban Release Area (URA).

The Landscape Specifications encompass both hard and soft landscaping elements interspaced between residential development, public open space, a protected riparian corridor and a planted streetscape. A pedestrian and bicycle pathway network links these spaces which maximises connectivity and ambiance throughout the URA.

2 MVRN URA Landscape Principles

- A high quality landscape addresses the road network, riparian corridors, parks, open space, major entryways and Village Centre.
- A streetscape planting hierarchy expresses a strong visual identity, drawing from a planting palette including a dominant tree canopy, medium to small street trees and an attractive shrub understory for year-round appeal.
- Tree planting allows winter sun to reach ground level, provide summer shade and enable a high visibility for pedestrians, cyclists and motorists throughout the streetscape network and green corridor.
- Landscape design includes both a fine grain planting scheme interwoven with amenity trees to create a high-quality planting aesthetic. The planting shall be woven into an urban design palette addressing the major entry points, street network and village centre.
- A robust planting selection integrates into the riparian zones and edges of open space abutting rural zones by including endemic and indigenous native vegetation.
- Plant selection minimises maintenance and water requirements whilst being hardy, resistant to pest and disease and provide high aesthetic value.
- The design of all aspects aims for high quality aesthetic in context to the setting.
- Pathways, planting and infrastructure placement incorporates Safer by Design principles.

3 Major Entry Treatments

The Moss Vale Road North URA has two major entries known as:

- Moss Vale Road primary entry; and
- Moss Vale Road secondary entry (i.e., Bells Lane).

A selection of iconic rural trees are to be used at major entries, in conjunction with exotic and native species, to provide a strong visual identity at a suitable scale to reinforce the road/entry hierarchy (refer to **Table 1**).

The major entry treatment objectives are to:

- Ensure the planting scheme consists of dominant trees and understory plantings of native and exotic vegetation.
- Establish an appropriate scale of trees to road entrances.
- Deliver bold strong planting arrangements using plants with colour, perfume, foliage definition.
- Ensure road surface treatment and built hard landscape elements provide an appropriate statement announcing the entryway to the URA.
- Ensure pedestrian and cyclist linkages are reinforced by landscape with low planting.
- Ensure sight lines for pedestrians and motorists are factored into landscape design.

The Moss Vale Road primary entry is to consist of:

- An avenue of deciduous trees for a distance of approximately 100m from the Moss Vale Road intersection.
- An entry zone with poplars and paving treatments.

The Moss Vale Road secondary entry (i.e., Bells Lane) is to consist of:

- An avenue of native trees for a distance of approximately 350m from the Moss Vale Road intersection.
- Rural style fence to road corridor edge.
- An entry zone with paving treatments.

Table 1: Primary and Secondary Gateway - Tree and Understory Plant List

Botanic Name	Common Name	Height *	Width*
Tree			
<i>Corymbia maculata</i>	Spotted Gum	30m	10-15m
<i>Crrymbia gummifera</i>	Red Bloodwood	20-25m	7-10m
<i>Syzygium smithii</i>	Lili Pily	12m	6m
<i>Ficus rubiginosa</i>	Port Jackson Fig	30m	30m
<i>Magnolia grandiflora</i>	Bull Bay Magnolia	25m	25m
<i>Acer platinoide</i> s	Crimson Sentry	7m	4m
<i>Acer freemanii</i>	Autumn Blaze	13m	10m
<i>Prunus cerasifera</i> 'Nigra'	Black Cherry Plum	5m	4m
<i>Populus simonii</i> 'Fastigiata'	Chinese Popular	8-12m	3m
<i>Pyrus</i> 'Aristocrat'	Aristocrat Pear	5-6m	3-4m
<i>Pyrus</i> 'Chanticleer'	Chanticleer Pear	11m	5-6m
<i>Fraxinus pennsylvanica</i> 'Urbanite'	Ash	15m	8m
Shrub/understory			
<i>Lomandra</i> 'Wingarra'	Lomandra	300mm	300mm
<i>Lomandra</i> 'Variegata Tanika'	Lomandra	600mm	650mm
<i>Lomandra</i> 'Frilly Lace'	Lomandra	450mm	450mm
<i>Lomandra</i> 'Tanika'	Lomandra	500mm	650mm

<i>Grevillea</i> 'Poorinda Royal Mantle'	Grevillea	250mm	3m
<i>Doryanthes excelsa</i>	Gynea Lily	3-4m	1.2-2.5m
<i>Cordyline australis</i> 'Red Star'	Cabbage Tree	1-5m	500mm
<i>Cordyline australis</i> 'Pink Passion'	Cabbage Tree	1-5m	500mm
<i>Convolvulus cneorum</i>	Silverbush	400mm	400mm
<i>Russelia equisetiformis</i>	Firecracker Plant	1m	1.5m
<i>Abelia grandiflora</i> 'Gold Dwarf'	Abelia	1m	1m
<i>Abelia grandiflora</i> 'Kaleidoscope'	Abelia	1m	1m
<i>Hebe elliptica</i>	Veronica	1m	500mm
* Plant growth habits may vary due to local site, soil and ecological conditions.			

4 Streetscape Planting

The Moss Vale Road North URA internal road network includes the following road typologies:

- Collector Roads – Tier 1 & Tier 2.
- Local and Retail Streets.
- Access Streets – Tier 1 & 2.
- Riparian Street.
- Rear Laneway.

The overarching streetscape planting objectives are to:

- Minimise maintenance, horticultural care and water use through suitable plant selections throughout the URA.
- Provide a green canopy linking streetscapes and open space throughout the URA.
- Provide a landscape which assists in safe wayfinding and informal surveillance throughout the built area.
- Provide canopy shade and protection to pedestrian and recreational areas from hot westerly sun in the hotter months of the year and consider heat island effect in paved and urban zones.
- Maximise solar access and gain to residential dwellings through careful positioning of dominant trees.
- Provide tree management systems to protect underground infrastructure within the verge of streets.
- Utilise permeable surfacing where possible.
- Retain the existing native trees and vegetation throughout the riparian corridor and open space areas.
- Ensure understory planting and landscape treatments at ground level provide clear definition between differing zones within the URA.

Table 2: Recommended Tree Offset and Spacing

Tree Size	Recommended Spacing	Consider
Small tree = 6m high x 4m wide	5m – 7m	5m offset from light posts, driveways, planted streets and carriageways.
Medium tree = 10m high x 6m wide	7m – 10m	
Large tree = 15-20m high x 8-10m wide	10-20m	

4.1 Collector Road – Tier 1 & Tier 2

The Collector Road objectives are to:

- Reinforce the rural character of the collector roads with cultural markers such as significant tree planting and broad use of ground covers and shrubby drifts.
- Provide interconnecting pedestrian and cycle links between the neighbourhood nodes and the village centre.
- Consider position for future bus shelters.

Table 3: Collector Road Tree and Understory Plant List

Botanic Name	Common Name	Height *	Width*
Tree			
<i>Tristania laurina</i> 'Luscious'	Watergum	4-8m	4m
<i>Brachychiton acerifolius</i>	Illawarra Flame	12m	6m
<i>Lophostemon confertus</i>	Queensland Brushbox	15m	10m
<i>Melaleuca stypheloides</i>	Prickly Paperbark	10-15m	8m
<i>Elaeocarpus eumundii</i>	Quandong	10m	5m
<i>Cupaniopsis anarcardioides</i>	Tuckeroo	6-8m	6m
<i>Acer freemanii</i> 'Jeffsred'	Freeman Maple	13m	10m
<i>Magnolia</i> 'Exmouth'	Magnolia	12m	8m
<i>Magnolia</i> 'Little Gem'	Magnolia	6m	3m
<i>Zelkova serrata</i>	Japanese Zelkova	14m	10m
<i>Ginkgo biloba</i>	Maidenhair Tree	12m	6m
<i>Backhousia citriodora</i>	Lemon Myrtle	8m	2-3m
<i>Eleocarpus eumundi</i>	Quandong	10m	3.5m
<i>Eucalyptus microcorys</i>	Tallow wood	35-40m	25m
<i>Lophostemon confertus</i>	Queensland Brushbox	15m	10m
<i>Tristania laurina</i> 'Luscious'	Watergum	8m	4m
<i>Ulmus parvifolia</i> 'Todd'	Chinese Elm	10-18m	15-20m
<i>Lagerstroemia indica</i> 'Natchez'	Crepe Myrtle	4-6m	6m
<i>Lagerstroemia indica</i> 'Lipan'	Crepe Myrtle	4-6m	4m
<i>Lagerstroemia indica</i> 'Tuscarora'	Crepe Myrtle	8m	4m
Shrub/understory			
<i>Correa pulchella</i> 'Fire Bells'	Correa	250mm	800mm
<i>Westringia fruticosa</i> 'Low Horizon'	Westringia	300mm	700mm

<i>Grevillea</i> 'Gold Cluster'	Grevillea	300mm	800mm
<i>Grevillea hybrid</i> 'Flat Az'	Grevillea	200mm	2-3m
<i>Rhagodia spinescens</i> 'Aussi Flat Bush'	Rhagodia	400mm	1m
<i>Casuarina glauca</i> 'Cousin It'	Casuarina	150mm	1.5m
<i>Dianella</i> 'Emerald Arch'	Dianella	550mm	450mm
<i>Loropetalum chinensis</i> 'Plum Delight'	Chinese Fringe Flower	1.5m	1.5m
<i>Alternanthera</i> 'Little Ruby'	Alternanthera	400mm	800mm
<i>Rosmarinus officinalis</i> 'Tuscan Blue'	Rosemary	1m	800mm
<i>Raphiolepis</i> 'Cosmic Pink'	Indian Hawthorn	500-800mm	800mm
* Plant growth habits may vary due to local site, soil and ecological conditions.			

4.2 Local and Retail Streets

A selection of trees and understory plants is to be used to line the main streets in the town centre and provide a lead into adjoining open space areas and local streets.

The Local and Retail Street objectives are to:

- Protect kerbside infrastructure by deflecting roots with root management systems.
- Provide shade and protection from hot westerly sun and position trees to allow for solar access and street lighting.
- Ensure planting provides year-round interest, summer shade and allows winter sun through to ground cover and lawn areas.
- Ensure that planting is part of the overall setting of lawn and paved areas, furniture groupings, paving and public art.

Table 4: Local and Retail Street Tree and Understory Plant List

Botanic Name	Common Name	Height *	Width*
Tree			
<i>Elaeocarpus eumundii</i>	Quandong	10m	5m
<i>Syzygium leuhmanni</i>	Riberry	7m	3m
<i>Buckinghamia celsissima</i>	Ivory Curl Tree	10m	3m
<i>Lagerstroemia indica</i> 'Tuscarora';	Crepe Myrtle	8m	4m
<i>Zelkova serrata</i>	Japanese Zelkova	14m	10m
<i>Fraxinus pennsylvanica</i> 'Cimmaron'	Cimmaron Ash	13m	8m
<i>Fraxinus pennsylvanica</i> 'Urbanite'	Ash	15m	8m
<i>Parrotia persica</i> 'Venessa'	Persian Ironwood	7m	5m
<i>Eucalyptus microcorys</i>	Tallow wood	35-40m	25m
<i>Magnolia</i> 'Exmouth'	Magnolia	12m	8m
<i>Magnolia</i> 'Little Gem'	Magnolia	6m	3m
<i>Zelkova serrata</i>	Japanese Zelkova	14m	10m
<i>Ginkgo biloba</i>	Maidenhair Tree	12m	6m
<i>Backhousia citriodora</i>	Lemon Myrtle	8m	2-3m

<i>Lophostemon confertus</i>	Queensland Brushbox	15m	10m
<i>Tristania laurina</i> 'Luscious'	Watergum	8m	4m
<i>Ulmus parviafolia</i> 'Todd'	Chinese Elm	10-18m	15-20m
<i>Lagerstroemia indica</i> 'Natchez'	Crepe Myrtle	4-6m	6m
<i>Lagerstroemia indica</i> 'Lipan'	Crepe Myrtle	4-6m	4m
<i>Lagerstroemia indica</i> 'Tuscarora';	Crepe Myrtle	8m	4m
<i>Corymbia citriodora</i>	Lemon Scented Gum	20-30m	12m
<i>Eucalyptus eugenoides</i>	Thin Leafed Stringybark	30m	18m
<i>Eucalyptus saligna</i>	Sydney Blue Gum	30m	12m
<i>Eucalyptus tereticornis</i>	Forest Red Gum	45m	20m
<i>Corymbia citriodora</i> 'Lemon Squash'	Dwarf Lemon Scented Gum	6m	4m
<i>Eucalyptus cladocalyx</i> 'Vintage Red'	Eucalyptus dwarf	6m	4m
Shrub/understory			
<i>Rhagodia spinescens</i> 'Aussie Flat Bush'	Rhagodia	500mm	1m
<i>Westringia fruticosa</i> 'Mundi'	Coastal Rosemary	500mm	1.5m
<i>Lomandra</i> 'Frilly Lace'	Lomandra	450mm	450mm
<i>Lomandra</i> 'Tanika'	Lomandra	500mm	650mm
<i>Lomandra longifolia</i> 'Lime Jet'	Lomandra	800mm-1m	800mm-1m
<i>Callistemon viminalis</i> 'Better John'	Callistemon	600mm	600mm
<i>Liriope muscari</i> 'Amethyst'	Liriope	400mm	400mm
* Plant growth habits may vary due to local site, soil and ecological conditions.			

4.3 Access Street – Tier 1 & Tier 2

The Access Street objectives are to:

- Provide shade and protection from hot westerly sun and position trees to allow for solar access and street lighting.
- Ensure planting provides year-round interest, summer shade and allows winter sun through to ground cover and lawn areas.

Table 5: Access Street Tree Plant List

Botanic Name	Common Name	Height *	Width*
Tree			
<i>Syzygium leuhmanni</i>	Riberry	7m	3m
<i>Buckinghamia celsissima</i>	Ivory Curl Tree	10m	3m
<i>Lagerstroemia indica</i> 'Tuscarora';	Crepe Myrtle	8m	4m
<i>Parrotia persica</i> 'Venessa'	Persian Ironwood	7m	5m
<i>Magnolia</i> 'Exmouth'	Magnolia	12m	8m
<i>Magnolia</i> 'Little Gem'	Magnolia	6m	3m
<i>Backhousia citriodora</i>	Lemon Myrtle	8m	2-3m

<i>Lophostemon confertus</i>	Queensland Brushbox	15m	10m
<i>Tristania laurina</i> 'Luscious'	Watergum	8m	4m
<i>Lagerstroemia indica</i> 'Natchez'	Crepe Myrtle	4-6m	6m
<i>Lagerstroemia indica</i> 'Lipan'	Crepe Myrtle	4-6m	4m
<i>Lagerstroemia indica</i> 'Tuscarora';	Crepe Myrtle	8m	4m
* Plant growth habits may vary due to local site, soil and ecological conditions.			

4.4 Riparian Street

The Riparian Street objectives are to:

- Incorporate a selection of Australian native trees and shrubs to reinforce the remaining natural character of the local area.
- Retain and enhance native tree canopy and existing natural riparian vegetation.
- Ensure drainage and landscape treatment relates to the riparian corridor in a natural and sustainable way.
- Ensure that recreational corridors and pathways along the riparian edge have good sight lines for pedestrians, cyclists and motorists.

Table 6: Riparian Street Tree Plant List

Botanic Name	Common Name	Height *	Width*
Tree			
<i>Tristania laurina</i> 'Luscious'	Watergum	8m	4m
<i>Waterhousia floribunda</i> 'Green Avenue'	Lili Pily	8m	5m
<i>Elaeocarpus reticulatus</i> 'Prima Donna'	Blueberry Ash	10-15m	5-7m
<i>Glochidion fernandii</i>	Cheese Tree	5-7m	3-5m
<i>Cupaniopsis anacardioides</i>	Tuckeroo	10m	5m
<i>Syzygium leuhmanni</i>	Riberry	7m	3m
<i>Melaleuca styphelioides</i>	Prickley Leaved Paperbark	20m	5m
<i>Melaleuca decora</i>	White Feather Honey Myrtle	10m	8m
* Plant growth habits may vary due to local site, soil and ecological conditions.			

4.5 Rear Laneway

The Rear Laneway objectives are to:

- Ensure pedestrian sight lines are not negatively impacted by vegetation planting.
- Consider the location of services to avoid conflict within the service corridor.
- Landscape to provide shade and to soften the hard surfaces and reflectivity of building materials and hardstand.

- Ensure turfed areas play a role in stormwater management by assisting in slowing surface run off.

Table 7: Rear Laneway Tree Plant List

Botanic Name	Common Name	Height *	Width*
Tree			
<i>Tristania laurina</i> 'Luscious'	Watergum	8m	4m
<i>Waterhousia floribunda</i> 'Green Avenue'	Lili Pily	8m	5m
<i>Elaeocarpus reticulatus</i> 'Prima Donna'	Blueberry Ash	10-15m	5-7m
<i>Prunus cerasifera</i> 'Oakville Crimson Spire'	Prunus	6m	2m
<i>Pyrus calleryana</i> 'Capital'	Pyrus	11m	3m
<i>Quercus palustris</i> 'PrinGreen'	Oak	14m	3m
<i>Pyrus</i> 'Capital'	Ornamental Pear	10m	1-3m
<i>Acer</i> 'Scarlet Sentinel'	Ornamental Maple	11m	5m
<i>Prunus cerasifera</i> 'Oakville Crimson Spire'	Ornamental Plum	6m	2m
<i>Ginkgo biloba</i> 'Lemonlime Spire'	Maidenhair Tree	5m	1m
<i>Banksia integrifolia fastigiata</i> 'Sentinel'	Banksia cultivar	2.5m	1m
<i>Syzygium australe</i> 'Straight & Narrow' TM	Lilly Pilly cultivar	5m	1-1.5m
<i>Callistemon viminalis</i> 'Slim' TM	Bottle brush cultivar	3m	1.5m
<i>Elaeocarpus reticulatus</i>	Blueberry Ash	9m	4m
Shrub/understory			
Kikuyu – net free	Lawn cover	40mm	4mm stem diameter
<i>Alternanthera</i> 'Little Ruby'	Cultivar	300mm	500mm
<i>Grevillea juniperina</i> 'Gold Cluster'	Grevillea cultivar	300mm	800mm
<i>Westringia fruticosa</i> 'Low Horizon'	Westringia cultivar	300mm	700mm
<i>Callistemon viminalis</i> 'Better John' TM	Callistemon cultivar	600mm	600mm
* Plant growth habits may vary due to local site, soil and ecological conditions.			

5 Open Space and Riparian Corridor Networks

The Moss Vale Road North URA open space and riparian network consists of the following main elements:

- Riparian corridors and open space areas adjacent to and within the riparian corridor network, including the pond.
- Large and small parks.
- Active open space area (sports field).

Technology focused recreation, youth facilities, waterplay and children's nature play are integral to the open space parklands. Playgrounds located in local parks shall vary in style in accordance with the space and setting.

The informal more natural style of wild play or nature play will sit well adjacent to the riparian corridor and rural edge whereas the constructed playgrounds with climbing nets, directed physical play are more suitable when located close to the urban centre.

5.1 Riparian corridor and open space areas adjacent to and within the riparian corridor network

The existing natural bushland within the riparian corridor network is to be improved and upgraded. The linear edges offer opportunities for bushland regeneration and recreational activities in a natural setting and should include cycleways, pathways and landscaping with water retention ponds, large boulders, viewing platforms and picnic facilities.

The remnant bushland set aside for parkland must meet the demands of a growing population within the URA and surrounding area whilst ensuring the biodiversity and ecosystem of the bushland remains viable and intact.

Bushland regeneration and urban weed control are to form part of the overall URA maintenance program.

The objectives are to:

- Ensure the intersection of the constructed drainage and the existing riparian corridor drainage system appears natural, includes natural style drainage channels, is functional and appealing for recreational activities and retains existing high value native vegetation.
- Ensure wetlands and ponds are located and designed to be sympathetic to the local environment and setting using materials that typically express the local aesthetic and appear as 'natural' as possible.
- Retain and enhance the existing ecosystem through preservation of land and vegetation in areas deemed to have primary conservation significance, native vegetation planting and bush regeneration, with follow up weed control and planting in subsequent seasons.
- Provide a vegetation buffer (tree and ground cover) to both sides of sloping riparian channels to assist in bank stabilisation as well as the provision of rock lined pockets to both sides of riparian channel.
- Facilitate people movement alongside and through the riparian corridor by including bridges, shared cycleways and pathways using a range of environmentally sustainable materials with long lifespan.
- Include decks and pontoons over wetlands near still and moving water and cater for people of all abilities and ages, using recycled and sustainable materials.
- Provide recreational spaces along and adjoining the riparian corridor, appropriately distanced for comfort and interest of users.
- Provide a relationship between the natural and built environment through the inclusion of BBQ's, picnic shelters and settings, play space, fitness equipment, viewing platforms and casual seating in the landscaped setting.
- Consider the location and inclusion of interpretive and wayfinding signage.

Draft Chapter NB4: Moss Vale Road North Urban Release Area**Draft Supporting Document 2: Landscape Specifications**

- Consider Safer by Design including lighting, landscape, sight lines and location of pathways from formal and informal surveillance.
- Vehicular crossings and pathways to be at appropriate grades with any disturbance revegetated.

Table 8 and **Table 9** presents a planting palette for the riparian corridors and open space areas adjacent to and within the riparian corridor network, specific to the following communities identified in Chapter NB4 Supporting Document 3: Vegetation Management Plan Requirements:

- Riverflat Eucalyptus Forest on Coastal Floodplains.
- Freshwater Wetlands on Coastal Floodplains.

Table 8: Riparian Planting List - Riverflat Eucalyptus Forest on Coastal Floodplains

Botanic Name	Common Name	Height *	Width*
Tree			
Acacia floribunda	White sally	5-10m	3-5m
Acacia parramattensis	Parramatta wattle	2.5m	2m
Angophora floribunda	Rough barked apple	10-20m	10m
Backhousia myrtifolia	grey myrtle	8m	3m
Casuarina cunninghamiana subsp. cunninghamiana	River Oak	10m	6m
Casuarina glauca	Swamp oak	8-20m	4m
Eucalyptus amplifolia	Cabbage gum	30m	10m
Eucalyptus botryoides	Bangalay	10-40m	8-12m
Eucalyptus elata	river peppermint	20-30m	8m
Eucalyptus grandis	Flooded gum	20-50m	12-15m
Eucalyptus longifolia	Woollybutt	35m	8m
Eucalyptus ovata	Swamp gum	30m	8m
Eucalyptus saligna	Sydney blue gum	20-50m	10m
Eucalyptus tereticornis	Forest red gum	30-50m	15-20m
Eucalyptus viminalis	Ribbon gum	50m	12m
Livingstonia australis	Cabbage tree palm	25m	8m
Maelaleuca linearifolia	Snow in summer	5-8m	5m
Maelaleuca styphelioides	Prickly teatree	10-20m	7m
Melaleuca decora	Paperbark	7m	4m
Melia azedarach	White cedar	6-20m	10m
Syzygium smithii	Lillypilly	5m	3m
Tristaniopsis laurina	River gum	10m	5m
Shrub/understorey			
Breynia oblongifolia	Coffee bush	3m+	1-2m
Lomandra longifolia	Matt rush	1.2m	1m
Erchinopogan ovatus		1.2m	3-5m

Draft Chapter NB4: Moss Vale Road North Urban Release Area**Draft Supporting Document 2: Landscape Specifications**

Commelina cyanea	Scurvy weed	200mm	1m
Microlena stipoides var stipoides	Weeping grass	70mm	30mm
Hymenanthera dentata	tree violet	2-5m	6m
Imperata cylindrica var major	Blady grass	50mm	50mm
Geranium solanderi	Native geranium	40mm	60mm
Dichondra repens	Kidney weed	20mm	1m
Lomandra filiformis	small lomandra	30mm	30mm
Solanum priniphyllum	Forest nightshade	500mm	500mm
Bursaria spinosa	blackthorn	5-10m	2-4m
Viola hederacea	Native violet	100mm	100mm
Trema aspera	Native peach	3m	2-3m
Rubus parviflorus	Native raspberry	2m	3-4m
Themeda triandra	Kangaroo grass	1-1.2m	40mm tuft
Pteridium esculentum	Bracken fern	1m	50mm
Plectranthus parviflorus	Plectranthus	40mm	50mm
Climbers/Twiners			
Clematis aristata	Old mans beard	3m+	1-5m
Clematis glycinoides	Old mans beard	3m+	1-2m
Hardenbergia violacea	native sasparrilla	2.5m	3m
Estrephus latifolius	Wombat berry	3m+	1m
Glycine mmicrophylla	Love creeper	500mm	2m
Stephonia japonica	Snake vine	2m	3m+
Pandorea pandorana	Wonga vine	20m+	3-5m
<i>* Plant growth habits may vary due to local site, soil and ecological conditions.</i>			

Table 9: Riparian Planting List - Freshwater Wetlands on Coastal Floodplains

Botanic Name	Common Name	Height *	Width*
Grasses			
Hemarthria uncinata	matgrass	1m	2m
Paspalum vaginatum	Wetland couch	500mm	5m
Paspalum distichum	Water couch	500mm	2m
Pseudoraphis spinescens	Spiny mud-grass	1m	1m
Herbs			
Eclipta platyglossa	Yellow twinheads	250mm	40mm
Eclipta prostrata	White eclipta	250mm	50mm
Gratiola pedunculata	Stalked brooklime	20-50mm	50mm
Ludwigia peploidea subsp montevidensis	Water primrose	50mm	200mm
Myriophyllum latifolium	Water milfoil	30mm	10mm
Persicaria attenuata	Smartweed	0.5-1m	2m
Persicaria decipiens	Slender knotweed	0.5-1m	2m
Persicaria hydropiper	Water pepper	0.5-1m	2m
Persicaria lapathifolia	Pale knotweed	0.5-1m	2m
Renunculus inundatus	River buttercup	50mm	800mm

Reeds			
Phragmites australis	Common reed	1-4m	10mm dia
Typha orientalis	Broad leaf cumbungi	1-4m	20mm dia
Sedges and Rushes			
Baumea articulata	Jointed twig-rush	1m	2mm dia
Baumea rubiginosa	Twig-rush	1m	2mm dia
Bolboschoenus caldwellii	Club-rush	1m	3mm dia
Bolboschoenus fluviatilis	Marsh club-rush	1m	3mm dia
Carex appressa	Tall sedge	80mm	50mm tuft
Cyperus lucidus	Leafy flat sedge	50mm	3mm dia
Eleocharis acuta	Common spike sedge	600mm	40mm tuft
Juncus usitatus	Common rush	1.5m	3mm dia
* Plant growth habits may vary due to local site, soil and ecological conditions.			

5.2 Large Parks

Within the URA, two large parks are required; one near the Village Centre (including a 3-4 hectare active and passive open space area, refer to Section 10 of DCP Chapter NB4) and one adjacent to the riparian corridor in the north of the release area.

The large park objectives are to:

- Ensure good sight lines and opportunities for passive surveillance from nearby picnic facilities and pathways/cycleways.
- Allow for increased connectivity via WIFI inclusions into smart furniture or play equipment.
- Provide intergenerational activities including early childhood play, teenage activities and outdoor fitness.
- Provide overhead and up lighting for night-time events in addition to power outlets and Three-Phase power for performance spaces.
- Ensure pathway connections link neighbouring streetscapes with activity zones.
- Ensure excellent walking and cycling connections from the large parks throughout the URA and to the Village Centre.
- Provide of picnic furniture under shelter, seating, BBQ's, bubbler and water refilling station with easy and compliant access for all.
- Provide quality amenities to the park near the Village Centre (e.g. parking, spectator areas, clubhouse storage room, amenities, children's playground facilities).

Refer to **Table 8** for appropriate planting palettes. Refer to the furniture palette at **Section 7**.

5.3 Small Parks

Four smaller parks (0.5 hectares) also required within the residential areas. These parks offer the opportunity to present differing characteristics which enhance the overall area with a close relationship to the local neighbourhood, family and intergenerational activities.

The small park objectives are to:

- Provide parks which present unique and differing play opportunities for all ages.
- Provide a play equipment selection to reflect all abilities and provide challenge to the users.
- Integrate outdoor exercise circuits within outdoor activity zones.
- Provide circuitous pathways surrounding playgrounds and linking with external cycleways.
- Provide picnic shade facilities and furniture including BBQ's in certain small parks which have sufficient space, carparking, good sight lines and incentives to linger longer in the park such as play or exercise equipment or interesting natural landscape.
- Provide shade trees in landscaped areas which provide a buffer against strong winds and sun exposure.
- Group trees and shrubs in garden beds to reduce maintenance and watering yet provide maximum enhancement to the park.

Refer to **Table 8** for appropriate planting palettes. Refer to the furniture palette at **Section 7**.

6 Village Centre

The Village Centre is an active zone catering to pedestrians, cyclists and vehicles within and around the commercial zone. The parallel on street car parking and centralised parking court provides formal parking within the centre.

It is intended that the built and landscaped spaces within the Village Centre are linked to adjoining open space networks through tree lined streets and pathways. The planting schedule provides a selection of exotic and native trees which help to reinforce these green linkages within and adjacent to the built environment. The provision of generous tree planting also provides comfort and amenity and also will soften areas of hard stand.

The Village Centre objectives are to:

- Provide an outdoor area where quality comfortable furniture, sculpture, paved surfaces and lighting are united by a cohesive planting palette within an urban setting which is slightly different to the recreational areas.
- Integrate retail, commercial, civic functions into a landscaped environment.
- Provide accessibility for all with smooth level transitions on areas of hard stand and pavement which conform to Australian Standards.

Draft Chapter NB4: Moss Vale Road North Urban Release Area**Draft Supporting Document 2: Landscape Specifications**

- Optimise spatial arrangement between hard and soft landscaping and infrastructure allowing people to move around comfortably.
- Provide winter sun and summer shade with specimen tree planting and garden bed niches of semi enclosed areas of shelter.
- Provide a semi formal outdoor space to deliver a hub where the community can participate in a variety of activities.
- Integrate public art, wayfinding and interpretive signage connecting urban and rural areas.
- Provide a communication hub bringing WiFi into the village centre.

Refer to **Table 4** and **Table 10** for appropriate planting palettes. Refer to the furniture palette at **Section 7**.

Table 10: Village Centre Tree Plant List

Botanic Name	Common Name	Height *	Width*
Tree			
<i>Fraxinus</i> 'Cimmaron'	Cimmaron Ash	13m	8m
<i>Fraxinus</i> 'Urbanite'	Urbanite Ash	11m	8m
<i>Lagerstroemia indica</i> 'Natchez'	Indian Summer Variety	6m	4m
<i>Lagerstroemia indica</i> 'Lipan'	Indian Summer Variety	6m	
Shrub/understorey			
<i>Abelia x grandiflora</i>	Abelia	1.5m	1m
<i>Casuarina glauca</i> 'Cousin It'	Casuarina	150mm	1.5m
<i>Convolvulus cneorum</i>	Silverbush	400mm	400mm
<i>Cordyline australis</i>	Cabbage Tree	1-5m	500mm
<i>Cordyline stricta</i>	Narrow-leaved Palm Lily	1m (to flower)	600mm
<i>Cordyline terminalis</i>	Ti Plant	1m	1m
<i>Correa alba</i>	White Correa	1.5m	1.5m
<i>Cyathea australis</i>	Australian Tree Fern	2-4m	2-4m
<i>Dicksonia antarctica</i>	Soft Tree Fern	3m	2m
<i>Dodonaea viscosa</i>	Purple Hop Bush	3m	1.5m
<i>Dodonaea triquetra</i>	Common Hop Bush	1-2m	1-3m
<i>Doryanthes excelsa</i>	Gynea Lily	3-4m	1.2-2.5m
<i>Indigophera australis</i>	Austral Indigo	2m	2m
<i>Lavandula stoechas</i>	Lavender	300-450mm	450-600mm
<i>Michelia figo</i>	Port Wine Magnolia	3m	2-3m
<i>Murraya paniculata</i>	Murraya Hedge	4m	3m
<i>Nandina domestica</i> 'Flirt'	Sacred Bamboo	300-400mm	400-500mm
<i>Rosmarinus officinalis</i>	Rosemary	1.8m	1.5m
<i>Russelia equisetiformis</i>	Coral Plant	1.8m	600mm
<i>Strelitzia juncea</i>	Leafless Bird of Paradise	2m	1m
<i>Westringia</i> 'Zena'	Native Rosemary	0.9m	0.9m

<i>Westringia</i> 'Smokey'	Coastal Rosemary	1.2m	1.5m
<i>Westringia</i> 'Wynjabbie Gem'	Coastal Rosemary	2m	2m
Climbers/Twiners			
<i>Parthenocissus tricuspidata</i>	Boston Ivy	4m+	3m
<i>Rosa sp</i>	Rose	3m+	3m+
<i>Trachelospermum jasminoides</i>	Star Jasmine	3m+	3m
<i>Pandora pandorana</i>	Snow Bells	20m+	2m
Grasses/Ground Covers			
<i>Ajuga reptans</i>	Carpet Bugle	350mm	600mm
<i>Alternanthera</i> 'Little Ruby'	Alternanthera Note: not to be planted from autumn through winter.	400mm	800mm
<i>Banksia spinulosa</i> 'Birthday Candles'	Hairpin Banksia	3m	2m
<i>Brachyscome multifida</i>	Break of Day	0.5m	1m
<i>Grevillea</i> 'Bronze Rambler'	Grevillea Bronze Rambler	0.3m	4.5m
<i>Westringia</i> 'Low Horizon'	<i>Westringia</i> 'Low Horizon'	300mm	700mm
<i>Westringia</i> 'Mundi'	<i>Westringia</i> 'Mundi'	500mm	1.5m
<i>Myoporum parvifolium</i>	Boobialla	300mm	3m
<i>Nandina domestica</i> 'Gulf Stream'	Heavenly Bamboo	750mm	750mm
<i>Nandina domestica</i> 'Flirt'	Sacred Bamboo	300-400mm	400-500mm
<i>Scaevola aemula</i>	Aussie Crawl	600mm	1m
<i>Liriope muscari</i>	Evergreen Giant	500mm	500mm
* Plant growth habits may vary due to local site, soil and ecological conditions.			

7 Furniture, Materials, Finishes and Colours

The following materials, finishes and colours seek to promote Moss Vale Road North URA as a desirable and attractive place to live and work.

The colour difference selected for the street and park furniture subtly reinforces the dynamic between the less formal parklands which stretch outside the urban and civic centre of the URA.

The furniture palette is comprised of one suite of furniture suitable for use throughout the entire URA. The furniture has been selected for the following qualities: sustainable, replaceable in the event of damage or wear and tear, long safe useful lifespan, comfort, contemporary and aesthetic appeal for the streetscape, urban precincts and recreational zones.

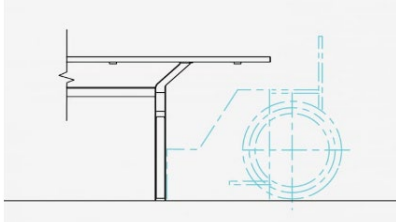
The Street Furniture Australia Pty Ltd Aria range includes various furniture types which can be combined into settings or for standalone use. Furniture types include benches without armrests, seats with armrests, picnic tables, lookout tables, a bubbler, bin enclosure and bollards.

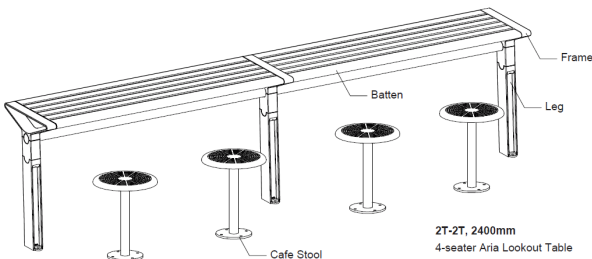
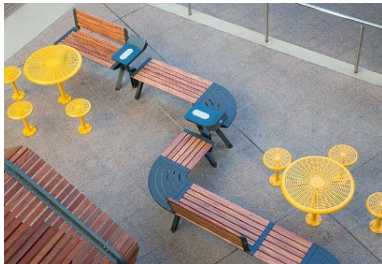
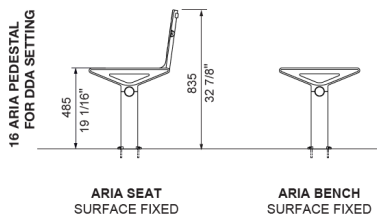
The furniture general requirements include:

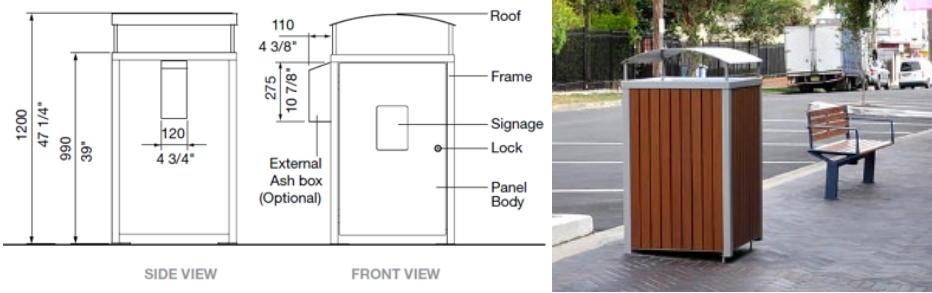
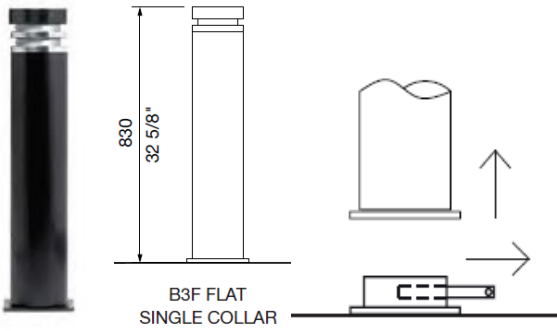
- All furniture, picnic facilities, bubblers to be compliant with Disability Discrimination Act (DDA) and Australian Standard specifications.
- All individual seats shall include arm rests and backs for comfort and DDA compliance.
- All furniture and picnic shelters are to surface mounted on hard stand (in accordance with manufacturer requirements) which links to adjoining pathways, cycleways and shared user paths.
- Seating is to be located throughout the URA in the Village Centre, parks, riparian corridor, in playgrounds and along the pathways which link these parks together in areas throughout the URA.
- Furniture is to be configured to provide group and private seating opportunities in the Village Centre, local parks and urban centre.
- Bins are to have door openings to street, have adjustable feet, rubbish hood to top of bin with side opening shafts.
- Bollards are to be either surface mounted and non-removable or surface mounted and removable depending upon location and requirements for access. Bollards are to have reflector strips mounted.

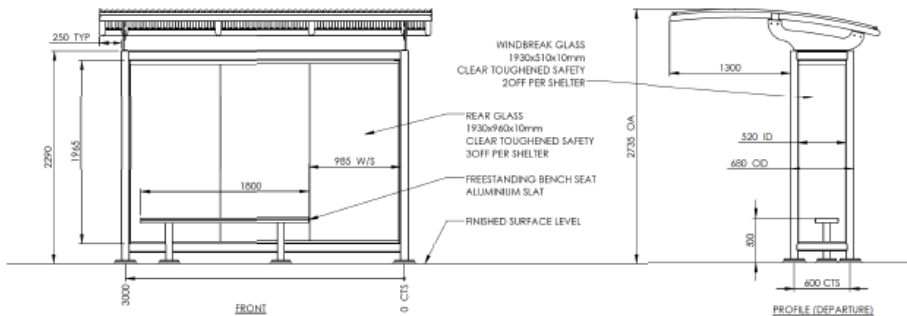
7.1 Furniture - Village Centre, Parks and Riparian Corridor Areas

Table 11: Furniture Specifications

Element	Specification and Principles
Picnic setting <i>Aria series by Street Furniture Australia Pty Ltd</i>	Setting to be any combination of table, bench, café stools as listed below: • DDA compliant picnic table: – Code CMA4. – Frame, top batons and baton end cap: Textura Monument (bottom left image). – Pedestal straight leg allowing for fixing surface mounted into concrete slab in accordance with manufacturer's recommendations. • Bench: – To be located as part of picnic setting as above, also in casual arrangement in village centre. – Code 3B. – Frame and front and back baton Textura Monument. – Seat batons and baton end caps Aluminum: ▪ Woodgrain Spotted Gum – Village Centre Core and Activation Precincts (bottom centre image) ▪ Woodgrain Beach Oak (Grey) – Parks (bottom right image) – Pedestal straight leg. – Armrests nil. – Fixing surface mounted into concrete slab in accordance with manufacturer's recommendations.  

	
Lookout Table and Café Stools <i>Aria series by Street Furniture Australia Pty Ltd</i>	<u>Urban area where casual dining opportunities exist</u> - Lookout Table: - CMA4-T. - DDA Compliant: 'Non-Standard' DDA compliant CMA Lookout table. - Fixing: Surface fixed. - Café Stools: - Code S1. - Frame colour selected from Street Furniture Australia standard colour palette. - Fixing surface mounted into concrete slab in accordance with manufacturer's recommendations.  
Seating and benches with arm rests <i>Aria series by Street Furniture Australia Pty Ltd</i>	- Seating with arm rests: - Code 3S. - Frame and armrests and top and bottom baton: Textura Monument. - Batons and baton end cap: - Woodgrain Spotted Gum – Village Centre Core and Activation Precincts. - Woodgrain Beach Oak (Grey) – Parks. - Pedestal: straight leg. - Fixing: surface mounted into concrete slab in accordance with manufacturer's recommendations. - Bench with armrests: - Code 3B. - Frame, armrests, front and back baton and corner frame (if used): Textura Monument. - Batons and baton end cap: - Woodgrain Spotted Gum – Village Centre Core and Activation Precincts. - Woodgrain Beach Oak (Grey) – Parks. - Pedestal: straight leg. - Fixing: surface mounted into concrete slab in accordance with manufacturer's recommendations.  
Dog Bubbler and Refill Pole	- Fully DDA compliant with stepper. Station certified under Water Mark Standard WMTS 105:2016. - Code: Aqua Dog Bubbler DF4 DB, Aqua Refill Pole DF7.

<i>Street Furniture Australia Pty Ltd</i>	- Fixtures and fittings: Marine Grade Steel fixtures and fittings. - Frame of bubbler and pole body: Textura Monument. - Fixing: surface mounted into concrete slab in accordance with manufacturer's recommendations. 
240lt Bin enclosure <i>Street Furniture Australia Pty Ltd</i>	• 240lt bin enclosure to suit 240lt Sulo®: - Code: WBE-nF240-BAT. - Frame: Textura Monument (Textured GL 329A). - Batons: Standard vertical baton with: ▪ Woodgrain Spotted Gum – Village Centre Core and Activation Precincts. ▪ Woodgrain Beach Oak (Grey) – Parks. - Module: single and double as required. - Fixing: surface mounted with adjustable feet placed on concrete slab. - Roof: angled Stainless Steel. - Door lock in accordance with Shoalhaven City Council requirements. 
Wide Bollard <i>Street Furniture Australia Pty Ltd</i>	• Wide bollard: various lengths to suit requirements: - Code: wide Flat Single Collar. - Pipe: powder coated Textura Monument (Textured GL 329A). - Head and collar finish: polished. - Fixing: surface fixed and removable surface fixed as required. 
Streetlamps <i>Schreder</i>	<u>Village Centre</u> • Luminaire: LED Piano by Schreder. • Pole: AS2700 Black Satin.

	• Installation in accordance with Manufacturer's Specifications. • Lighting to encourage night economy and events in safe and comfortable surrounds. • Lighting style to be in context with overall street furniture and material palette. 
Esplanade Bus Shelter <i>Stoddart</i>	• Frame colour: powder Coat Monument® Satin. • Module single with clear sides. • Fixing: Stainless Steel fixings, galvanized steel posts, surface mounted on concrete slab to manufacturer's recommendations. • Roof: angled Stainless Steel. • Seating: DDA compliant. • Powder coated aluminium, toughened glass. • Fixing: surface mounted.  
Modular Electric BBQ <i>Christies Pty Ltd</i>	• Stainless Steel cook top with low impact corners for all units. • Flat packed ready for assembly. • Single cook top with double bench cutout (bottom left image) - DDA Certified A Series: Code A 2E. • Double cook top with single shared bench cutout (bottom centre image): - Code E3.2. - Colour of panel (the colour panel is shown in green in bottom centre image): Aztec Silver (bottom right image). - Colour of door panel: Standard dark grey (as shown in bottom centre image).

	 Aztec Silver
Picnic Shelters <i>Landmark</i>	• Colorbond roofing colour: Ironstone ®. • Fixings: hot dipped gal turnbuckle bracing and galvanized steel brackets and fixings. • Mounting: bolt below slab. • Village Centre Core and Activation Precincts: Longreach Series hardwood frame with KoppersArch Tanacoat penetrative sealant (bottom left image). • Parks and riparian corridor area: Longreach Series hot dipped galvanised posts and frame (bottom right image).  
Permeable Paving to tree base <i>Stoneset Pty Ltd</i>	• 300mm diameter tree ring around base of tree. • Stoneset applied in accordance with manufacturer's specifications. • Colour of stones: tan (top left image).   

7.2 Footpaths and Slabs

Note: Quality control requirements for supply and batching of concrete oxide:

- Traceability from the specified oxide supplier to the batching plant in the form of invoice/delivery docket/batching documentation with quantities and materials as ordered and delivered. Documentation to be provided upon request.
- Request 'back to back' warranty and guarantee that the specified colour and quantity of mix in accordance with the manufacturer's recommendations are met along the supply, batching, delivery and installation of concrete oxide to site from original oxide and concrete suppliers.

Table 12: Footpath and Slab Specifications

Element	Specification and Principles
Concrete Path, Furniture and Picnic Slabs which occur on Retail Streets within Village Centre	• Pedestrian pathways to be designed in accordance with Engineering Specifications. • Sealed with penetrative non-slip sealant equivalent to Klen Tuscan Seal® • 125mm depth with SL72 reinforcement placed to centre of concrete slab 50mm depth from top/bottom surface of concrete. • 10mm thick Expansion Joint. • 10mm thick Isolation Joint adjacent between other built structure such as kerb and gutter, concrete pads, buildings. • Construction Joint. • Sawcut Joint. • 50mm minimum compacted metal base. • Minimum 98% compacted sub-base. • Concrete pathway with Oxide: - Lightly broomed - R10 non-slip resistance. - 32mPa concrete with full depth 'Colourmix' oxide Papyrus (image right) in accordance with Manufacturer's recommendations. 
Footpaths within road reserves on Local streets, Access Streets Tier 1 & Tier 2, Village Green, Riparian Corridor and Local Parks throughout Open Space	• Lightly broomed - R10 non-slip resistance. • Pedestrian pathways to be designed in accordance with Engineering Specifications. • Sealed with penetrative non-slip sealant equivalent to Klen Tuscan Seal®. • 125mm depth with SL72 reinforcement placed to centre of concrete slab 50mm depth from top/bottom surface of concrete. • 10mm thick Expansion Joint. • 10mm thick Isolation Joint adjacent between other built structure such as kerb and gutter, concrete pads, buildings. • Construction Joint. • Sawcut Joint. • 50mm minimum compacted metal base. • Minimum 98% compacted sub-base. • Concrete pathway 25mPa concrete.
Paver and Header for Village Centre	• Stradapave® 50 Exposed Aggregate or similar for paving in urban areas - 300mm x 300mm x 50mm Charcoal (bottom left image). • Trihex® 80 Exposed Aggregate Charcoal or similar for driveways, commercial centers where vehicles enter (bottom right image).

<i>Adbri Masonry</i>	
--------------------------	--

7.3 Public Art and Wayfinding/Interpretative Signage

Public art and wayfinding or interpretive signage are valuable inclusions into the urban and escarpment, rural heritage and creek lines. Inclusion of public art should reflect and reinterpret the surrounding natural environment, whilst the wayfinding signage should stand out and act as key marker for pedestrian and vehicular navigation around the URA.

8 References

Landscape Study: Moss Vale Road North Urban Release Area (URA) (Taylor Brammer Landscape Architects Pty Ltd, April 2019).

Moss Vale Road North Urban Release Area Traffic Study (Bitzios, July 2020).

Riparian Restoration Planning – Moss Vale Road North Urban Release Area (Ecological Australia, November 2020).

Shoalhaven Development Control Plan 2014, Chapter G17: Business, Commercial and Retail Activities.

Supporting Document 3

Riparian Restoration Planning – Moss Vale Road North Urban Release Area

Shoalhaven City Council

DOCUMENT TRACKING

Project Name	Riparian Restoration Planning – Moss Vale Road North Urban Release Area
Project Number	20HAR-16715
Project Manager	Max Massa
Prepared by	Max Massa
Reviewed by	Andrew Whitford/David Bonjer
Approved by	David Bonjer
Status	Final
Version Number	v3
Last saved on	8 February 2021

This report should be cited as 'Eco Logical Australia 2020. *Riparian Restoration Planning – Moss Vale Road North Urban Release Area* . Prepared for Shoalhaven City Council.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Molly Porter from Shoalhaven Council

Disclaimer

This document may only be used for the purpose for which it was commissioned and in accordance with the contract between Eco Logical Australia Pty Ltd and Shoalhaven Council. The scope of services was defined in consultation with Shoalhaven Council, by time and budgetary constraints imposed by the client, and the availability of reports and other data on the subject area. Changes to available information, legislation and schedules are made on an ongoing basis and readers should obtain up to date information. Eco Logical Australia Pty Ltd accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report and its supporting material by any third party. Information provided is not intended to be a substitute for site specific assessment or legal advice in relation to any matter. Unauthorised use of this report in any form is prohibited.

Template 2.8.1

Contents

1. Introduction	1
1.1 Background.....	1
2. Site description	3
2.1 Waterways and riparian corridors	3
2.2 Vegetation communities.....	4
2.3 Resilience potential	7
2.4 Management issues.....	7
2.4.1 Priority weeds	7
2.4.2 Pest animals	8
3. VMP Aims and objectives.....	9
3.1 Aims	9
3.2 Objectives	9
4. Action plan.....	10
4.1 Typical management zones	10
4.2 Site management principles for VMPs.....	12
4.2.1 Temporary construction fencing.....	12
4.2.2 Soil preparation	12
4.2.3 Pest control.....	12
4.2.4 Erosion and sediment control.....	12
4.2.5 Revegetation	13
4.2.6 Instream aquatic habitat enhancement	14
4.2.7 Assisted regeneration	15
4.3 Weed treatment	16
4.3.1 Weed control techniques	16
4.3.2 Management of weed waste	16
4.3.3 Herbicide use	16
4.4 Site maintenance	16
4.5 Performance criteria.....	17
4.6 Bush regeneration contractors	17
5. Monitoring, evaluation and reporting	18
5.1 Monitoring.....	18
5.1.1 Photo monitoring.....	18
5.1.2 Evaluation and reporting	18
References	20

Appendix A Revegetation and Cross-section for E2.....21

List of Figures

Figure 1 Site location.....	2
Figure 2 Vegetation communities and waterways.....	6
Figure 3 Resilience categories.....	11
Figure 4 Typical Cross section of final structure by year-5 in E2/VMP zone.....	23

List of Tables

Table 1 Key weed species and biosecurity duty.....	7
Table 2 VMP objectives	9
Table 3 Revegetation densities for vegetation communities	13
Table 4 Performance criteria.....	17
Table 5 Recommended revegetation species for corresponding zones shown in cross section	21

Abbreviations

Abbreviation	Description
DA	Development Application
ELA	Eco Logical Australia
SCC	Shoalhaven City Council
LLS	Local Land Services
MVRN URA	Moss Vale Road North Urban Release Area
VMP	Vegetation Management Plan

1. Introduction

1.1 Background

Eco Logical Australia (ELA) was engaged by Shoalhaven City Council (SCC) to provide advice on future planning and development controls in relation to revegetating and rehabilitating existing watercourses and associated riparian corridors (E2 lands) within the Moss Vale Road North Urban Release Area (MVRN URA). The location of MVRN URA is shown in Figure 1.

This report provides advice on suitable development controls for activities across the MVRN URA, specifically, that subdivisions in E2 lands carry a DA condition which requires the implementation of a 5-year Vegetation Management Plan (VMP).

As such this report provides the following guidelines:

- maps and descriptions of areas identified for riparian restoration
- descriptions of vegetation communities to be restored - Plant Community Types (PCTs) and Threatened Ecological Communities (TECs)
- cross section diagram showing by year-5 of the VMP, the structure of the vegetation communities / riparian zone
- minimum requirements for a riparian restoration / VMP, including:
 - planting species list
 - planting densities
 - fencing
 - weed and pest control
 - erosion control
 - performance criteria



Figure 1 Site location

2. Site description

The MVRN URA is located approximately six kilometres from the Shoalhaven City Council chambers (Figure 1). The site is bordered by Moss Vale Rd on its south, Princes Highway to the east, rural lands to the north-east, and Cambewarra Range Nature Reserve to the north-west. Access is via Moss Vale Rd onto Bell's Lane which crosses north to south, with Abernethy's Lane crossing the site east to west.

The MVRN URA was rezoned for residential development and environmental protection under the Shoalhaven Local Environmental Plan (SLEP) 2014.

The majority of the MVRN URA has been previously cleared for agricultural use. The site currently comprises large rural landholdings and smaller lifestyle allotments, generally with each containing a single dwelling plus farm and outbuildings. Cows, horses and alpaca were observed on a number of properties during the field survey.

2.1 Waterways and riparian corridors

Abernethy's Creek is the main watercourse on site, comprising a 3rd order stream, with the three tributaries (south-west, south-east and north-east) on site being 2nd order streams. Other 2nd order streams link off the study area to the north-west off Lot 1 DP1191186. Stream order classifications are mapped as per Figure 2.

The streambank width of Abernethy's Creek varies from two to three metres with steeply incised banks, to 10-30 m top of bank (eg: mid-section west of Bells Lane). The channel is generally well defined and often aggraded with sediment one to three metres deep and one to twenty metres wide. The latter where it braids into two channels around a small island near the existing dwelling on Lot 4 DP708356. There are deep and / or broad pools sporadically from near the north-west limits to its exit off-site, but these are most common from just below high energy section just upstream of the dwelling on Lot 1 DP1191186. Pools increase in depth and frequency within about 50 m west of Bells Lane, with several deep, small pools with tentative connection via a series of incised channels and localised scour pools (latter appear permanent due to depth). An in-stream dam with a pumping station provides the largest pool on Lot 4 DP708356.

The creek is ephemeral and subject to short-term high velocity flood flows. Water quality appears to be good with low to medium turbidity due to fine clay suspensions, but clarity is sufficient to allow diatomic algae, benthic algae and submerged aquatic plants to prosper within the pools from the mid-section down. The substrate varies from bedrock and gravel in the upper mid-section where it cuts a steep slope of the adjacent hill on Lot 1 DP1191186, to soil in the mid and lower reaches and the uppermost reaches.

The north-east tributary on Lot 7 DP618693 has very deeply incised banks along most of its middle and upper length until Bells Rd, and the substrate is soil only. Water is present only in the mid-section above the large dam which dominates this stream. Above the dam is a well-defined, but heavily vegetated channel about two metres wide, which links to a localised broad, shallow wetland that was probably originally a deep pool, subsequently infilled with sediment and now an in-stream wetland. Water here is shallow and low quality due to high levels of decaying organic matter (i.e. highly tannin stained,

indications of low dissolved oxygen and low pH, very high bacterial levels) but this may be due to lack of recent rainfall, with conditions improving with flushing.

The south-west tributary which falls on Lot 4 DP268209 has a channel with variable definition, from a near deltaic like structure below the largest dam on the property which bisects this watercourse, to a well-defined channel in its lower and middle to upper middle length. Above the dam, the channel is generally shallow (<30 cm) and about one to three metres wide, and heavily vegetated with grasses and / or sedges. Water at the time of the survey was limited to a few centimetres and appeared highly tannin stained, and probably had an acid pH due to decaying organic matter. The large dam which bisects this watercourse is permanent but had a very high turbidity and hence low clarity. Submerged plants were not noted and floating plants were very limited. Depth is at least 1.5-2 m judging by the height of the dam wall.

All other watercourses on site are dry with no pools, apart from the upper limit of the 2nd order tributary in the north-northwest, which has a deep scour, possibly excavated, near the northern boundary. This pool was highly turbid with very high levels of suspended clay, hence algae growth was minimal, but lack of bacterial surface scum or blue-green algae suggested good water quality otherwise. Some deep scours occur in this watercourse but all were dry at time of survey and with poor channel connectivity, are unlikely to support native fish.

2.2 Vegetation communities

The site vegetation communities in term of distribution, floristics and condition reflect the long-term use of the area for pastoralism. All vegetation remnants contain a simplified assemblage of the original native ecosystems, often dominated by regrowth.

Historically the land appears likely to have been largely dominated by PCT 1206 with Spotted Gum being the dominant canopy tree, with canopy associates and undergrowth varying with soil types. The riparian zones have been highly degraded, with the original associations likely to have been a transition of PCT 1245 *Sydney Blue Gum x Bangalay - Lilly Pilly moist forest*, via a wet sclerophyll forest/rainforest/ecotone, to a swamp forest community, based on remnant species present and occurrence of PCTs in similar situations in the locality.

The Flora and Fauna Assessment (ELA 2018) determined the following vegetation communities (Figure 2):

- *1206 Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion*
- *1245 Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion*
- Exotic Pasture / Agricultural woodland / Ornamentals / Lawns - Highly degraded forms of PCT 1206 and 1245 and possibly other PCTs
- Aquatic vegetation - PCT not applicable as vegetation is either in artificial habitat (i.e. dams) or is the vestiges of the original riparian community, although a distinct patch in the north-east tributary could be classed as *PCT 781 Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion*.

The Flora and Fauna study (ELA 2018), concluded that the following TECs are present:

- Presence of Flooded Gum plus Bangalay x Sydney Blue Gum hybrids on site plus rare occurrences of Forest Red Gum and *Angophora floribunda* localised to the alluvial soil landscape, plus presence of many understorey, groundcover, shrub and vine species listed in the Final Determination suggest that an intergrade form of the TECs *Riverflat Eucalypt Forest on Coastal Floodplains* and *Swamp Sclerophyll Forest on Coastal Floodplains* may have occurred depending on local relief and position in the catchment. Such intergrades are recognised in all the Final Determinations (e.g. NSWSC 2004a, 2004b).
- Applying the Precautionary Principle, therefore, all areas of PCT 1245 on alluvial soil landscapes are mapped as the TEC - *Riverflat Eucalypt Forest on Coastal Floodplains*.
- Currently, the only precisely definable TEC on site is *Freshwater Wetlands on Coastal Floodplains*. This TEC appears to be a derived form – occupying the central channel of the watercourses which have undoubtedly altered via erosion and sedimentation since clearing of the original vegetation. Such changes may have seen shallowing of former channels, with removal of forest allowing colonisation due to increased solar access (such plants are absent where the riparian zone is enclosed by forest and streamflow is permanent due to a rocky substrate). This vegetation is generally restricted to the channel with pasture grasses and weeds dominating most of the habitat. For this reason, the TEC is mapped as low (high weed infestation, very simplistic, highly impacted by stock, low floristic diversity / structural integrity) and moderate (medium weed infestation, medium impact by stock, medium floristic diversity / structural integrity) condition.

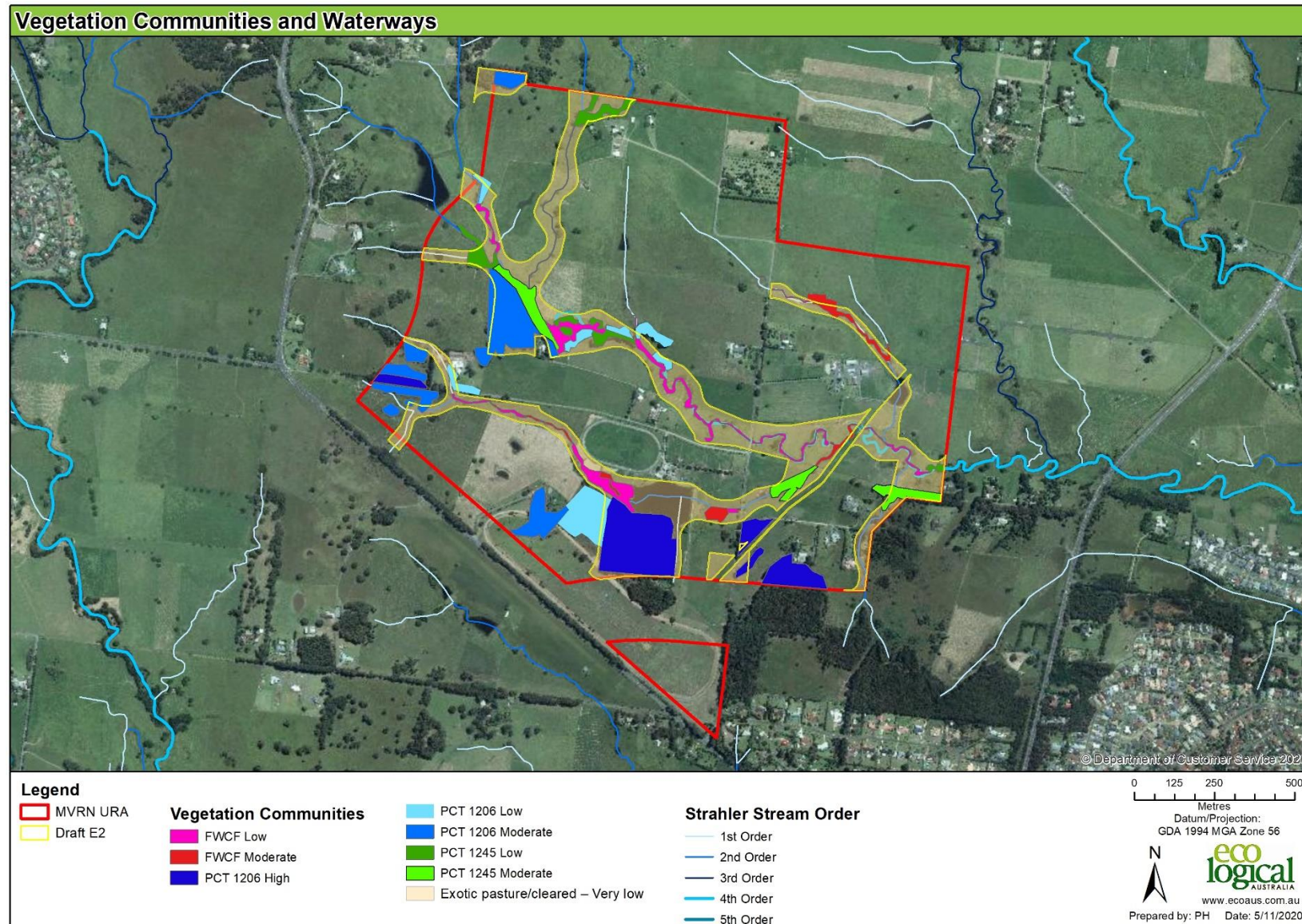


Figure 2 Vegetation communities and waterways

2.3 Resilience potential

The resilience of a site refers to the degree, manner and pace of recovery of species after disturbance or stress, or the potential for such recovery. Resilience is impacted by factors such as vegetation composition, structure and function as well as the amount of biodiversity and presence/absence of key threats (e.g. weeds or pest fauna species).

The study area has low resilience (ELA 2018). Areas of native vegetation are in very low (high content of exotic species over all strata) condition. The dominant weed is Kikuyu due to the fact most of the E2 zones along the creeks and drainage lines have been historically cleared and converted to pasture in all but the channel.

Key weeds such as Lantana and Blackberry are generally localised and relatively amenable to control at their current level of infestation e.g. via herbicide application including initial treatments with strategically timed follow-ups to control regrowth and recruitment. Similarly, Willows are also considered readily controlled and hence these weeds overall are not a major impediment to rehabilitation of the E2 zones.

2.4 Management issues

2.4.1 Priority weeds

Table 1 contains species are listed as Weeds of National Environmental Significance (WoNS) or under the NSW *Biosecurity Act 2015* identified in the South East Regional Weed Management Plan (SELLS 2017). Under the NSW Biosecurity Act 2015, eight weeds have been identified to fall under the 'general biosecurity duty'. Where these fall into the E2 zones, they are to be eliminated. Plants outside the E2 zone will eventually be eliminated by development of the R1 and other development zones. Weeds could potentially be introduced via imported road base materials and construction vehicles. Standard hygiene practices in the following section will also control this risk.

Table 1 Key weed species and biosecurity duty

Name	WoNS	Biosecurity Act	Abundance / distribution on site	Biosecurity obligations
<i>Asparagus africanus</i> (Climbing Asparagus)	No	Yes	Small patch and some individuals in northern foot of main remnant on Lot 4 DP268209; and some plants in medium condition remnant on Lot 4 DP 708356.	General biosecurity duty. North Shoalhaven falls into core infestation area outside the exclusion zone. A person must not import into the State or sell.
<i>Ageratina riparia</i> (Mistflower)	No	Yes	Common in patches along Abernethy Creek.	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.
<i>Salix babylonica</i> (Weeping Willow)	No	Yes	Common in lower sections of Abernethy's Creek and its northern tributary.	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.
<i>Senecio madagascariensis</i>	Yes	Yes	All pasture.	General biosecurity duty. North Shoalhaven falls into core infestation area outside the exclusion zone.

Name	WoNS	Biosecurity Act	Abundance / distribution on site	Biosecurity obligations
(Fireweed)				Species to be managed in accordance with published weed management plan.
<i>Lantana camara</i> (Lantana)	Yes	Yes	Edges of some forest remnants and riparian zones, and undergrowth of remnants where cattle have access.	General biosecurity duty. Shoalhaven falls into core infestation area outside the exclusion zone. Species to be managed in accordance with published weed management plan. A person must not import into the State or sell.
<i>Salix babylonica</i>	Yes	No	Locally common in lower Abernethy's Creek with a local stand in the north-east tributary.	General biosecurity duty. A person must not import into the State or sell.
<i>Ligustrum sinense</i> (Small-leaved privet)	No	Yes	Few plants in Abernethy Creek	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.
<i>Ligustrum lucidum</i> (Broad-leaved privet)	No	Yes	Single plant in intact remnant on Lot 4 DP268209.	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.
<i>Rubus fruticosus</i> aggregate (Blackberry)	Yes	Yes	Common along riparian zones, especially first order streams converted to pasture. Some patches up to 100 m ²	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk. Subject to local management plans. A person must not import into the State or sell.
<i>Zantedeschia aethiopica</i> (Arum Lily)	No	Yes	Middle and lower section of Abernethy's Creek.	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.

2.4.2 Pest animals

Pest animals can negatively impact natural ecosystems on E2 lands. These impacts can also affect VMP performance criteria. Any adverse impacts by pest animals that are observed will need to be addressed with appropriate pest management measures.

3. VMP Aims and objectives

3.1 Aims

The aims of the report is to:

- Provide guidance for VMPs that will accompany future DAs.
- Provide general management principles that will improve the composition, structure and function of native riparian vegetation.
- Provide consistency with best practice guidelines including the Society for Ecological Restoration Australasia *National Standards for Ecological Restoration, 2016*.
- Be consistent with relevant environmental legislation and policies

3.2 Objectives

The overall objective of individual VMPs is to restore the function of the E2 lands and to provide a stable watercourse which will increase and enhance local native vegetation and habitat whilst improving connectivity of the waterway. The objectives are summarised below in Table 2.

Individual VMPs will be developed to accompany future DAs on land containing the E2 zone. These will outline specific aims, objectives and indicators and will cover a five-year period. Consideration of future land ownership arrangements of the riparian corridors will be undertaken by SCC.

Table 2 VMP objectives

Objectives	Approach
Improve water quality and riparian vegetation	Revegetation of riparian corridor
Improve ecological health and integrity	Control woody weeds and pasture grasses Maximisation of biodiversity and ecological functions Revegetate with appropriate species (See Appendix A) Undertake ongoing maintenance weed control
Maintain and enhance habitat values	Protect existing native vegetation Weed control Increase native plant cover Increase habitat for native fauna

4. Action plan

4.1 Typical management zones

VMP management zones will be prescribed upon receipt of detailed designs during the Development Application stage for the E2 area. Management zones are based on the vegetation community and the predicted natural resilience of each area. Zones are mapped out in Figure 3.

Management zones have been identified as the following:

- **High Resilience (PCT 1206)**
 - Weed coverage approximately 5-24% of area. Revegetation required approximately 5-24% of area
- **Moderate Resilience (FWCF, PCT1206 and 1245)**
 - Weed coverage approximately 25-49% of area. Revegetation required approximately 25-49% of area
- **Low Resilience (FWCF, 1206 and 1245)**
 - Weed coverage approximately 50-74% of area. Revegetation required approximately 50-74% of area
- **Very Low Resilience (Exotic pasture/cleared)**
 - Weed coverage approximately 75-100% of area. Revegetation required approximately 75-100% of area

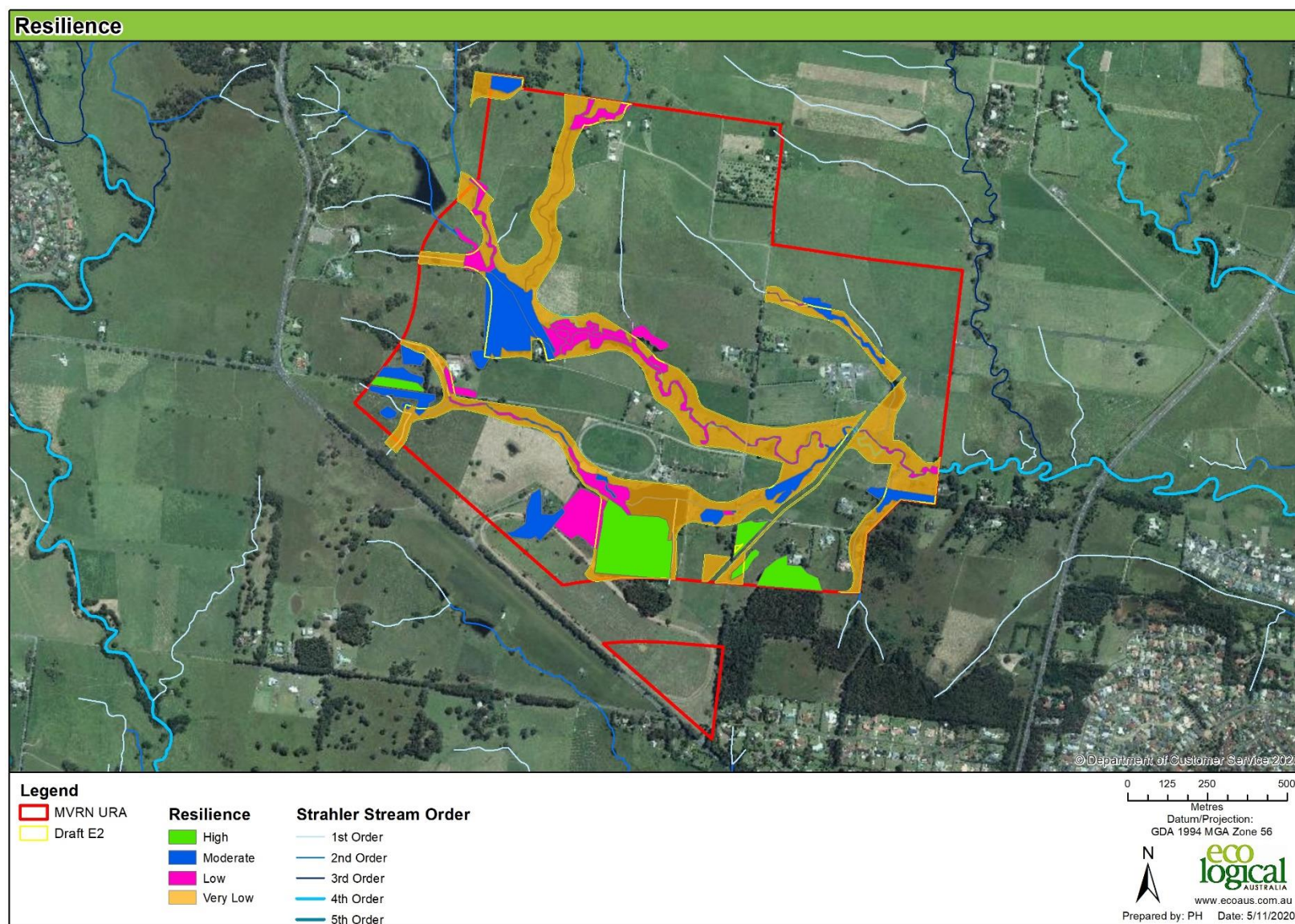


Figure 3 Resilience categories

4.2 Site management principles for VMPs

4.2.1 Temporary construction fencing

The edge of the VMP area where it borders the development footprint is to be fenced with temporary construction fencing to prevent civil construction machinery from entering the VMP area.

Information signage should be installed on the construction fencing that identifies that there is to be no entry into the VMP area without an ecologist or bush regenerator present.

4.2.2 Soil preparation

During all earthworks in the VMP area, i.e. for stormwater connections, the natural soil is to be retained and returned to the area following works. Topsoil will need to be a loose, friable soil free of weed propagules suitable for planting. Topsoil is to be kept free of weed propagules whilst retained on site.

4.2.3 Pest control

The site is to be monitored for evidence of pest species, which will be included in monitoring reports. Negative impacts include:

- Grazing and trampling on native vegetation
- Erosion and bank instability
- Spread weed species

The results of this monitoring will be used to inform whether pest control actions are required in the VMP area. Any damage by pests will require rectification. The report should outline all rectification works and pest control measures. Pest control and rectification works will need to be completed in the 5-year VMP period.

4.2.4 Erosion and sediment control

General consideration of erosion and sediment control within the VMP area should be considered. Examples of the types of specifications which should be considered for the VMP area are as follows: :

- No storage of plant, equipment and construction materials (including fill) in the VMP area
- No removal of soil/stone from the VMP area
- Where bush regeneration occurs, works will aim to reduce disturbance to topsoil. Weed removal is to be undertaken in a manner which minimises impact to the topsoil and disturbed topsoil will be replaced in its original location or the appropriate soil profile.
- Weed removal should not involve the removal of root ball (along waterways to prevent bank instability)
- Woody weed treatment should be limited to cut and paint and frill/drill techniques rather than removal with excavator or other heavy equipment.
- Pasture grasses should be slashed with a brush cutter or a ride on mower. The use of a ride on mower should be avoided when soil is wet and done when the soil is dry to reduce any disturbance. Grass cutting is allowed (subject to applicable planning and management controls) provided cutting blades are sufficiently raised from the ground to avoid inference with surface stones

- Where mulching is required, mulch will need to be stockpiled outside of the VMP area. Mulch can be spread onsite by a mini skid loader. Spreading mulch should be avoided when soil is wet and done when the soil is dry to reduce any disturbance. If soil conditions are not favourable, then mulch spreading can be done pneumatically.
- Any adverse effects identified, or measures in contravention of the above, will be brought to the immediate attention of SCC and managed in consultation with SCC.
- No work with heavy machinery (eg excavator) should be done in waterways or directly on banks

4.2.5 Revegetation

Complete revegetation is required where there are areas of very low natural resilience (see Section 4.1 and Figure 2). These areas occur where the vegetation is predominantly exotic cover. Revegetation to some degree is also likely to be required in areas of moderate and high resilience, typically referred to as assisted regeneration. Revegetation usually involves two rounds of weed removal followed by replanting of native groundcovers, shrubs and trees either by direct seeding or planting of tubestock once adequate weed control has been achieved.

Appendix A contains information on revegetation species and management works on a typical cross section in E2 lands. The cross section shows:

- zones corresponding to the type of native vegetation that should be planted
- Any erosion control measures in waterways

Additionally, Appendix A contains a revegetation list showing which species should be planted in each zone as per the cross section.

Replanting is typically required at the densities indicated in Table 3. Species for revegetation will be based on characteristic species of the PCT native to that location as indicated in Appendix A. If species are unavailable, others may be substituted but they must be typical species of that PCT and be a 'like-for-like' substitution, i.e. a tree can only be substituted for a tree. All plantings are to be sourced from local provenance stock (wherever possible), as per SCC guidelines and Florabank guidelines (Mortlock, 2000).

Table 3 Revegetation densities for vegetation communities

Vegetation Community	Revegetation densities (plant per m ²)			
	Tree	Shrub	Herbs/scrambler	Sedge
PCT 1206 and 1245	1/25m ²	1/20m ²	1/m ²	3/m ²
Riparian/Waterway, including PCT 781	-	-	-	8/m ²

Revegetation should aim to provide the following species diversity:

- Trees: 5-10 species
- Middle: 7-12 species
- Ground cover & vines: 5-10 species

For the growth of the plants used in the revegetation works, seed must be collected from local provenance species (wherever possible). Groundcovers, shrubs and trees should be collected as within close proximity (e.g. <20km) to the site. However, soil type, climate and aspect of the collection site(s) should also be considered. Native grasses typically have much larger dispersal mechanisms and are to be collected from within the Illawarra Escarpment.

Where species identified cannot be sourced, they may be substituted for other appropriate species. Species must be substituted with species of a similar form, e.g. trees for tree, grasses for grasses, etc. Only wild native species are to be used. Plants are not to be substituted with horticultural varieties under any circumstances.

Record keeping of seed collection and planting locations is to be as per the Flora Bank guidelines (Mortlock 2000). The bush regeneration contractor is responsible for recording this information and providing it to SCC. A Section 132C licence under the NSW *National Parks and Wildlife Act 1974* may be required to undertake seed collection works.

The VRZ / E2 land which falls on alluvial soils will be revegetated as per NRAR (formerly Department of Primary Industries - Water) requirements (DPI 2012). The target community will vary with soil, but are to target the TEC – *Riverflat Eucalypt Forest on Coastal Floodplains* to a coastal floodplain rainforest community which potentially have previously existed in the riparian zones. To minimise bushfire risk and APZs, canopy species of *Eucalyptus*, *Corymbia* and *Angophora* should be planted at low density with a dense rainforest understory aimed to be established where the TEC – *Riverflat Eucalypt Forest on Coastal Floodplains* is desired.

In localised areas where soil is prone to waterlogging and where wetland species currently dominate, this habitat is to be retained, with an ecotonal planting of species suitable for the soils of the location planted. Where suitable conditions occur and native wetland species are absent, exotic vegetation should be replaced by native wetland species.

Areas of the VRZ / E2 land on non-alluvial soils will be planted with species to match PCT 1206 or 1245 where relevant.

4.2.6 Instream aquatic habitat enhancement

Opportunities to enhance the instream aquatic habitat should be explored for 3rd order (Strahler) streams and greater during the design stage and flood modelling. Any modification to the stream alignment, bed or banks will require instream restoration. Aquatic habitat opportunities include:

- Provision of a variety of aquatic habitat types, such as riffle-run-pool sequence (where the gradient allows), with the selection and placement to complement or supplement adjacent habitat types along the reach outside of the development.
- Removal of unnecessary barriers to fish passage (e.g. instream dams, eroded crossings, old weirs).
- Provision of fish passage at new structures, by ensuring they do not:
 - create a drop or step of greater than 100 mm
 - form a slope greater than 1:20
 - increase flow velocity through a constriction
 - percolate water into the substrate (i.e. water must flow over the bed).

- Prevention of erosion at crossings and culverts by using rip rap and avoiding placement on bends
- Prohibition of planting deciduous exotic trees along roads and where leaf drop can't be intercepted from entering the waterway. Leaves from exotic trees decompose rapidly (unlike native trees), so they don't provide a stable food resource for aquatic detritivores (e.g. some fish and invertebrates). Deciduous leaves often accumulate during a short period (unlike native species that shed leaves slowly all-year round), and large amounts of organic material deposited in the water can cause anoxic benthic conditions fatal to aquatic organisms.

All instream works must adhere to guidelines published by DPI Fisheries (for streams identified as Key Fish Habitat) and the Natural Resources Access Regulator (for works within 40 m of a watercourse), including:

- Guidelines for controlled activities (e.g. outlet structures, pipe, cables and crossings), <https://www.industry.nsw.gov.au/water/licensing-trade/approvals/controlled-activities/guide>
- Policy and guidelines for fish habitat conservation and management (update 2013) <https://www.dpi.nsw.gov.au/fishing/habitat/publications/pubs/fish-habitat-conservation>

4.2.7 Assisted regeneration

Assisted natural regeneration is based on the ecological principles of community succession and is most practical if there are patches of natural vegetation within the cleared area. It involves the natural regrowth of vegetation using the existing seed bank in the soil and of limited supplementary revegetation. It guarantees that vegetation will be a representation of what was previously growing at the site. Due to the varying condition of native vegetation and largely poor resilience across most of the E2 zone, it is anticipated that assisted regeneration will be used only in areas of moderate - high resilience as a complementary method for maintaining the health and integrity of vegetation communities. Supplementary planting over a 5-year timeframe will also be required depending on the level of natural native regeneration (which will need to be monitored during the implementation of a VMP).

4.3 Weed treatment

Weed control will be undertaken across the E2 zone. A selection of the best suited weed control method within the study area depends on several factors including:

- The species or combination of weeds being targeted.
- The density of the weeds.
- Resources available (time, labour, equipment, and finances).
- Weather conditions of the day.

Due to the high density and abundance of weed species in the E2 zone, primary weed control is required. Following primary weed control, maintenance weed control will occur for a period of five years to ensure exotic species do not encroach into the E2 zone.

4.3.1 Weed control techniques

Details of specific weed control techniques to be used such as cut and paint, scrape and paint, herbicide spraying, and hand weeding are given in Brodie (1999). The principles of bush regeneration and techniques to trigger natural regeneration are to be in accordance with the Bradley Method and other techniques described in Buchanan (2000).

4.3.2 Management of weed waste

All exotic vegetation material should be removed from site and composted at a registered green waste disposal facility. Fruiting parts and tubers should be bagged before being removed from site.

4.3.3 Herbicide use

The use of herbicide to control weeds should be carefully considered. Herbicide use should assess potential long-term impacts of the technique including whether the proposed works address the source of the weed infestation. However, herbicide application forms an important and useful component of an integrated weed management approach and can be the most appropriate method to control some weed species.

Herbicide use should occur during the active growing season for plants to encourage the chemical uptake into the plant. The selection of herbicides should also consider the type of weed and the location. Where non-selective herbicides are required for use, glyphosate is the most suitable. If herbicides are required to be used near waterways, a glyphosate-based herbicide formulated for use near waterways will be used (e.g. RoundUp® Biactive™).

Broad-leaf selective herbicide may be used as per the *Noxious and environmental weed control handbook* (DPI 2010). However, this type of herbicide is extremely toxic to aquatic life and must not be used in, or adjacent to, waterways. Registration and records must be kept in accordance with the *NSW Pesticide Regulation 2009*.

4.4 Site maintenance

Maintenance weed control will be completed for a minimum five-year period, to control emergent and encroaching weeds. Maintenance work is to be undertaken by a qualified bush regeneration contractor(s).

Maintenance will be undertaken on a regular basis in the peak growing seasons (spring and summer), with less frequent visits in cooler periods (autumn and winter). Maintenance programs will also comment on other site issues such as pest animal activity and condition of sediment control structures. Maintenance work will include actions to encourage native regeneration where it is not occurring naturally.

4.5 Performance criteria

The progress and compliance with the VMP will be monitored and reviewed annually. This process will involve the bush regeneration contractor, landowners and a staff member from SCC. A report will be prepared by a certified bush regenerator commenting on each performance criteria. If required, reporting will be followed by a site visit.

The performance criteria which will be applied to management zones are described in Table 4.

4.6 Bush regeneration contractors

All vegetation management works in establishment and 5-year maintenance period is to be undertaken by suitably qualified and experienced bush regeneration contractors or individuals. In addition to this, team leaders should have, as a minimum, a Certificate III in Conservation & Land Management or equivalent. The contractor will need to carry out best practice bush regeneration techniques as described by Buchanan (2009). A flexible approach to this site is recommended since techniques may need to be changed or modified to suit site conditions. This approach is consistent with adaptive management and allows the contractor to develop and build on site knowledge. Monitoring will assist in the development of any management actions in subsequent years.

Works in the maintenance period will be the responsibility of the land-owner in accordance with this report.

Table 4 Performance criteria

By end of Year 5
An increase in native cover and diversity and a decrease in exotic cover and diversity
Percentage of total native vegetation cover should be the following: Minimum 15% by end of year 1, 30% by end of year 2, 45% by end of year 3, 60% by end of year 4 and 75% by end of year 5
A minimum of 85% survival rate of each vegetation strata planted in each zone (e.g. tree, shrub and groundcover)
Revegetation is to be undertaken with a minimum of 60% of the benchmark levels for species diversity as provided in the PCT
Native vegetation diversity in no less than 40% of the benchmark levels for species provided in the PCT
Any localised plant failure within planting areas are addressed with no area larger than 2 m x 2 metres without surviving plants
Maintenance replanting is to replace plants by the same species, or where that species is not available, with the same growth form (i.e. tree for tree etc.) and must not decrease species diversity. Any new species to be planted must be from the community being emulated and of local provenance
Complete eradication of noxious weeds from the site and no establishment of new noxious species
Exotic groundcover vegetation no more than 15% of zone.
Native groundcover vegetation no less than 75% of zone.

5. Monitoring, evaluation and reporting

The bush regeneration contractor and the land manager (typically the landowner or developer) will monitor the vegetation for changes over the 5 year maintenance period. VMPs adopt the principle of observing, recording, and monitoring treatments and responses to interventions in order to inform changes and different approaches for future work. Regular assessment and analysis of progress is required to adapt treatments (adaptive management) as required.

5.1 Monitoring

Monitoring is done by assessing the site against the set performance criteria for each year and include:

- Collection of data prior to works commencing and at annual intervals to identify whether objectives, goals and targets are being attained; and
- Collecting data on specific treatments and approximate costs.

A minimum standard of monitoring is the use of photo points (Section 5.1.1), along with species lists and condition descriptions. Management works also monitor the recovery performance using pre-identified indicators consistent with the objectives. These are used to track progress towards full recovery. Formal quantitative sampling methods (e.g. vegetation plots) supported by a condition assessment are preferred mechanism to demonstrate achievement of objectives.

Adequate records of interventions and all monitoring are maintained to enable evaluation. Secure records of the provenance of re-introduced plants should include location, description of site, reference to collection protocols and date of acquisition.

5.1.1 Photo monitoring

Photo monitoring points should be set-up using a permanent reference point to provide a visual reference of changes in the vegetation. Photo monitoring to include:

- set up a minimum of two monitoring points within each VMP zone, with a minimum of six photo points across the VMP area
- place two six-foot star pickets 10 m apart
- record the location (eastings and northings) of the first star picket with a GPS
- as well as the bearing to the second star picket
- take a digital photo from the first star picket looking towards the second star picket, the entire length of the gap
- label each digital image with a unique reference number that indicates where the photo was taken (i.e. the photo monitoring point) and the date it was taken (e.g. 01_190405 for a photo taken at the first photo monitoring point on the 5th April 2019).

5.1.2 Evaluation and reporting

Evaluation of the outcomes of each VMP interventions is carried out, with progress measured against the performance criteria for each year. Evaluation includes asking key questions to adequately assess the results from monitoring. Evaluation results are used to inform ongoing management.

Progress reports are to be provided on an annual basis for five years or until the completion of the VMP project, whichever is longer. This reporting includes the implementation of the monitoring actions specified in Section 4 and a description of the works that have been undertaken. These reports will be submitted to Council and NRAR. Reports will include at a minimum:

- The time period the report relates to.
- Qualifications and experience of contractors.
- A summary of works carried out within the period including.
 - Date and time of site visits.
 - Works completed on the site at each visit.
 - A table detailing total man hours for each task carried out on site.
 - Methods of weeding undertaken and details of herbicide use.
 - Methods implemented for Assisted Natural Regeneration.
 - Photo and quadrat monitoring results to date.
 - Pest animals observed and any adverse impacts
 - A description of any problems encountered in implementing the works recommended in the VMP and how they were overcome.
 - Any observations made, including new plant species recorded (native and weed species), comments on rates of regeneration and any problems which impact on the implementation of the VMP.

If applicable, the results of the implementation works in relation to the relevant performance criteria.

References

Brodie, L et al.1999. Bush regenerators' Handbook, Second Edition. National Trust of Australia, Sydney, NSW.

Buchanan RA. 2000. Bush regeneration: recovering Australian landscapes. 2nd Edition. TAFE NSW, Sydney.

DPI. 2010. Noxious and environmental weed control handbook.

DPI (Office of Water), NSW 2012. Guidelines for riparian corridors on waterfront land. http://www.water.nsw.gov.au/__data/assets/pdf_file/0004/547222/licensing_approvals_controlled_activities_riparian_corridors.pdf

Eco Logical Australia 2018. *Flora and Fauna Assessment for Moss Vale Rd North Urban Release Area Masterplan and Development Control Plan*. Report to Allen Price & Scarratts Pty Ltd. ELA, Huskisson.

NSW Office of water. 2012. Guidelines for riparian corridors on waterfront land.

Appendix A Revegetation and Cross-section for E2

Table 5 Recommended revegetation species for corresponding zones shown in cross section

Stratum	Species	Common name	Zone			
			A	B	C	
PCT – 1206: Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion						
Trees	<i>Corymbia maculate</i>	(Spotted Gum)			•	
	<i>Eucalyptus pilularis</i>	(Blackbutt)			•	
	<i>Eucalyptus paniculata subsp. Paniculata</i>				•	
	<i>Corymbia gummifera</i>	(Red Bloodwood)			•	
	<i>Eucalyptus globoidea</i>	(White Stringybark)			•	
Middle	<i>Breynia oblongifolia</i>	(Coffee Bush)			•	
	<i>Cissus hypoglauca</i>	(Giant Water Vine)			•	
	<i>Elaeocarpus reticulatus</i>	(Blueberry Ash)			•	
	<i>Eustrephus latifolius</i>	(Wombat Berry)			•	
	<i>Hibbertia aspera</i>	(Rough Guinea Flower)			•	
	<i>Leucopogon lanceolatus</i>				•	
	<i>Macrozamia communis</i>	(Burrawang)			•	
	<i>Notelaea longifolia</i>	(Large Mock-olive)			•	
	<i>Pandorea pandorana</i>	(Wonga Wonga Vine)			•	
	<i>Persoonia linearis</i>	(Narrow-leaved Geebung)			•	
	<i>Tylophora barbata</i>	(Bearded Tylophora)			•	
	<i>Synoum glandulosum</i>	(Scentless Rosewood)			•	
	Ground cover	<i>Dianella caerulea</i>	(Blue Flax-lily)			•
		<i>Entolasia stricta</i>	(Wiry Panic)			•
<i>Lepidosperma urophorum</i>					•	
<i>Lomandra longifolia</i>		(Spiny-headed Mat-rush)			•	
<i>Pteridium esculentum</i>		(Bracken)			•	
<i>Schelhammera undulata</i>					•	
PCT 1245: Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion						
Upper	<i>Acmena smithii</i>	(Lilly Pilly)			•	
	<i>Livistona australis</i>	(Cabbage Palm)			•	
	<i>Synoum glandulosum</i>	(Scentless Rosewood)			•	
	<i>Pittosporum undulatum</i>	(Sweet Pittosporum)			•	
	<i>Cryptocarya glaucescens</i>	(Jackwood)			•	
	<i>Eucalyptus saligna</i>	(Sydney Blue Gum)			•	
	<i>Eucalyptus quadrangulate</i>	(White-topped Box)			•	
	<i>Eucalyptus pilularis</i>	(Blackbutt)			•	
	<i>Syncarpia glomulifera</i>	(Turpentine)			•	
Middle	<i>Notelaea venosa</i>	(Veined Mock-olive)			•	
	<i>Clerodendrum tomentosum</i>	(Hairy Clerodendrum)			•	

Stratum	Species	Common name	Zone		
			A	B	C
Ground	<i>Eupomatia laurina</i>	(Bolwarra)			•
	<i>Doodia aspera</i>	(Prickly Rasp Fern)			•
	<i>Pseuderanthemum variabile</i>	(Pastel Flower)			•
	<i>Oplismenus imbecillis</i>				•
	<i>Gymnostachys anceps</i>	(Settler's Twine)			•
	<i>Blechnum cartilagineum</i>	(Gristle Fern)			•
	<i>Adiantum formosum</i>	(Giant Maidenhair)			•
	<i>Calochlaena dubia</i>	(Rainbow Fern)			•
Riparian/Waterway areas - PCT 781: Coastal freshwater wetlands					
Upper	<i>Melaleuca ericifolia</i>	(Swamp Paperbark)		•	
Middle	<i>Casuarina glauca</i>	(Swamp Oak)		•	
	<i>Melaleuca ericifolia</i>	(Swamp Paperbark)		•	
Ground	<i>Isachne globosa</i>	(Swamp Millet)	•	•	
	<i>Blechnum indicum</i>	(Swamp Water Fern)	•	•	
	<i>Eleocharis sphacelata</i>	(Tall Spike Rush)	•	•	
	<i>Hypolepis muelleri</i>	(Harsh Ground Fern)	•	•	
	<i>Phragmites australis</i>	(Common Reed)	•	•	
	<i>Triglochin microtuberosa</i>		•	•	
	<i>Baumea juncea</i>		•	•	
	<i>Baumea articulata</i>	(Jointed Twig-rush)	•	•	
	<i>Bolboschoenus fluviatilis</i>	(Marsh Club-rush)	•	•	
	<i>Carex appressa</i>	(Tall Sedge)	•	•	
	<i>Gleichenia dicarpa</i>	(Pouched Coral Fern)	•	•	
	<i>Persicaria praetermissa</i>		•	•	
	<i>Triglochin procerum</i>	(Water Ribbons)	•	•	
	<i>Cladium procerum</i>		•	•	
	<i>Persicaria strigosa</i>		•	•	

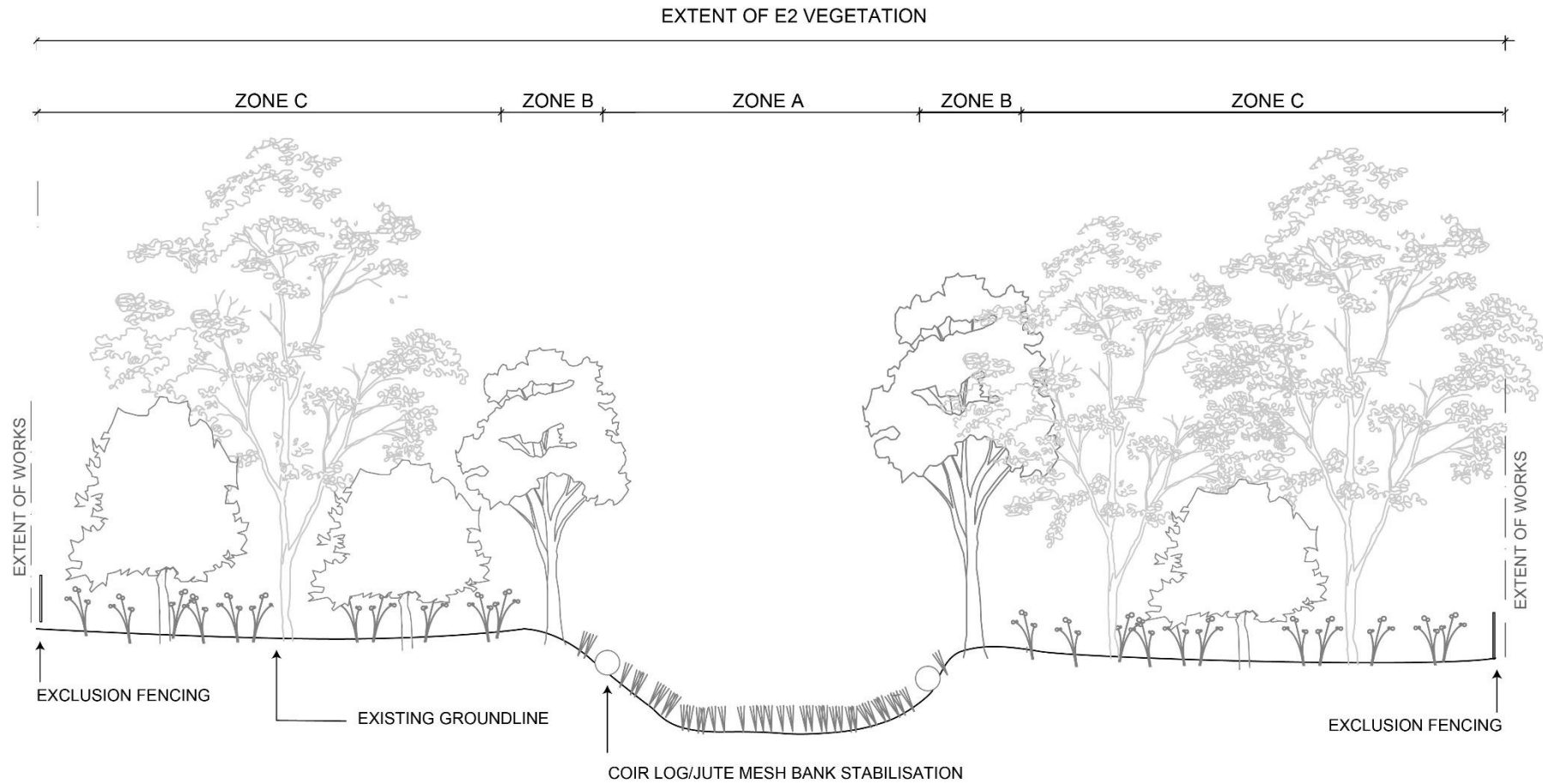


Figure 4 Typical Cross section of final structure by year-5 in E2/VMP zone



Draft Residential Planting List - Moss Vale Road North Urban Release Area

The purpose of this Residential Planting List (Table 1) is to provide planting guidance and inspiration for residential land (private property) in the Moss Vale Road North Urban Release Area (URA). Planting guidance can also be found in the [Cambewarra](#) and [Bomaderry](#) planting lists.

Landscaping detail for land in the public domain in the Moss Vale Road North URA can be found in Chapter NB4: Moss Vale Road North Urban Release Area of Shoalhaven Development Control Plan 2014 here [\[Insert link\]](#).

Table 1: Tree and Understory Plant List - Moss Vale Road North Urban Release Area

Botanic Name	Common Name	Height *	Width*
Tree			
<i>Syzygium leuhmanni</i>	Riberry	7m	3m
<i>Buckinghamia celsissima</i>	Ivory Curl Tree	10m	3m
<i>Lagerstroemia indica</i> 'Tuscarora';	Crepe Myrtle	8m	4m
<i>Parrotia persica</i> 'Venessa'	Persian Ironwood	7m	5m
<i>Magnolia</i> 'Exmouth'	Magnolia	12m	8m
<i>Magnolia</i> 'Little Gem'	Magnolia	6m	3m
<i>Ginkgo biloba</i>	Maidenhair Tree	12m	6m
<i>Backhousia citriodora</i>	Lemon Myrtle	8m	2-3m
<i>Tristania laurina</i> 'Luscious'	Watergum	8m	4m
<i>Lagerstroemia indica</i> 'Natchez'	Crepe Myrtle	4m-6m	6m
<i>Lagerstroemia indica</i> 'Lipan'	Crepe Myrtle	4m-6m	4m
<i>Lagerstroemia indica</i> 'Tuscarora';	Crepe Myrtle	8m	4m
<i>Corymbia citriodora</i> 'Lemon Squash'	Dwarf Lemon Scented Gum	6m	4m
<i>Eucalyptus cladocalyx</i> 'Vintage Red'	Eucalyptus dwarf	6m	4m
<i>Acer rubrum</i> 'October Glory'	Acer cultivar	10m	9m
<i>Pyrus calleryana</i> 'Chanticleer'	Ornamental pear	10m	5-6m
<i>Prunus cerasifera</i> 'Nigra'	Ornamental plum	4m	4m
<i>Cercis canadensis</i> 'Forest Pansy'	Cercis cultivar	5m	5m
Shrub/understory			
<i>Rhagodia spinescens</i> 'Aussie Flat Bush'	Rhagodia	500mm	1m
<i>Westringia fruticosa</i> 'Mundi'	Coastal Rosemary	500mm	1.5m
<i>Westringia</i> 'Grey Box'	Rosemary cultivar	500mm	500mm
<i>Lomandra</i> 'Frilly Lace'	Lomandra	450mm	450mm
<i>Lomandra</i> 'Tanika'	Lomandra	500mm	650mm
<i>Lomandra longifolia</i> 'Lime Jet'	Lomandra	600	600mm
<i>Lomandra</i> 'Variegated'	Lomandra	500mm	600mm
<i>Lorepetalum chinense</i> 'Purple Pixie'	Chinese Fringe	400mm	1-1.2m
<i>Callistemon viminalis</i> 'Better John'	Callistemon	600mm	600mm
<i>Liriope muscari</i> 'Amethyst'	Liriope	400mm	400mm

Draft Residential Planting List - Moss Vale Road North Urban Release Area

<i>Nandina domestica</i> 'Flirt'	Ornamental Nandina	400mm	400mm
<i>Convolvulus cneorum</i>	Silverbush	400mm	400mm
<i>Russelia equisetiformis</i>	Firecracker Plant	1m	1.5m
<i>Abelia grandiflora</i> 'Gold Dwarf'	Abelia	1m	1m
<i>Abelia grandiflora</i> 'Kaleidoscope'	Abelia	1m	1m
<i>Hebe elliptica</i>	Veronica	1m	500mm
<i>Correa pulchella</i> 'Fire Bells'	Correa	250mm	800mm
<i>Westringia fruticosa</i> 'Low Horizon'	Westringia	300mm	700mm
<i>Grevillea</i> 'Gold Cluster'	Grevillea	300mm	800mm
<i>Grevillea hybrid</i> 'Flat Az'	Grevillea	200mm	2-3m
<i>Casuarina glauca</i> 'Cousin It'	Casuarina	150mm	1.5m
<i>Dianella</i> 'Emerald Arch'	Dianella	550mm	450mm
<i>Loropetalum chinensis</i> 'Plum Delight'	Chinese Fringe Flower	1.5m	1.5m
<i>Alternanthera</i> 'Little Ruby'	Alternanthera	400mm	800mm
<i>Rosmarinus officinalis</i> 'Tuscan Blue'	Rosemary	1m	800mm
<i>Raphiolepis</i> 'Cosmic Pink'	Indian Hawthorn	800mm	800mm
<i>Ajuga reptans</i>	Bugle Herb	100mm	400mm
<i>Banksia spinulosa</i> 'Birthday Candles'	Banksia cultivar	400mm	500mm
<i>Brachyscome multifida</i>	Break of Day	150mm	200mm
<i>Grevillea</i> 'Bronze Rambler'	Grevillea cultivar	300mm	500mm
<i>Myoporum parvifolium</i>	Creeping Boobialla	200mm	300mm
<i>Liriope</i> 'Isabella'	Liriope cultivar	400mm	400mm
* Plant growth habits may vary due to local site, soil and ecological conditions.			