Marrangaroo Master Plan

Lithgow City Council

REVISION A
DECEMBER 2017

Lithgow CITY COUNCIL

Introduction

Master Plan

Appendix

Introduction

Figure 1: Marrangaroo Urban Release Area and Employment Lands

1. About the Master Plan

This Master Plan has been prepared by Lithgow Council in order to provide an overarching vision, strong design principles and a physical plan for the Marrangaroo Urban Release area and adjoining employment lands.

This Master Plan is to be read in conjunction with the Development Control Plan (DCP), which provides a detailed guide for the development of the area and satisfies the provisions of Part 6.3 Development Control Plan of Lithgow Local Environment Plan 2014 (LEP).

2. The Vision for Marrangaroo

"Marrangaroo will be a new urban village that will provide housing, amenity, recreational and employment opportunities to a diverse range of residents and visitors, while promoting sustainability initiatives and maintaining the semi rural and natural qualities of the site."

3. The Process

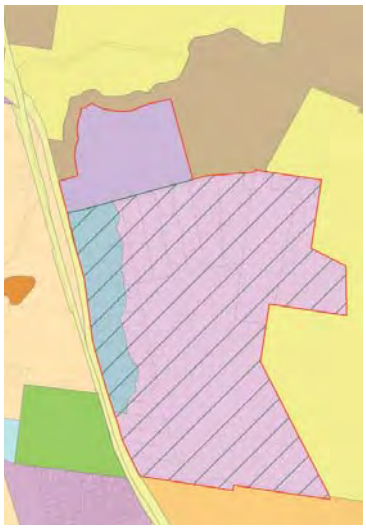
A process of collaboration

Creating a new village or development is a process that requires more than the ideas or expertise of a single person or team. The planning and design of Marrangaroo has evolved through the community and landowners, poilitical leaders and design professionals working together towards the best outcome for the site.

The plan incorporates extensive background analysis, best-practice design principles and the overall vision into a cohesive plan that will provide the direction for the Marrangaroo precinct.

Figure 2: Master Plan Process

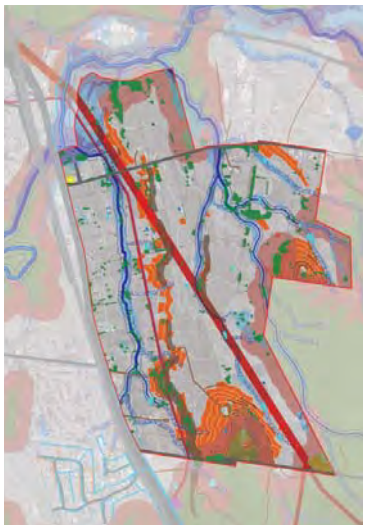
Analysis, Consultation and Vision



LEP Rezoning

In 2006, Lithgow City Council zoned the area of IN1 employment lands located north of Reserve Road and immediately east of the Great Western Highway and created an Urban Release Area at Marrangaroo. This was based on a full Local Environmental Study and Structure Plan prepared by Geolyse Pty Ltd in 2006.

The current land zoning and studies leading up to it form the starting point for the Marrangaroo Structure Plan work.



Site Analysis

Comprehensive site analysis has been undertaken for the site area, which confirms, revises and builds on the 2006 work. The preliminary analysis covers topography and landform, key views, hydrology and flooding, infrastructure, land uses and ownership, vegetation and bushfire.

Community, Stakeholder and Landowner Consultation

Several rounds of community, stakeholder and landowner consultation were undertaken before the Structure Plan Options were produced.

A Briefing Session held on the 3 November 2016, informing attendees of the project aims and gathering any initial feedback.

The second was a Vision Workshop held on the 24 November 2016, which established high level values, principles and a vision for Marrangaroo. These principles and vision set a benchmark for the masterplan and guidelines that will continue to be referenced throughout the process to ensure outcomes meet the expectations of the community.

One-on-one consultation with landowners was also carried out in December 2016 to gain a greater understanding of individual concerns and approaches to development.

4. The Site

Marrangaroo is a unique site with open and undulating farmland dotted with mature trees, rural homes and rocky outcrops, enclosed by tree-covered hills.

The Master Plan for Marrangaroo is informed and underpinned by a thorough understanding of the site's natural attributes and special qualities and its contextual relationships to surrounding land uses.

A full outline of site analysis can be found in the Appendix.

Location and Context

The Marrangaroo Project Area is located approximately mid way between the urban centres of Lithgow and Wallerawang and approximately 150km west-north-west of Sydney.

The area and immediate surrounds are enclosed by steep and vegetated slopes and the area is bounded on the east by the Great Western Highway.

The project area is predominantly semi rural in character with scattered rural lifestyle development and highway service land use including a motel and service station. A maximum security correctional centre adjoins the employment lands to the north with the western most boundary of the project area adjoining a defence facility.

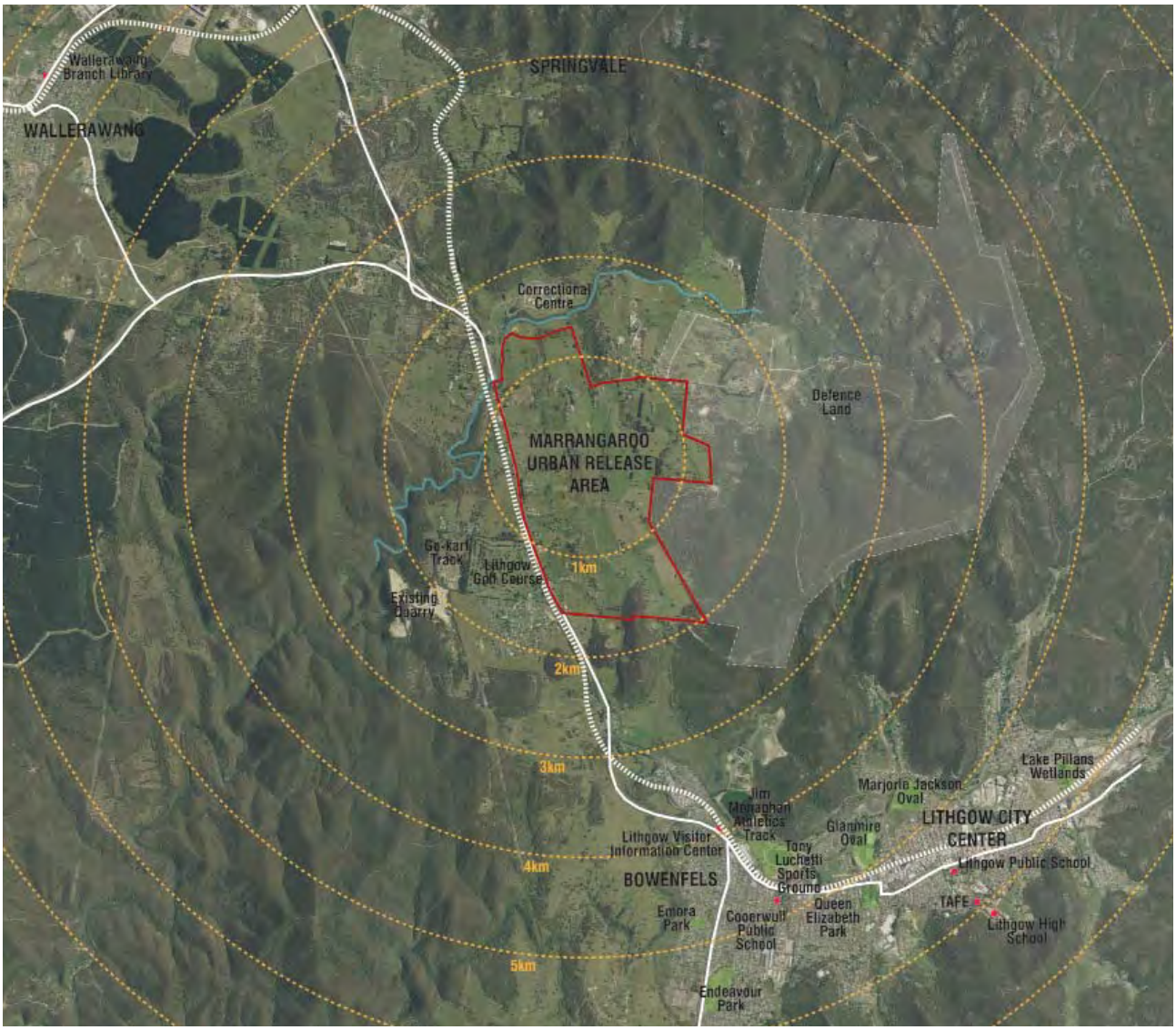


Figure 3: Site Context and Location

Recent Industrial Development

Ephemeral creeks

Open farmland and rolling hills

Rocky scarps

Highway service station

Rural residential houses

Mature vegetation and surrounding woodland

Heritage chapel

Figure 4: Existing Character

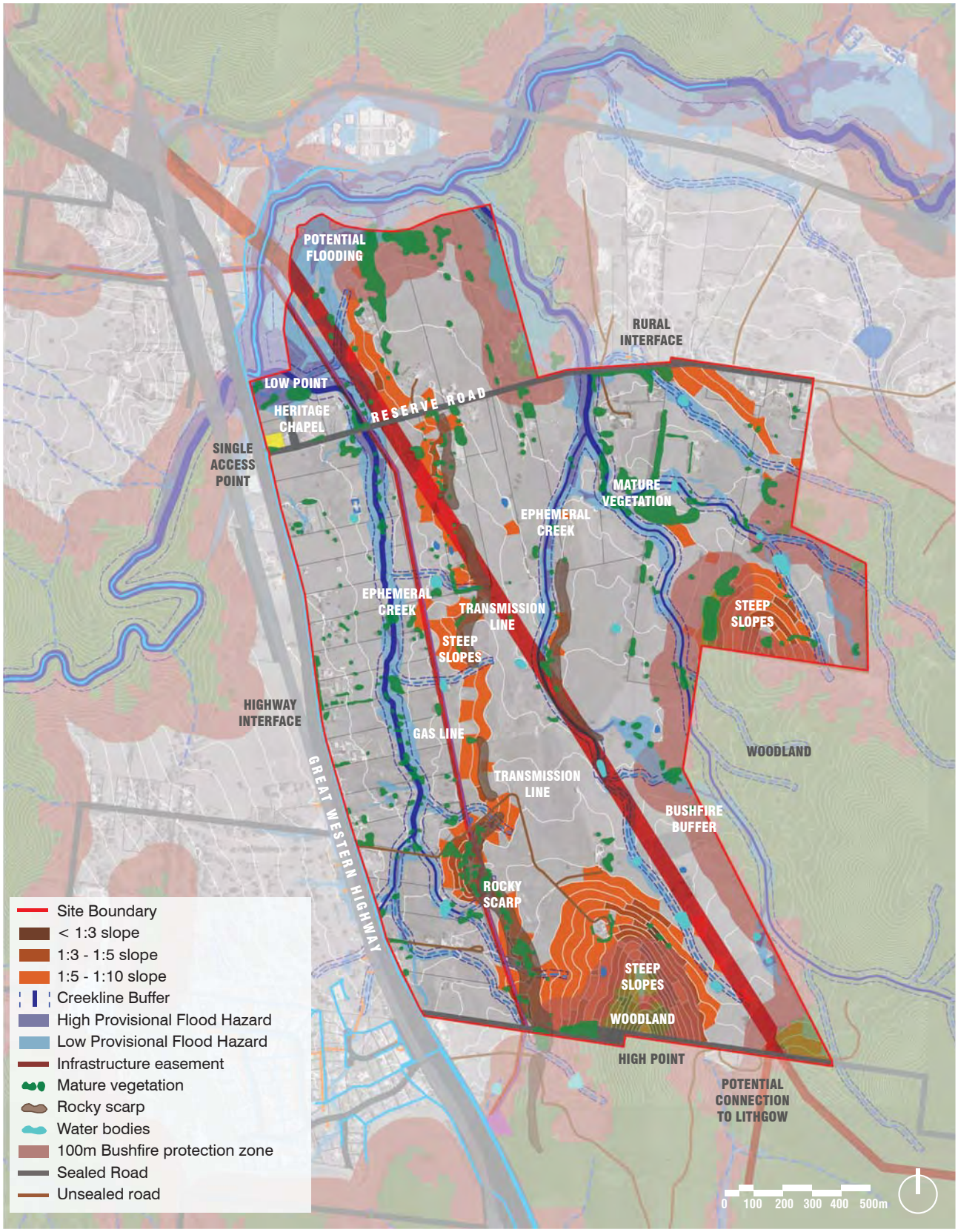


Figure 5: Constraints

Constraints and Considerations

Location and Context

- The site is physically separated from Lithgow with the topography providing a visual and physical barrier and car access available only via the Great Western Highway. This provides the opportunity to make Marrangaroo a distinct place of it's own.
- The site's projected population and proximity to Lithgow mean that the development will rely on Lithgow for many essential services, including schools and community facilities.

Land Ownership

- Existing lot boundaries and ownership will impact on staging and future development boundaries. Individual landowner's stances on development to be acknowledged.
- Having one landowner for 36% of the site area reduces the constraints on the site.

Heritage

- The chapel at the corner of Reserve Road and the highway is the only heritage constraint.

Natural Features

- The site has significant woodland areas to the north, south and east with associated environmental protection and bushfire buffers. These areas also provide a picturesque backdrop to any future development.
- There are a large number of mature trees on site that should be retained where possible.
- Rocky outcrops create a natural feature that should be retained where possible.
- Several ephemeral feeder creeks run north-south across the site. These have associated environmental protection buffers that pose a constraint to development.

Slope and Topography

- Steep slopes occur across parts of the site, including a north-south stretch of land that divides the site as well as two hills to the south and east.
- The topography generally slopes down to the north, resulting in the best views across the site and to surrounding areas from the south.
- The topography creates a natural division between the site and Lithgow, with potential future pedestrian and/or vehicle access via a saddle to the south of the site.

Drainage and Hydrology

- Potential flood zones occur along the creek lines.
- Existing creeks, dams/water bodies and overland flow paths to be incorporated into the overall drainage strategy.
- Any increased drainage load resulting from development will need to be accommodated in water sensitive design measures across the site.

Infrastructure

Roads

- Reserve Road is currently the only sealed road within the site.
- Access from Great Western Highway to be limited to Reserve Road and one other left-in / left-out access point.

Water

- Limited water infrastructure - Current water infrastructure under councils control includes 100mm water main along Reserve Road and 250mm water main along the Great Western Highway.
- Additional reservoir required north of the site (no smaller than 20ML)

Sewer

- Dedicated trunk infrastructure to Lithgow STP required for future development (current infrastructure at capacity)

Gas

- Existing gas line with 20m easement runs N-S through the site and constrains development
- 160m buffer zone to gas line to be confirmed - this would be a major constraint to development

Electricity

- Minor transmission lines run across the site

Master Plan

1. Design Principles

Marrangaroo will be developed in accordance with the following Design Principles which underpin the Master Plan:

Context and Interfaces

- Provide natural buffers between enterprise corridor and industrial and urban areas
- Ensure safe and adequate access from the highway
- Maintain the visual quality of the entrance to Lithgow
- Consider impacts of stormwater, flooding and drainage on adjacent properties
- Provide cycle and public transport connections to Lithgow
- Protect Marrangaroo Creek, its water quality and wildlife
- Separate Correctional Centre and residential housing
- Retain key landscape views from the Highway and residential areas east of the Highway
- Create a distinct and identifiable community with a strong sense of arrival

Natural Features

- Consider bushfire access
- Consider building heights in relation to topography
- Maintain the natural beauty of hills and ridgelines for wildlife attractiveness and recreation
- Avoid urban development in flood prone areas, bushfire danger and steep slopes
- Incorporate water sensitive urban design into all aspects of the development, utilising existing drainage corridors and waterways

Community and Amenity

- Provide a range of recreational opportunities including play spaces and access to bushland walks
- Do not plan or develop services greater than the needs to the target population
- Provide green streets that minimise road pavement and maximise green verges and trees. Provide and encourage walking, cycling and public transport use
- Provide a connected network of open spaces distributed throughout the development and in varying topographic locations
- Preserve and celebrate heritage features
- Promote efficient land-use for urban purposes to preserve rural land
- Create a village heart within the residential neighbourhood that provides basic services such as local retail/education/community centre

Housing and Density

- Provide large lots in areas that will contribute to landscape views, rural character and environmental protection
- Provide enough housing to sustain infrastructure costs, public transport, community facilities and a small amount of local retail.
- Locate density where amenity is the highest, such as adequate open space or neighbourhood centre.
- Provide for senior living
- Provide housing choice and diversity

Employment and Economy

- Separate incompatible uses from one another
- Increase economic opportunities to live and grow in Lithgow
- Provide enough land to encourage investment and cater for future demand
- Provide employment generating land uses, including land with good access and visibility

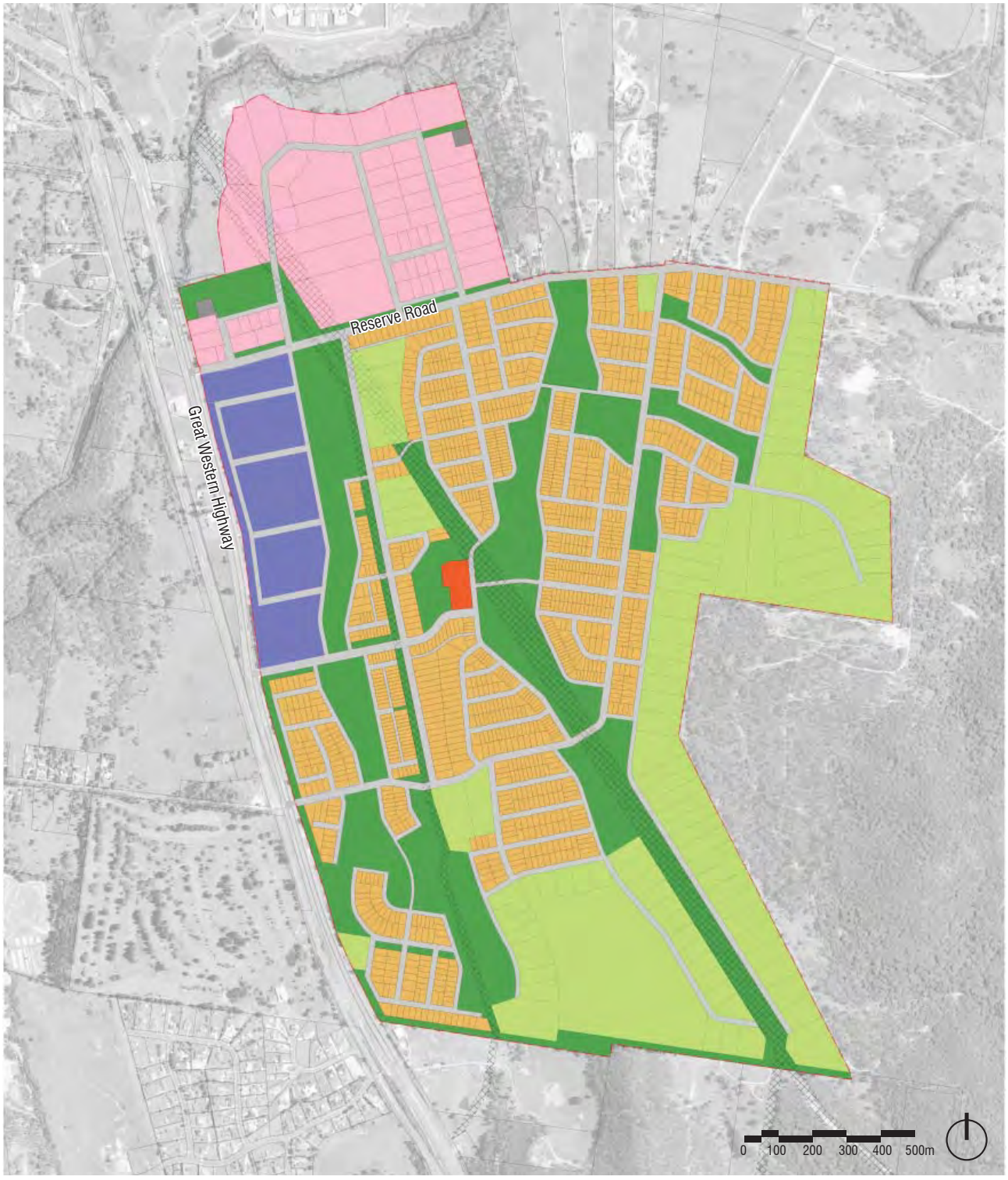
Staging and Implementation

- Provide a robust set of development guidelines to ensure a well considered and consistent outcome into the future
- Recognise the impact of existing property boundaries on staging
- Design and implement cost effective infrastructure for the whole area to support its development
- Locate development near existing services and infrastructure where possible

2. Master Plan

1. Village Centre with retail and community facilities
2. Planted setback to the highway
3. Entry points from the highway
4. Industrial lands
5. Enterprise Corridor
6. Sewer pumping station
7. Open space corridor
8. Residential lots
9. Large residential lots
10. Electrical easement

3. Land Use



- Neighbourhood Centre (B1)
- Industrial (IN1)
- Enterprise Corridor (B6)
- Open Space (RE1)
- General Residential (R1)
- Large Lot Residential(R5)
- Road reserves
- Sewer infrastructure (SP2)

4. Aerial Views

Looking south along the eastern open space corridor

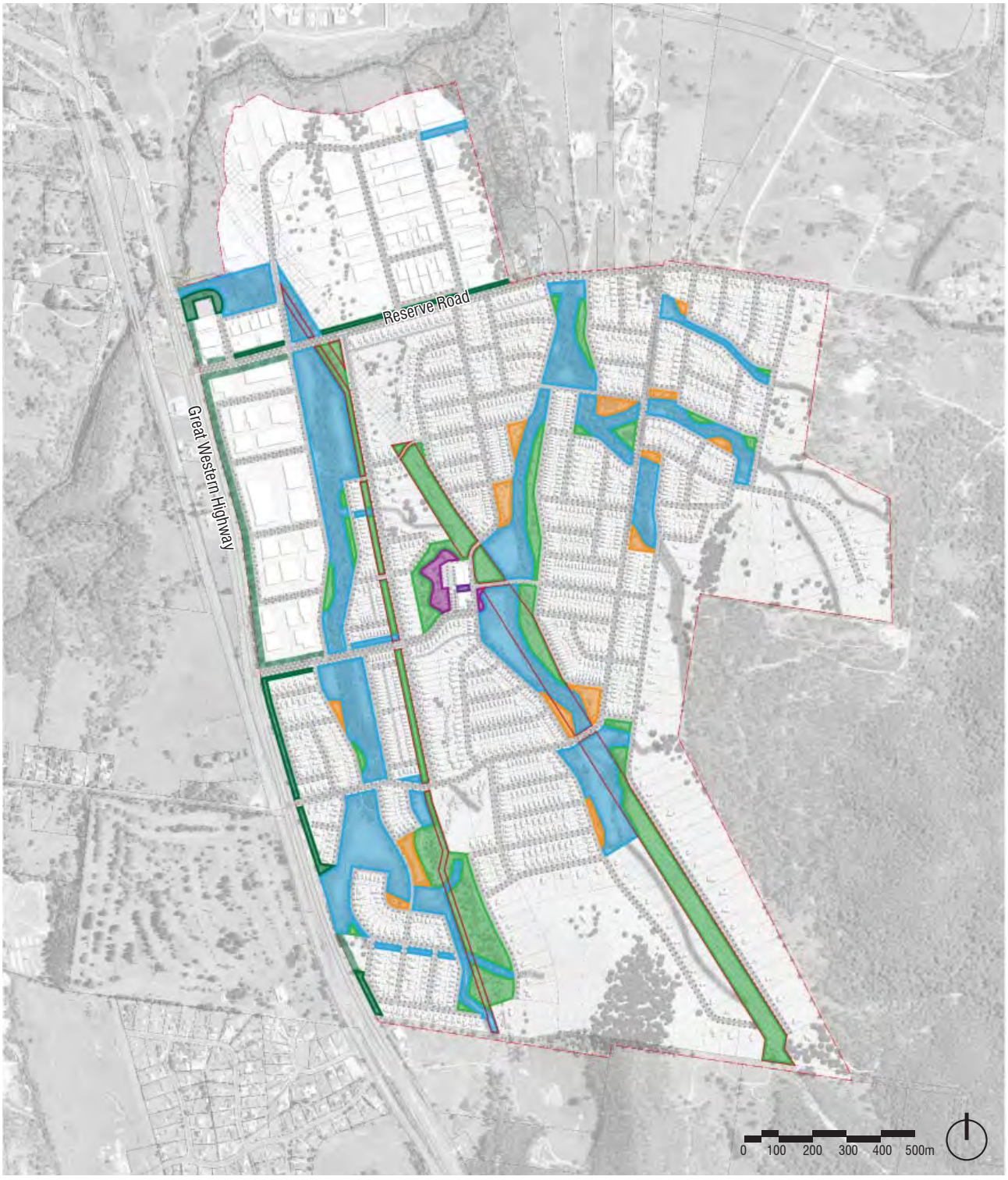
Looking north-east to the village centre across the southern highway intersection

Looking south-east over the employment lands

Looking north towards the village centre

Looking west to the village centre over residential lots and open space

5. Open Space



- Village Square
- Village Park
- Neighbourhood Park
- Drainage Corridors
- Rural Open Space
- Landscape Buffer
- Landscape Buffer - on private land
- Easements - restrictions apply

Village Square

- This will be the focal public space for the village centre
- A flexible space for small community events
- Framed by retail on one side and community uses on the other
- Connects the main street through the village centre to the hilltop village park
- High quality materials with predominantly hard surfaces
- Opportunity for public art
- Consider shade structures and/or awnings for weather protection
- Trees for shade and as a feature
- Seating opportunities

Village Park

- A high quality public park for use by the whole community
- Adjacent to the village centre retail and community facilities with clear access and visual connections
- Play opportunities for all ages incorporated into the overall design of the park
- Picnic shelters and barbecue facilities
- Open lawn to provide a space for informal recreation and events
- Tree planting to frame views and provide shade
- Opportunity for public art
- Viewing deck overlooking the permament water body on eastern side of main street

Neighbourhood Parks

- Local parks that provide opportunities for informal recreation and gathering
- Play opportunities incorporated into the overall design of the parks
- Picnic shelters
- Mixture of native planting and open lawn areas
- Trees to provide shade and visual amenity
- Heavily planted drainage corridors and rocky outcrops provide a backdrop to the parks
- Park furniture include seating and bike racks

Drainage Corridors

- Ephemeral creeks and Water Sensitive Urban Design (WSUD) to manage and treat all of the stormwater drainage for the site
- Heavily planted with local species include wetland species and trees where appropriate
- Largely inaccessible except for pedestrian pathways including creek crossings
- Designed for minimise maintenance requirements once established
- Must comply with DPI Water standards for waterways
- Wayfinding signage at key intersections and pedestrian/cycle routes

Rural Open Space

- Low maintenance open space
- Emphasis on pedestrian connections and enhancing the existing natural and rural qualities of the site
- Includes services easements that are restricted in what they may contain
- Mixture of trees, native planting and open lawn areas
- Limited facilities apart from pathways
- Wayfinding signage at key intersections and pedestrian/cycle routes

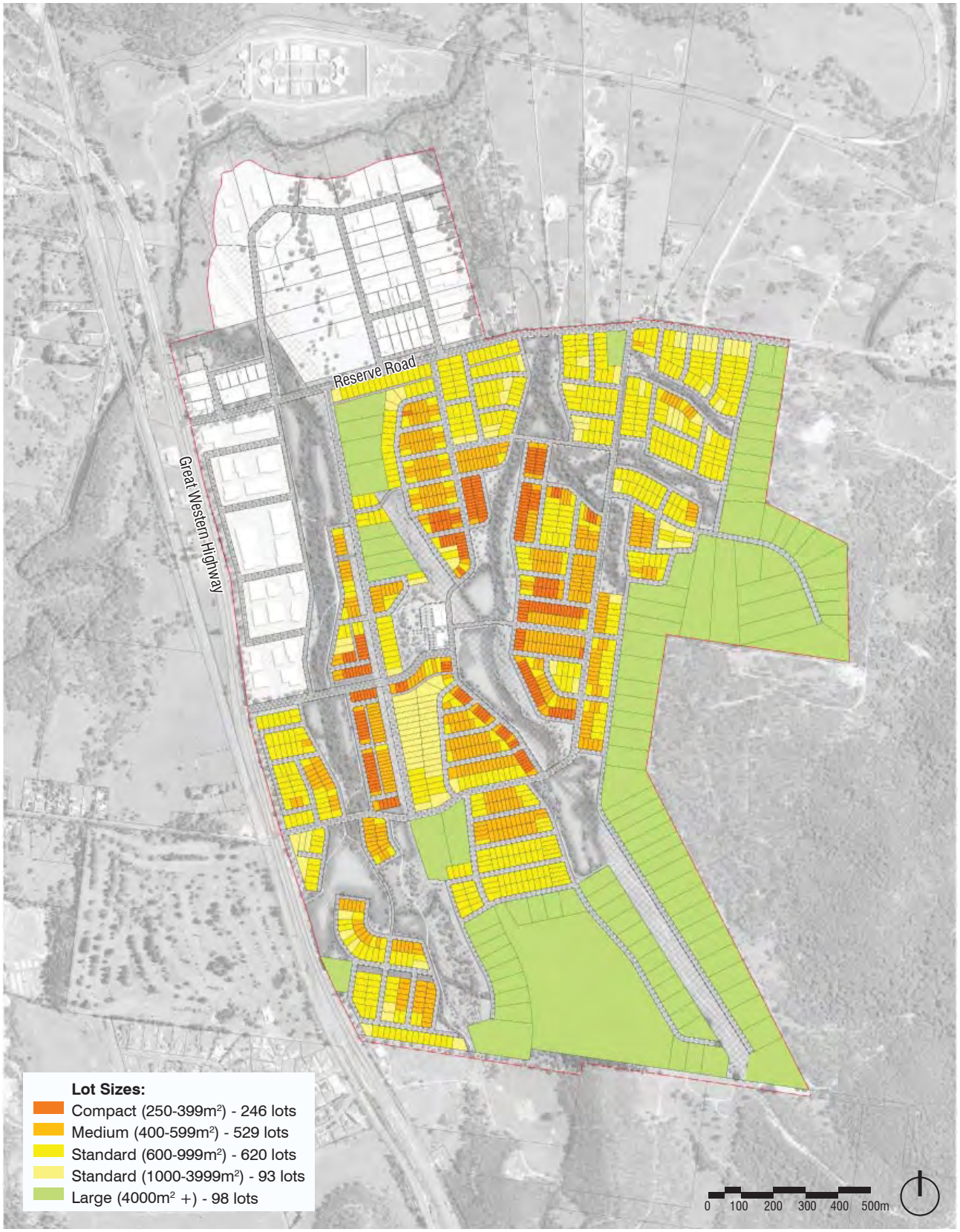
Landscape Buffers

- Heavily planted spaces designed to screen undesirable views and contribute to a green and natural aesthetic
- Layered local species planting including understorey planting, shrubs and trees
- Inaccessible
- Some areas to remain in private ownership including maintenance, specifically the planting around the business enterprise corridor

Easements

- Easements are incorporated into the open space system to provide access as a requirement by the service providers
- Service easements must comply with all requirements and designed in consultation with their relative service providers
- Easements to provide amenity where possible in the form of native planting, paths, water treatment and open lawn areas ,with minimal ongoing maintenance where possible

6. Residential Density



Large Lot Residential

- Greater than 4000m^2 lot size
- Provides for a semi-rural character on large blocks of land
- Located to the outskirts of the development and generally backing onto rural properties or woodlands
- Responds sympathetically to the natural landforms of the area including steeper slopes, creeklines, rocky outcrops and bushfire setbacks

Standard and Medium Lots

- 400-599m^2 lot size for medium, 600-1000m^2 for standard
- Makes up the bulk of the housing product in line with market epectations
- Open to a variety of housing products at one or two storeys

Compact Lots

- 250-399m^2 lot size
- Located in areas of greatest amenity close to the town centre or open space
- Provides another housing typology to increase the overall housing choice and diversity

7. Connectivity

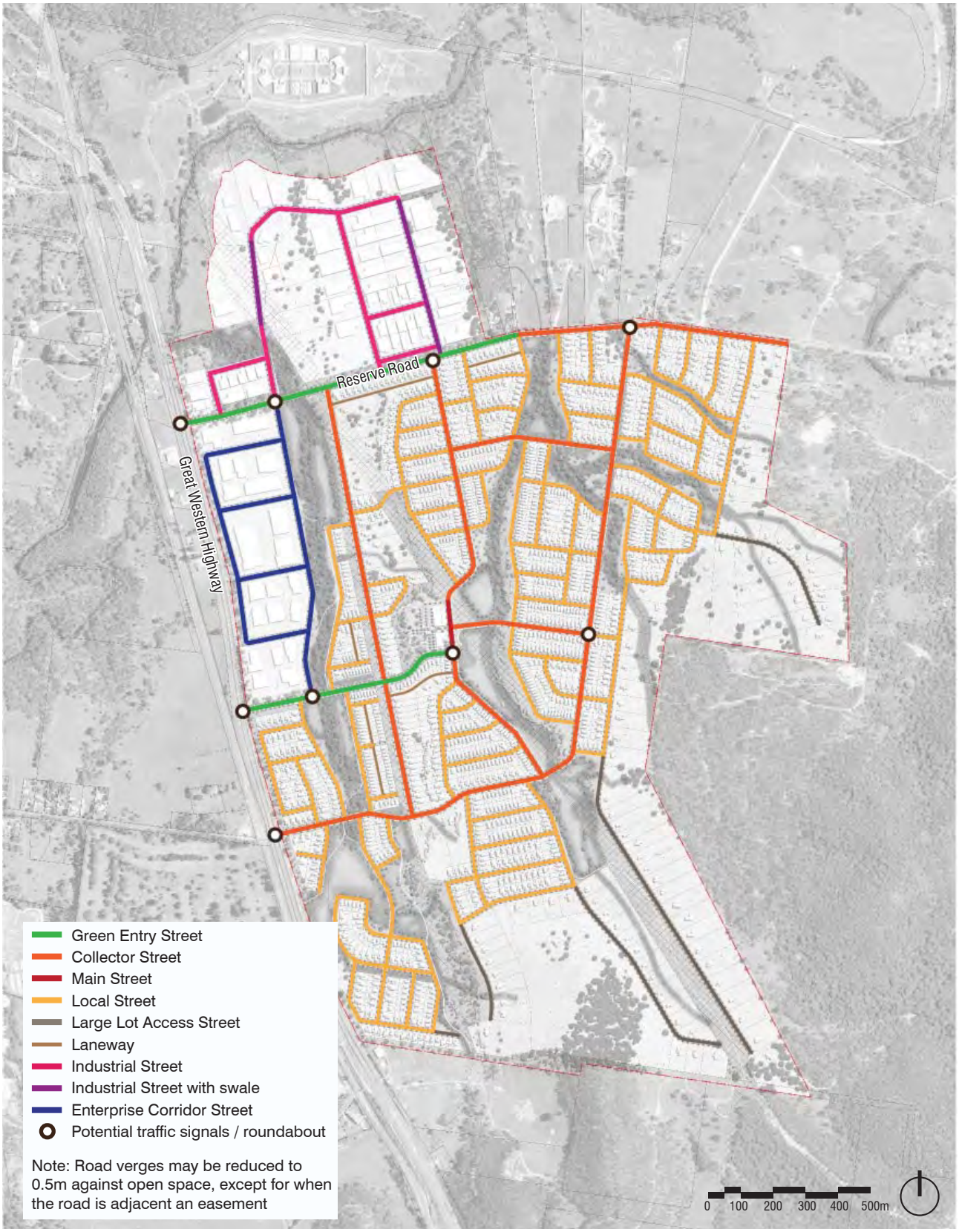


Figure 6: Street Hierarchy

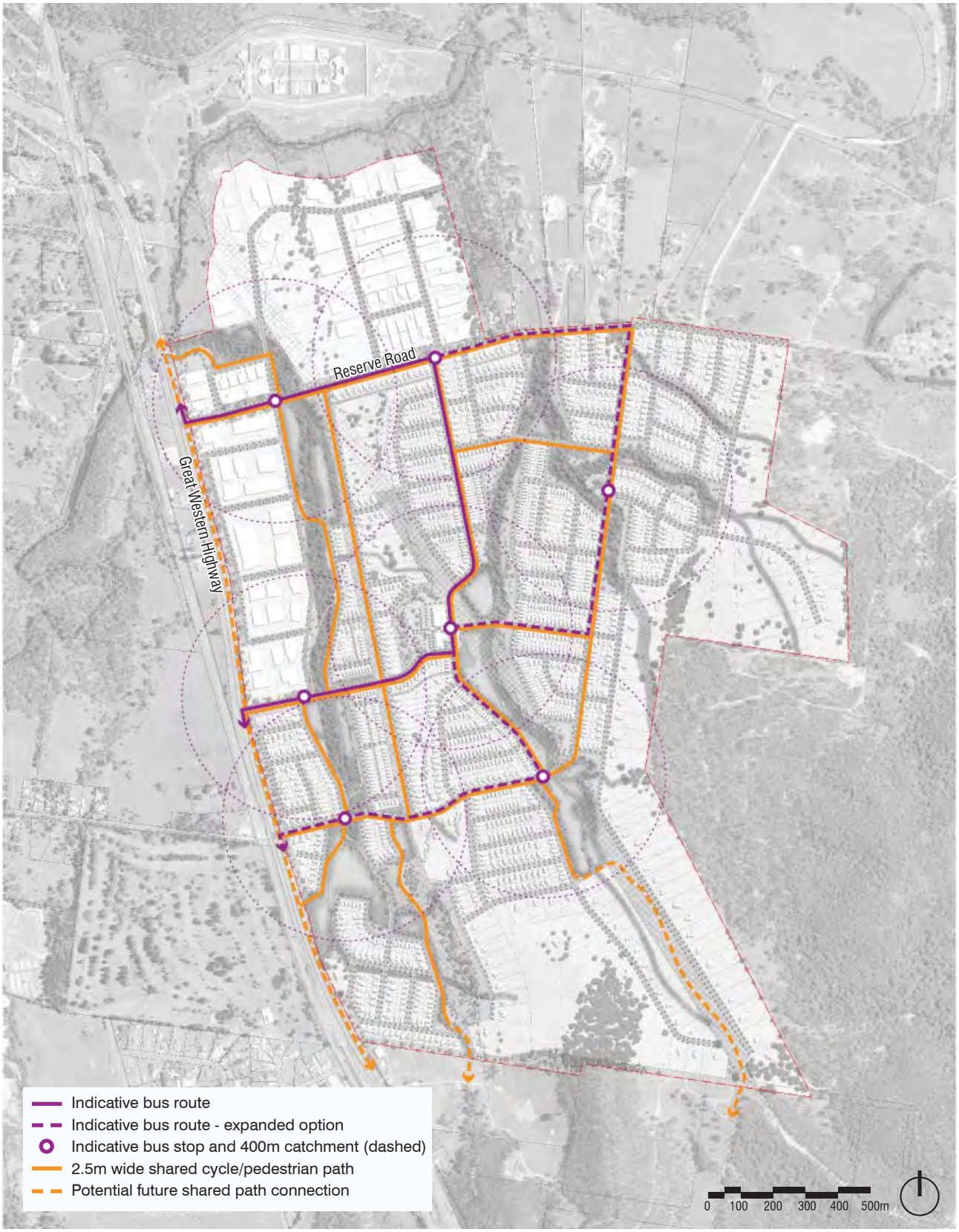
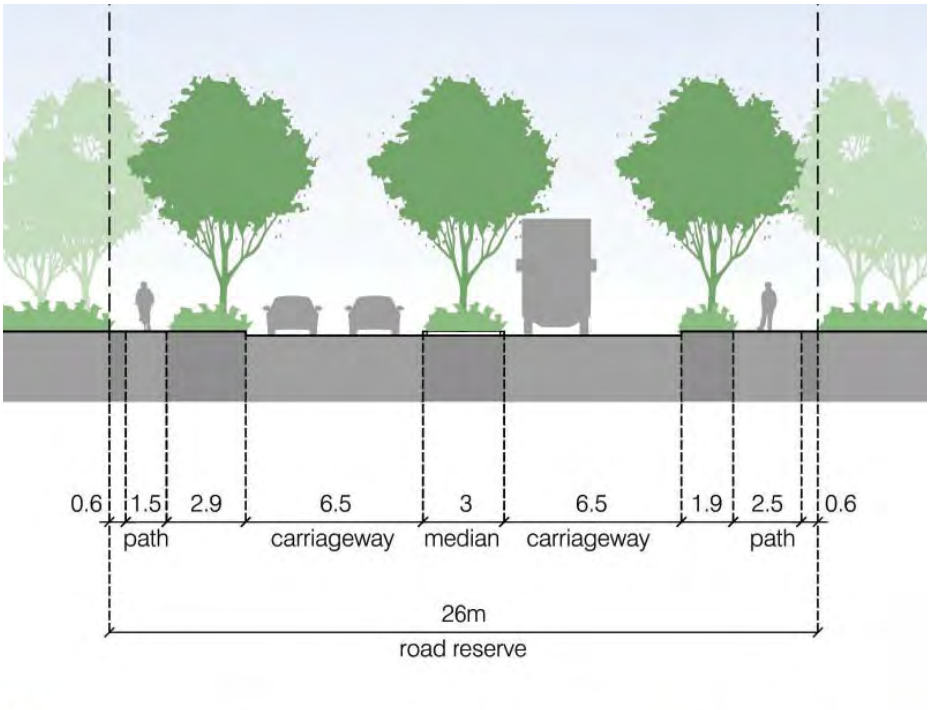


Figure 7: Bus and Cycle network

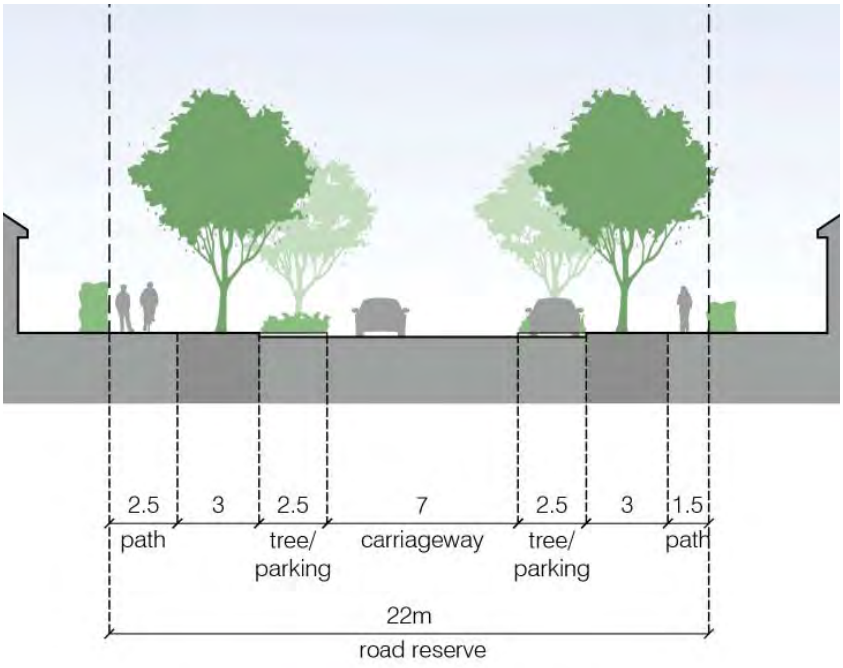
Green Entry Street



Notes:

- Central planted median (with WSUD if appropriate)
- On-street car parking and/or two lanes in each direction
- Footpaths to both sides
- Native low-maintenance verge and median planting
- Street trees at typical 15m centres
- 2.5m shared path to one side - refer to master plan for location

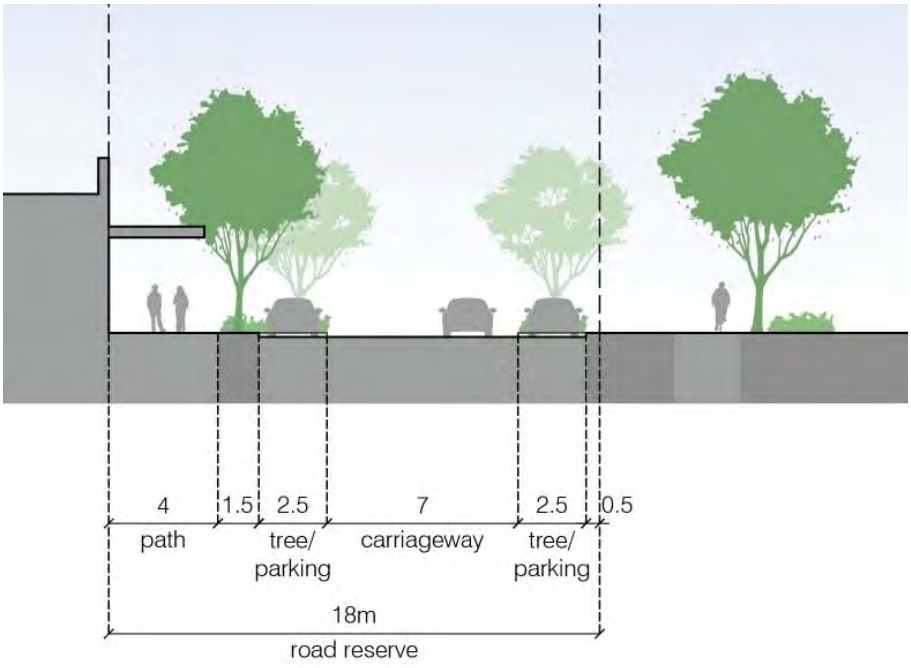
Collector Street



Notes:

- On-street car parking
- Planted tree pits within parking lanes at typical 20m centres
- Footpaths to both sides with turf verges
- Street trees at typical 20m centres (offset with parking lane trees)
- 2.5m shared path to one side - refer to master plan for location

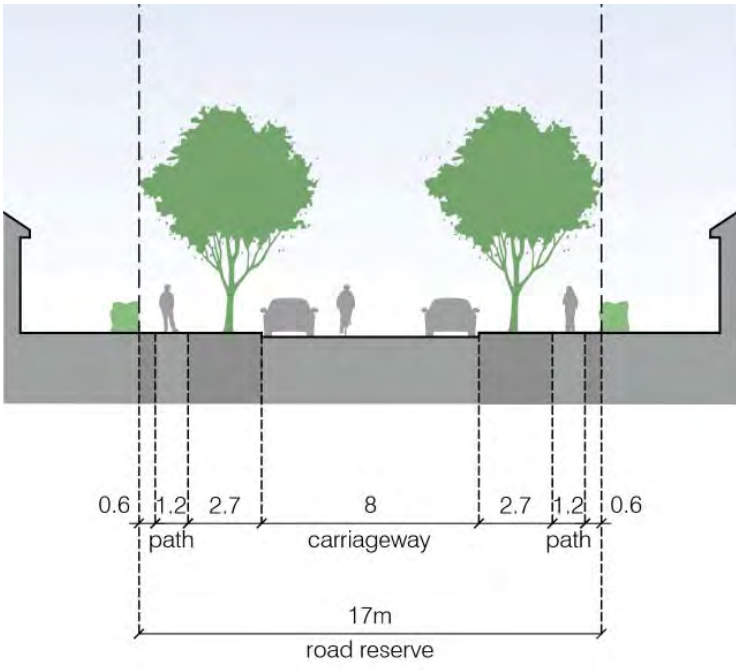
Main Street



Notes:

- Full width paving along the town centre side of the street
- Planted tree pits in the carriageway and footpath
- Street trees at typical 20m centres (offset with parking lane trees)
- Retail built to property boundary with a continuous awning over the footpath

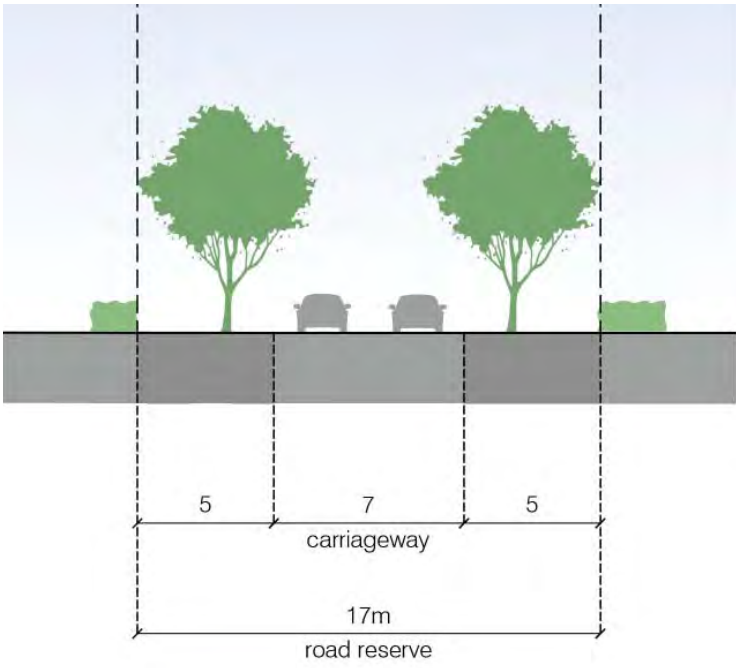
Local Street

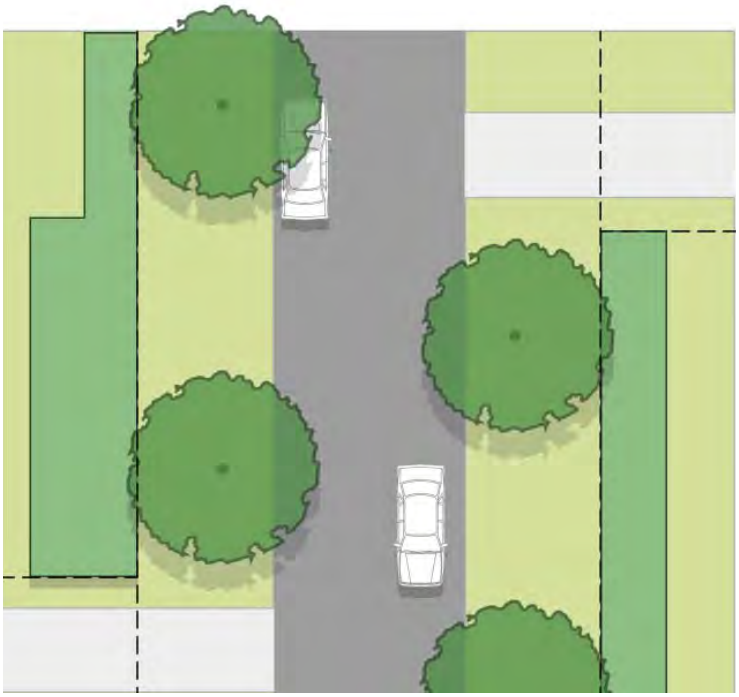


Notes:

- Narrow carriageway with unmarked parking to both sides
- Footpaths to both sides with turf verges
- Street trees at typical 10m centres, with a minimum of 1 tree in front of every lot

Large Lot Access Street

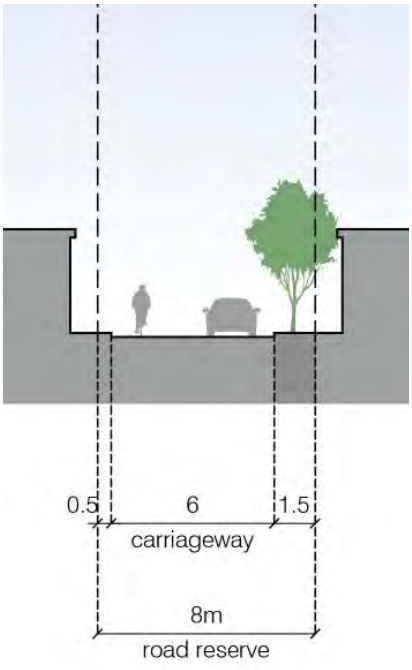


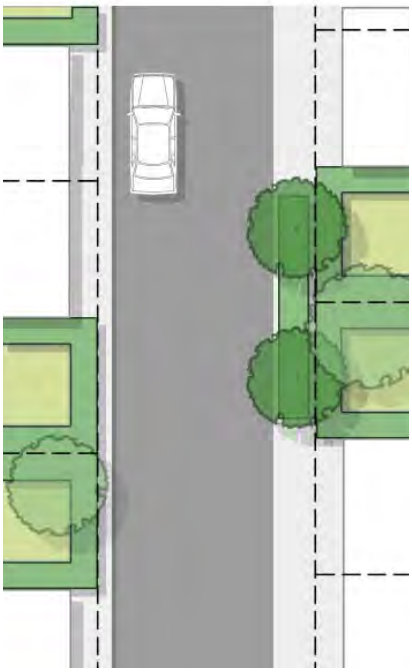


Notes:

- Narrow carriageway
- Turf verges with no footpaths
- Grass swale in verge if required for stormwater drainage
- No upright kerbs to carriageway
- Street trees at typical 10m centres

Laneway

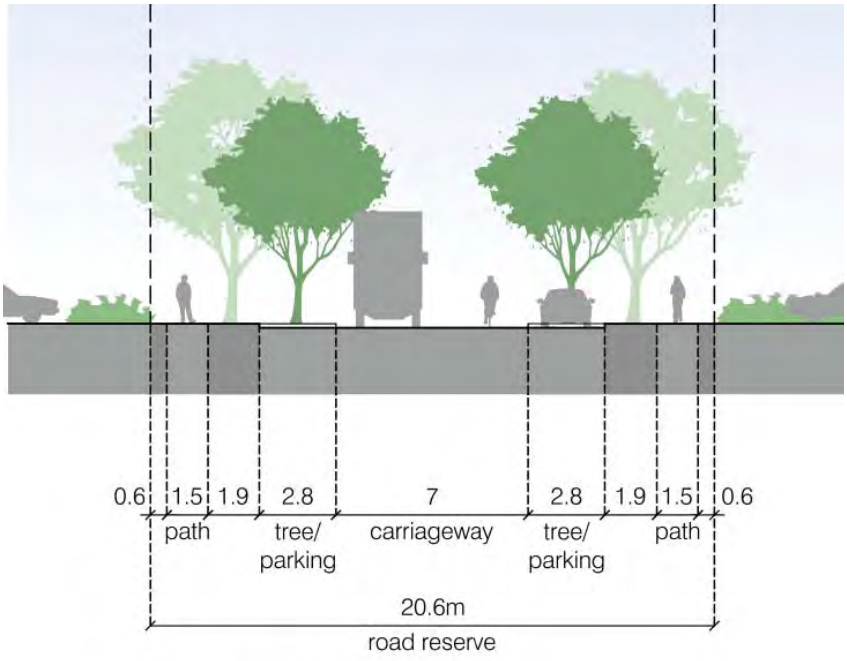


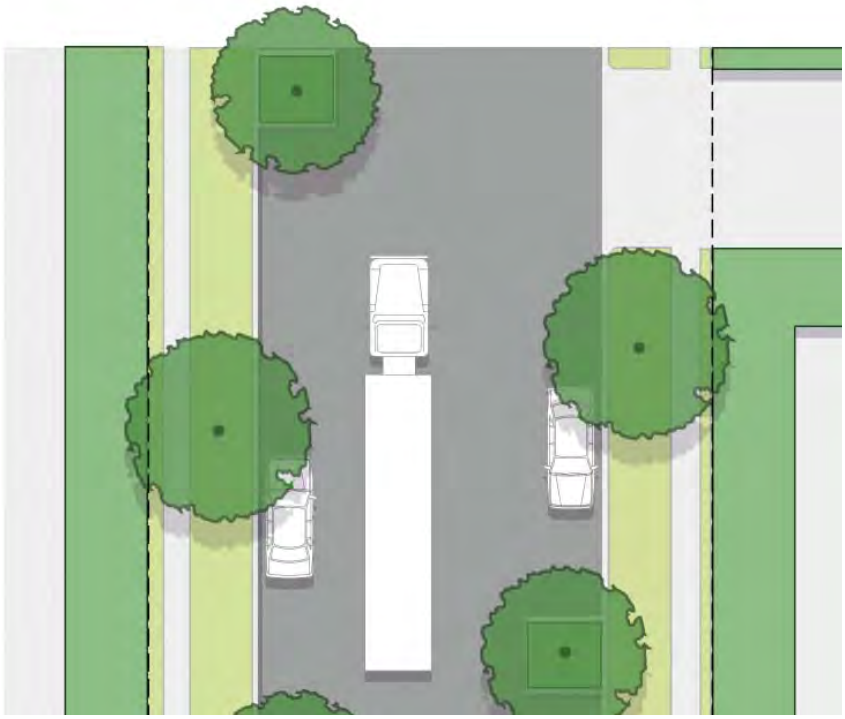


Notes:

- Narrow carriageway
- No footpaths
- No parking
- Rear lane access to residential blocks
- Small street trees to one side

Enterprise Corridor Street

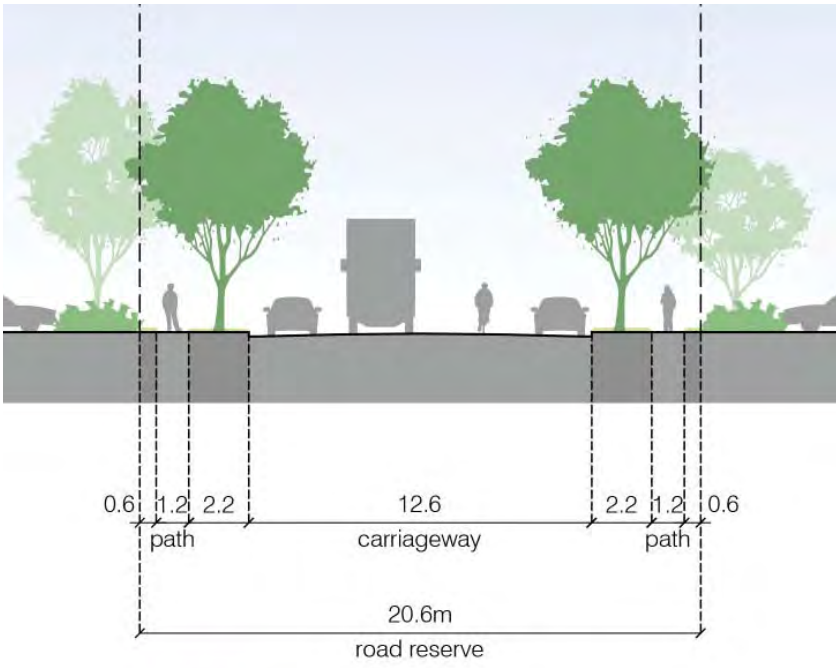


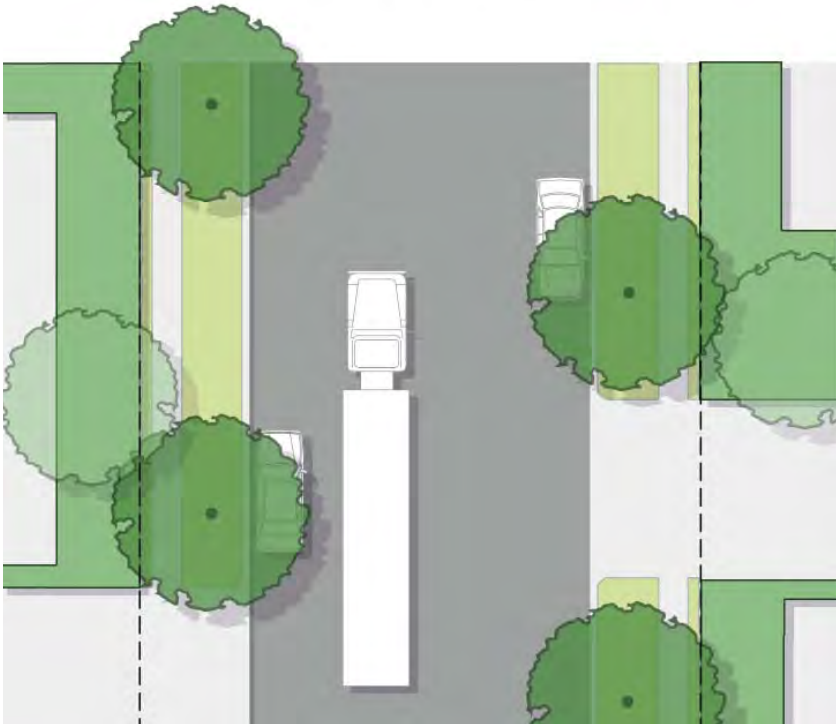


Notes:

- On-street car parking
- Planted tree pits within parking lanes at typical 20m centres
- Footpaths to both sides with turf verges
- Street trees in verge at typical 20m centres (offset with parking lane trees)
- Mixed traffic for cyclists

Industrial Street

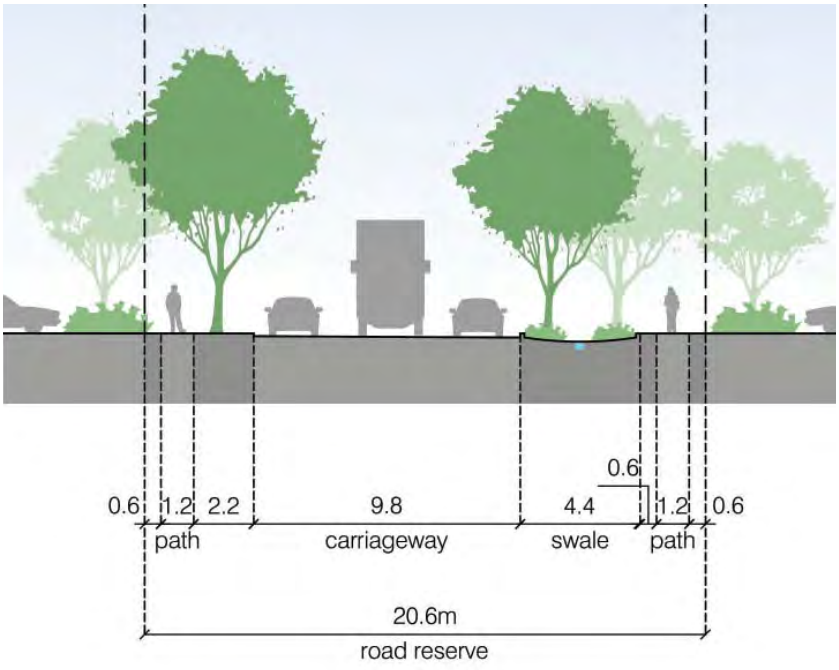




Notes:

- On-street car parking
- Footpaths to both sides with turf verges
- Street trees at typical 15m centres
- Mixed traffic for cyclists

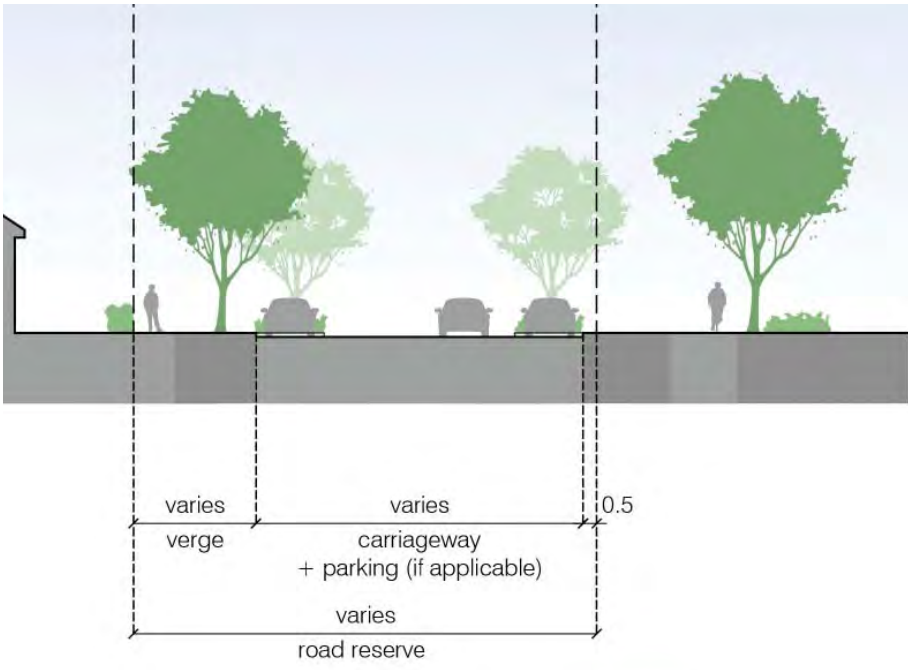
Industrial Street with swale



Notes:

- Drainage swale with native planting
- On-street car parking to one side only - no parking against swale
- Footpaths to both sides
- Street trees at typical 15m centres, informal tree planting along swale
- Mixed traffic for cyclists

Park Edge Street



Notes:

- 500mm verge on park side of the road
- Footpath on park side to be located within park and accessible from the street
- Verge and parking configuration on development side as per street typology
- Option to have on-street car parking and footpath to one side only (No parking against buffer/park edge)

8. Village Centre

At the centre of Marrangaroo will be a compact low-scale village centre to one side of the main street, with a mid block public square and a hilltop park.

The village centre will function as a focal point for day-to-day retail activities with a small grocer and a section of specialty shops. The centre will also include community facilities that will make the centre a destination for local people of all ages and physical abilities.

The centre will face out onto the drainage corridor to the east and overlook the main village park to the west from its position on top of the ridgeline.

The village centre has the potential to enhance the community spirit and identity within the broader Marrangaroo and Lithgow context.

Figure 8: Village Square, retail and community facilities

1. Small grocer
2. Retail facing onto main street
3. Community facilities
4. Village Square
5. Car parking
6. Village Park
7. All-ages playground
8. Rocky outcrops
9. Shared path
10. Electrical easement
11. Stormwater treatment basin
12. Park overlooking the permanent pond
13. Permanent pond

Figure 9: Village Centre

9. Master Plan - Detail Areas

1. Industrial Lands
2. Setbacks to retain views from road
3. Electrical easement
4. Open space and drainage corridor
5. Sewer pumping station
6. Chapel building to be retained
7. Entry street from highway
8. Enterprise Corridor
9. Planted buffer
10. Shared path
11. Large lot residential lots
12. Residential lots
13. Neighbourhood park
14. Village Centre
15. Gas easement

1. Industrial Lands
2. Planted buffer
3. Residential lots
4. Open space and drainage corridor
5. Large lot residential lots
6. Waterways through large lots
7. Electrical easement
8. Village Centre

1. Enterprise Corridor
2. Open space and drainage corridor
3. Village Centre
4. Electrical easement
5. Entry street from highway
6. Planted buffer
7. Gas easement
8. Rocky outcrops
9. Residential lots
10. Shared path
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1. Village Centre
2. Open space and drainage corridor
3. Electrical Easement
4. Waterways through large lots
5. Gas easement
6. Rocky outcrops
7. Residential lots
8. Shared path
9. Large lot residential lots
10. Neighbourhood park

10.Stormwater Management

The Marrangaroo Master Plan promotes current ‘best practice’ Water Sensitive Urban Design (WSUD) principles. WSUD will augment a traditional pit and pipe system. The street network, linear open spaces and public open spaces will facilitate WSUD and water detention.

The main focus of WSUD treatment at Marrangaroo will be the protection of natural systems, the integration of storm water treatment into the landscape, the protection of water quality, and the reduction of runoff and peak flows.

Post development peak flows are to be less than pre-development peak flows, with equal to or better than pre-development water quality, at the development outlets for each overall development site. The adjacent diagram illustrates the indicative water detention measures required to achieve this.

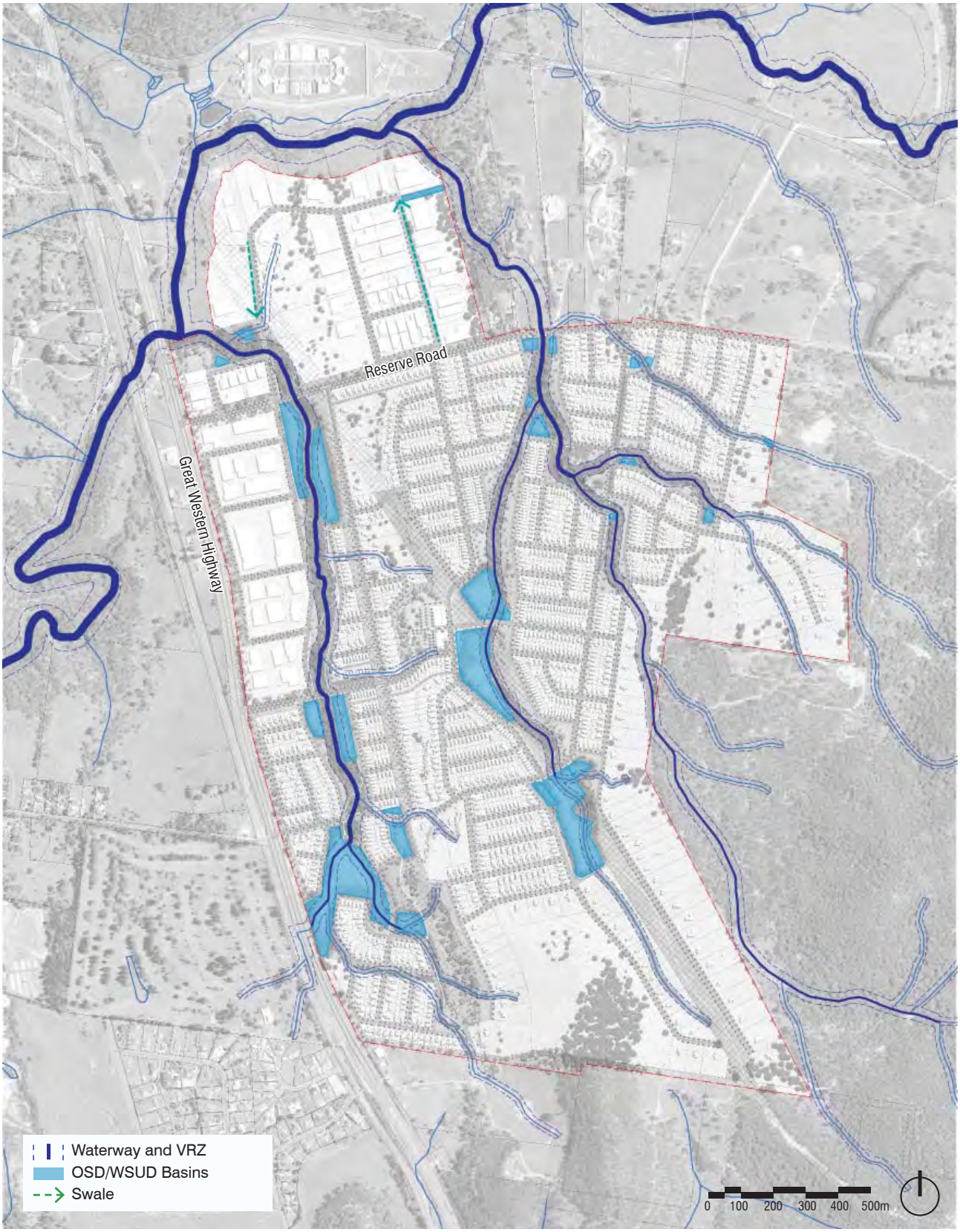


Figure 10: Stormwater Management

11.Staging

The development of Marrangaroo will be a long term process over many years and separate stages.

The development will be staged in line with infrastructure provision, initially taking advantage of existing infrastructure and then staged in tandem with staged infrastructrure provision.

Ultimately, the pace and scope of development will be dependent on individual land owners and will be largely market-driven. Having this Master Plan and the DCP in place ensures that individual stages remain part of an overall plan and vision for the area.

Infrastructure Staging

Indicative infrastructure staging for Marrangaroo is summarised in Figure 11 based on 2 stages relating to the catchments as shown. The recommended trunk infrastructure works for water and wastewater for each stage are outlined below. For more information refer to the full infrastructure report in the Appendix.

Water Supply Infrastructure

Stage 1:

- Clean and refurbishment of existing DN250 - no additional infrastructure required

Stage 2:

- Construction of a 5ML reservoir
- Construction of transfer main from Fish River Scheme (500 m DN300 transfer main)

Wastewater Infrastructure

Stage 1:

- Construction of a Sewerage Pumping Station
- Dual rising mains to Sewerage Treatment Plant (5km)

Stage 2:

- Construction of a second Sewerage Pumping Station
- Rising main to first SPS

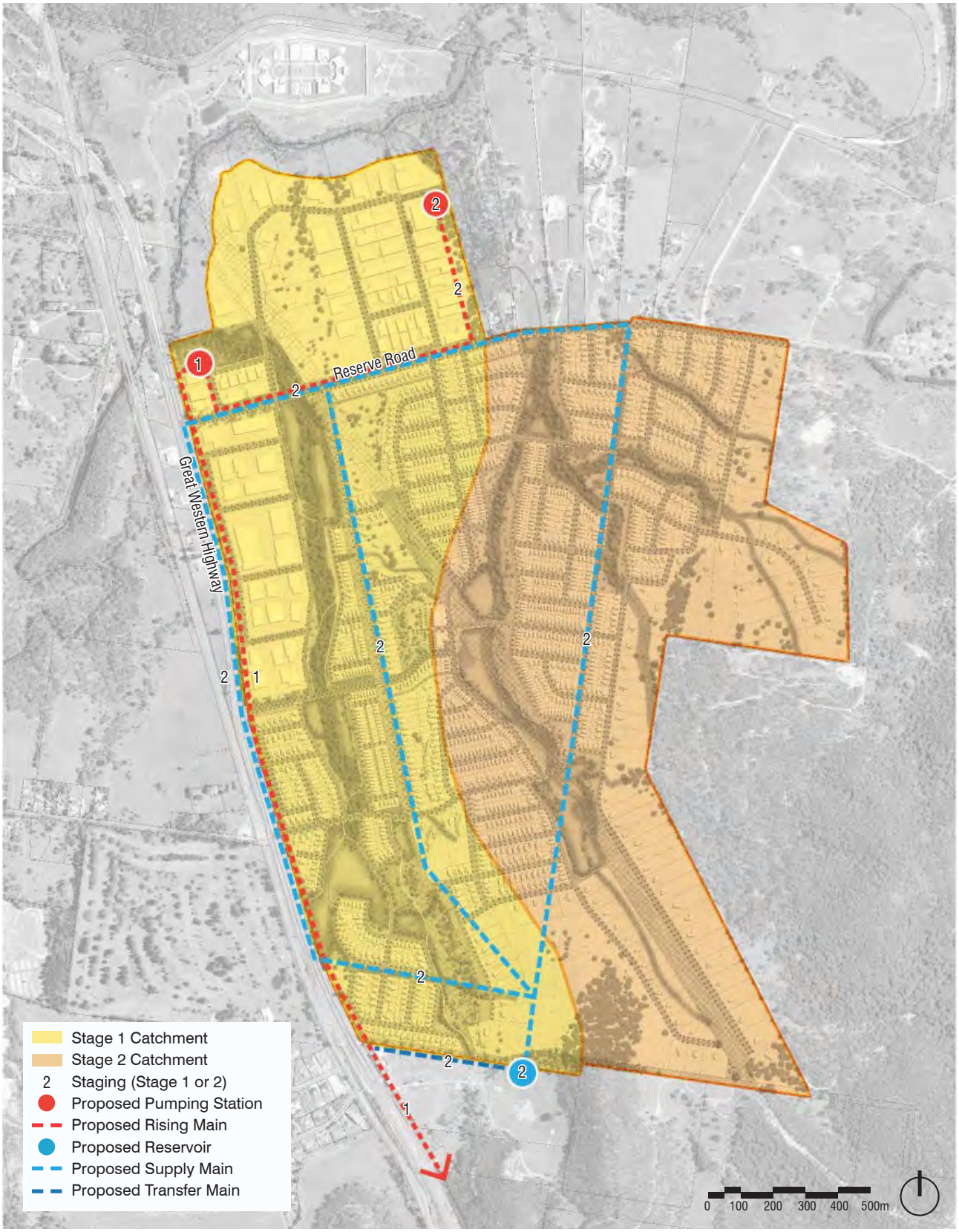
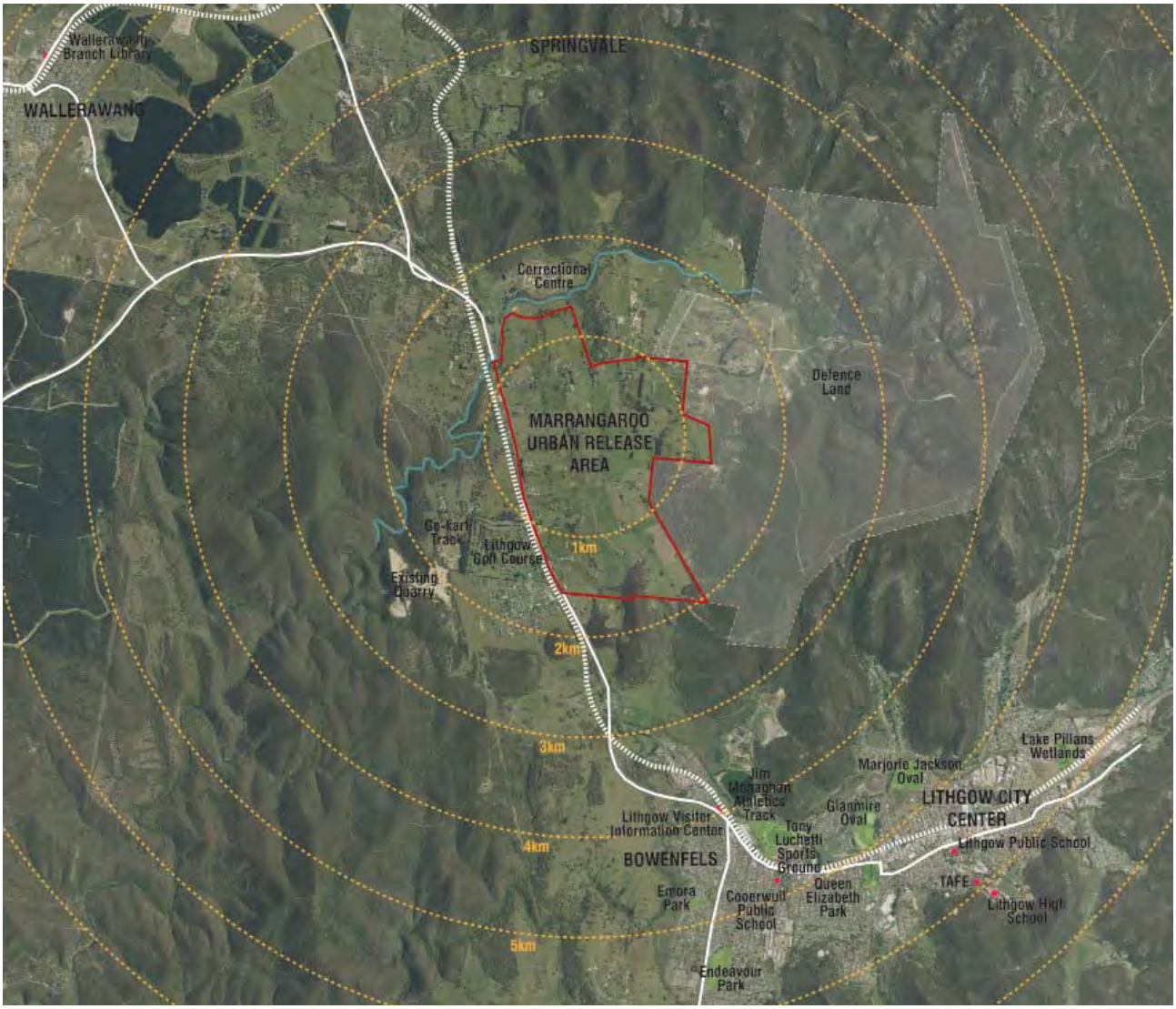


Figure 11: Infrastructure Staging

Appendix

1. Site Analysis



Location and Context

The Marrangaroo Project Area is located approximately mid way between the urban centres of Lithgow and Wallerawang and approximately 150km west-north-west of Sydney.

The area and immediate surrounds are enclosed by steep and vegetated slopes and the area is bounded on the east by the Great Western Highway.

The project area is predominantly semi rural in character with scattered rural lifestyle development and highway service land use including a motel and service station. A maximum security correctional centre adjoins the employment lands to the north with the western most boundary of the project area adjoining a defence facility.

The project area comprises 339.22ha of land within the Marrangaroo Urban Release Area (URA) and 54.85ha of IN1 zoned land (employment lands as mapped in Lithgow Local Environmental Plan 2014). Within the URA there is 41.22 ha of land zoned for B6 Business Corridor and 298 ha of land zoned R1 General Residential.

The Project Area has approximately 38 individual landowners with one land holding of 143.9ha in single ownership in the centre of the URA representing 36.4 % of the project land area or 42.4% of the URA land area.

Figure 12: Site Context and Location

Recent Industrial Development

Ephemeral creeks

Open farmland and rolling hills

Rocky scarps

Highway service station

Rural residential houses

Mature vegetation and surrounding woodland

Heritage chapel

Figure 13: Existing Character

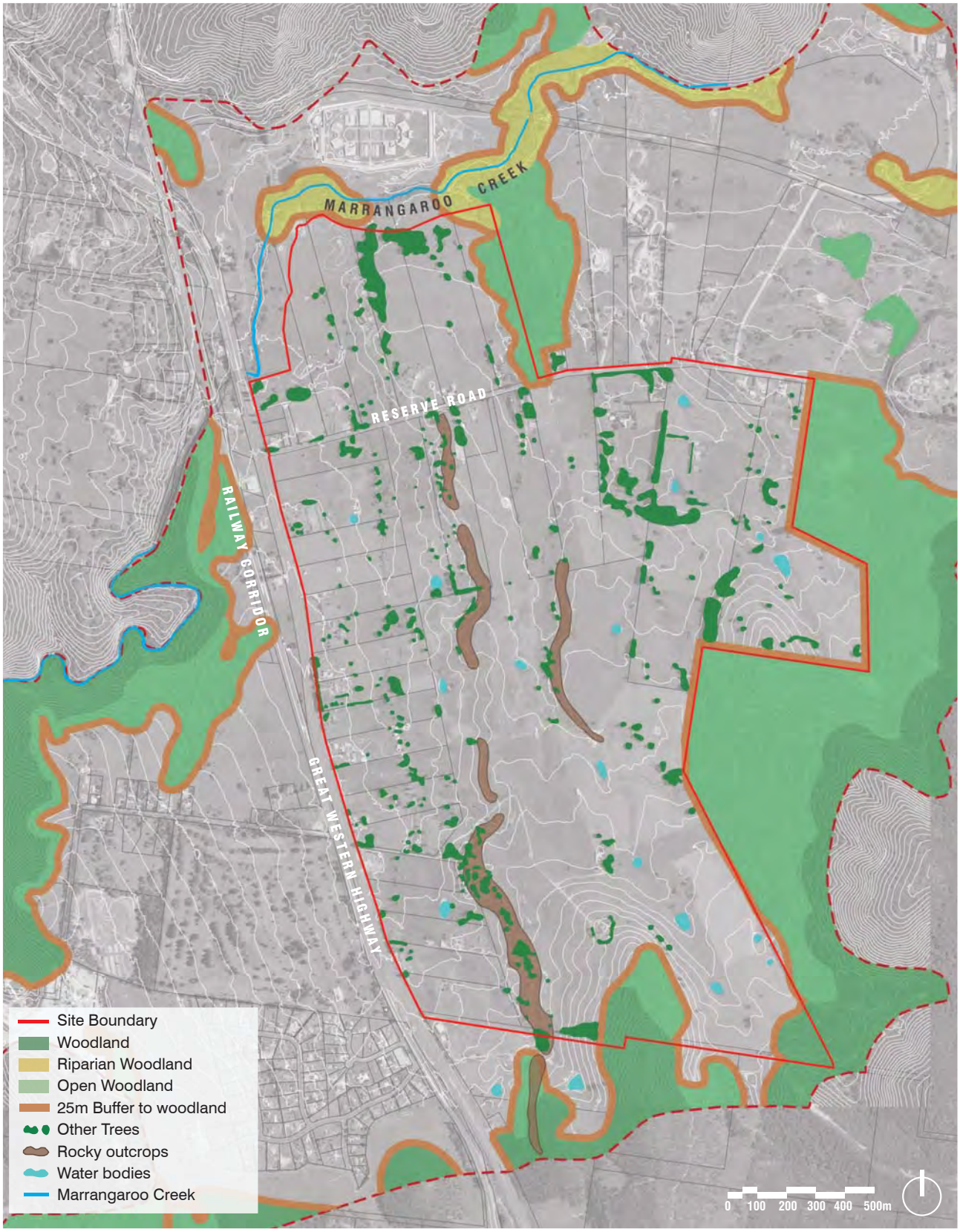


Figure 14: Natural Features

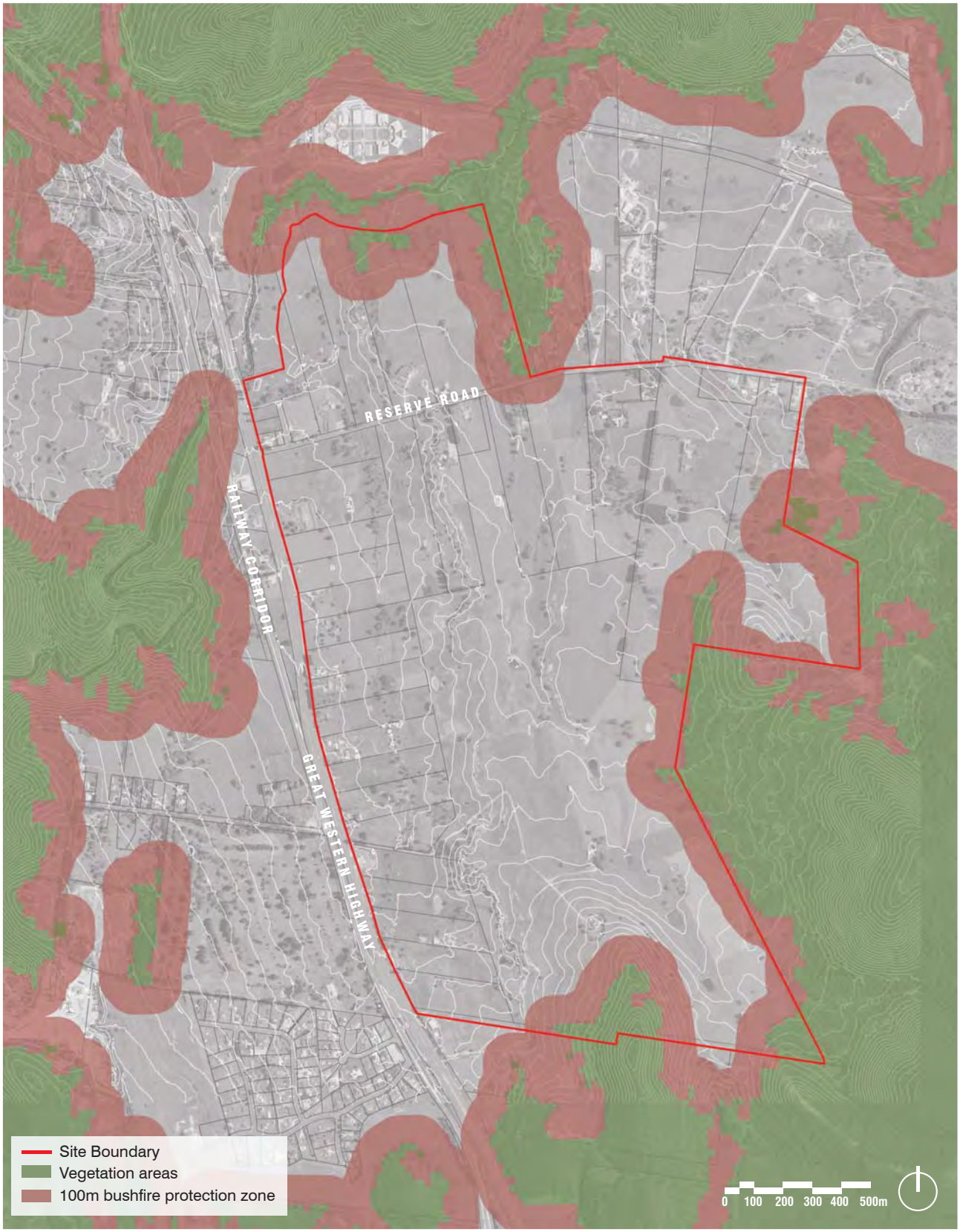


Figure 15: Bushfire Assessment

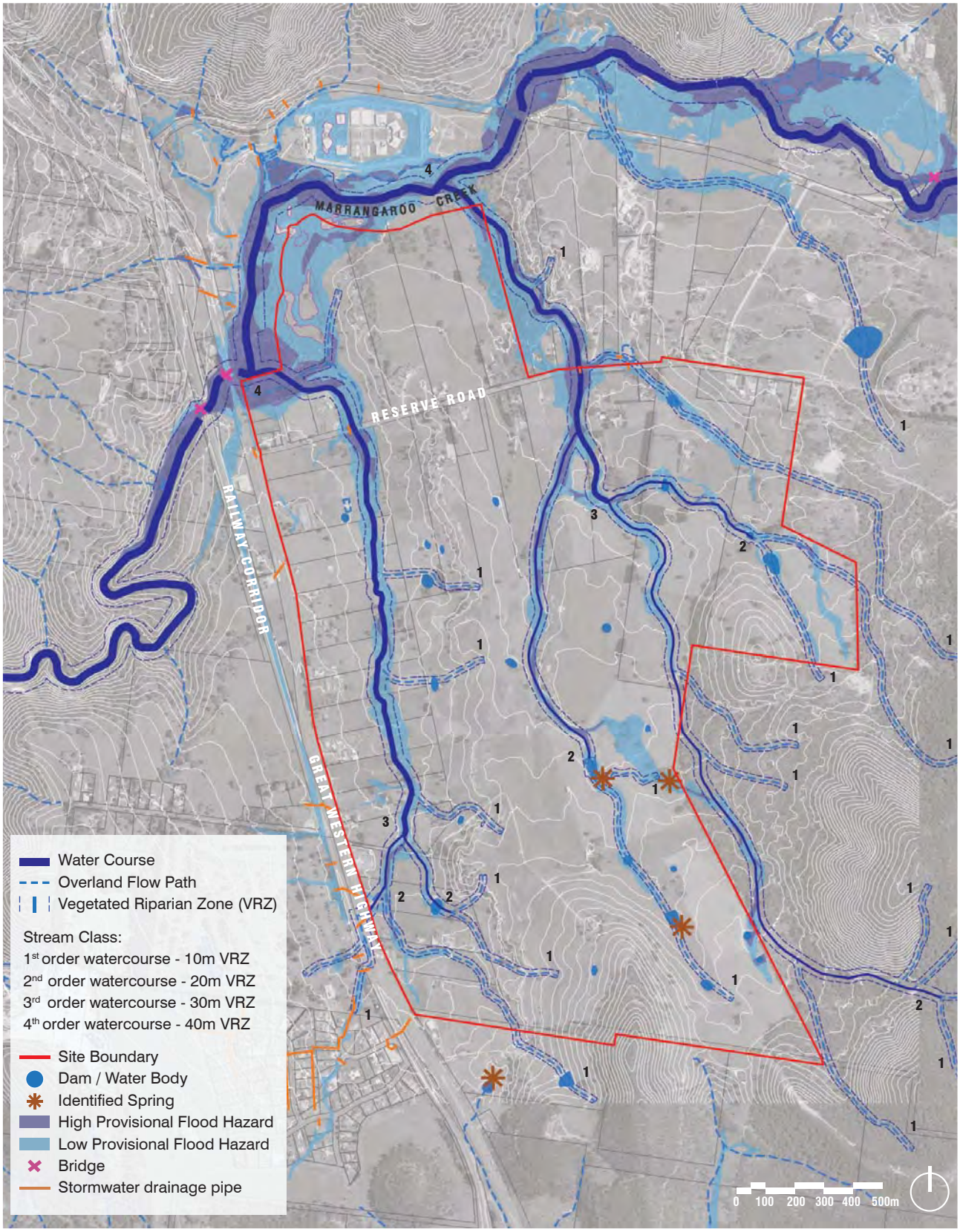


Figure 16: Hydrology, Flooding and Stormwater Management

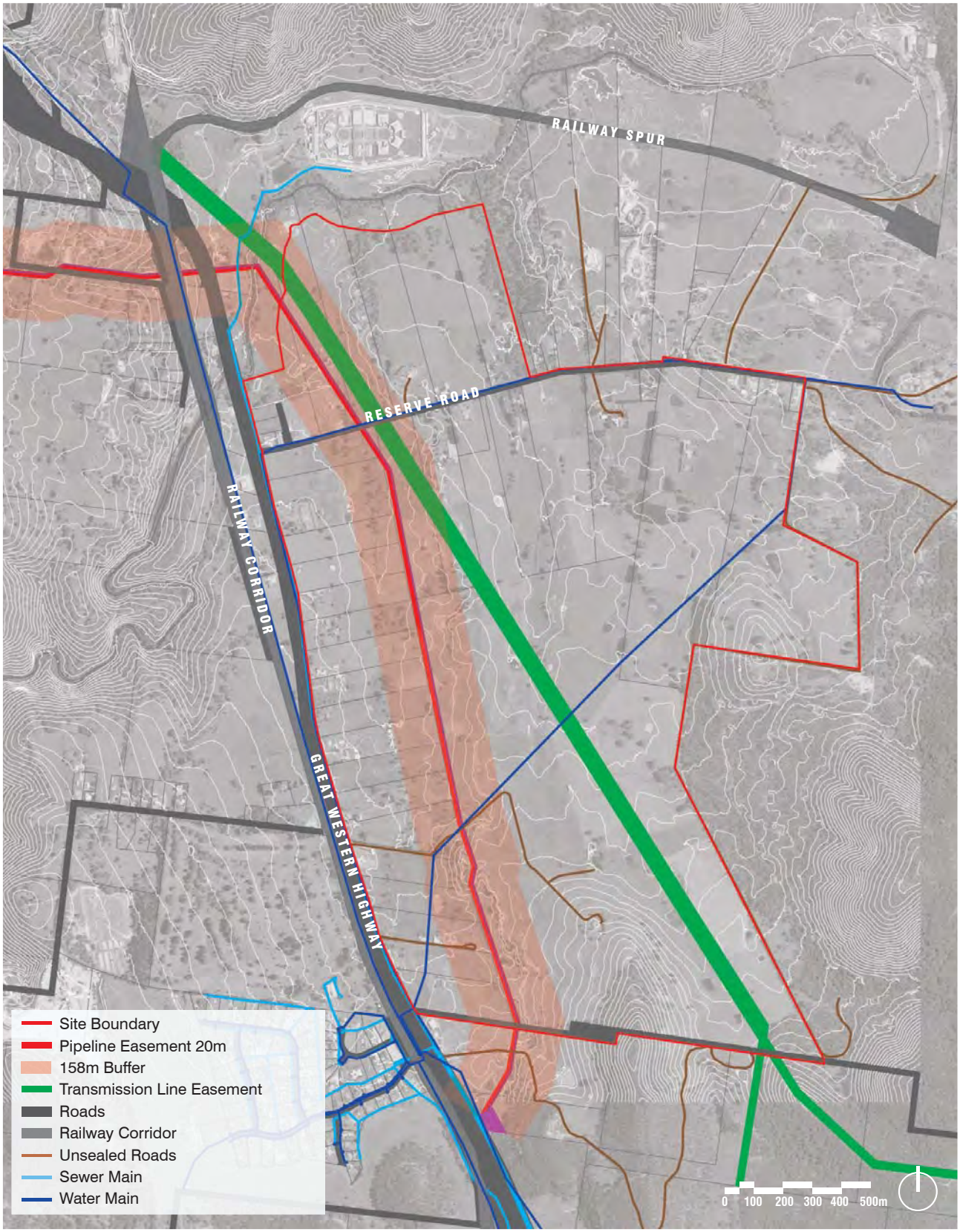


Figure 17: Infrastructure

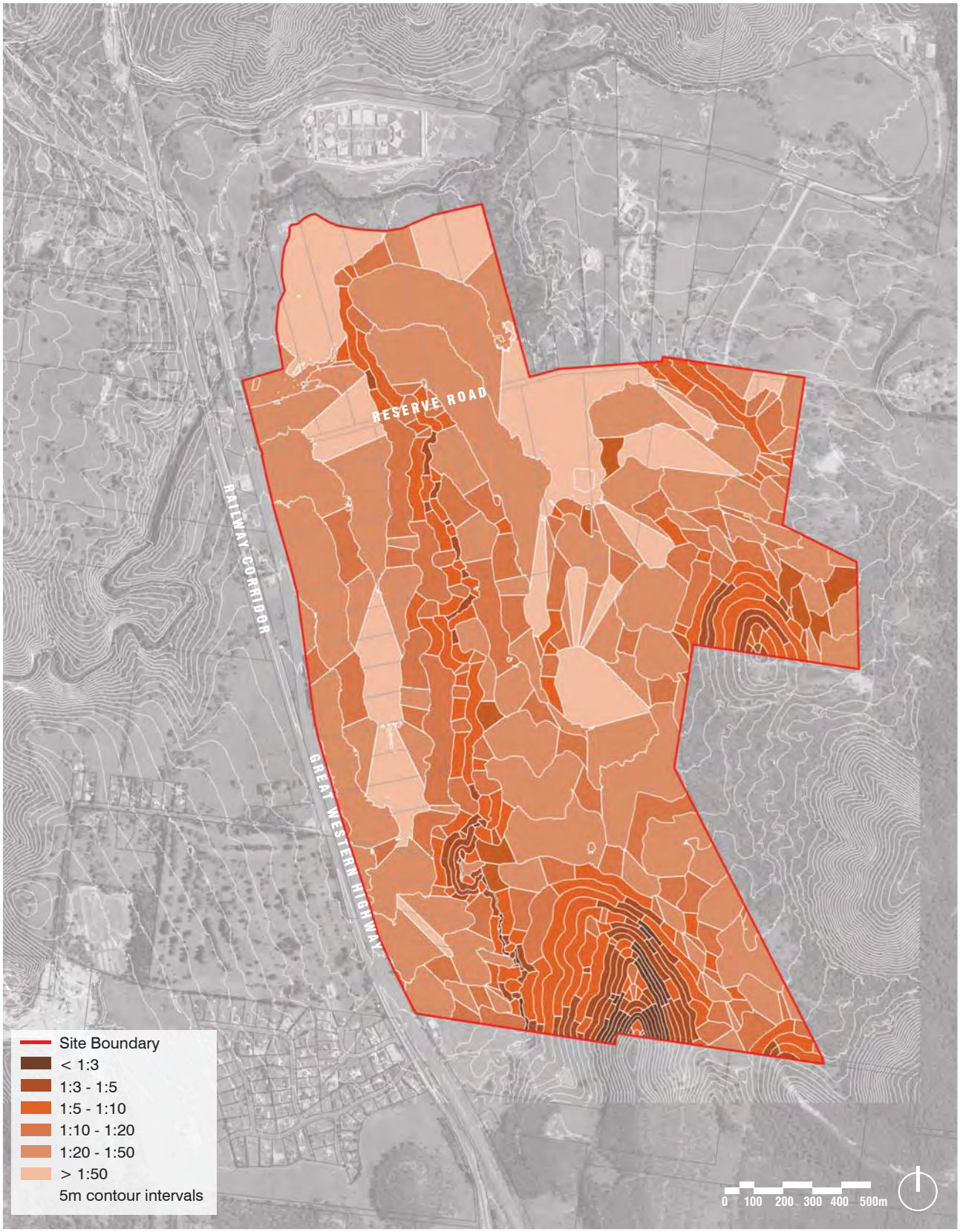


Figure 18: Slope Analysis

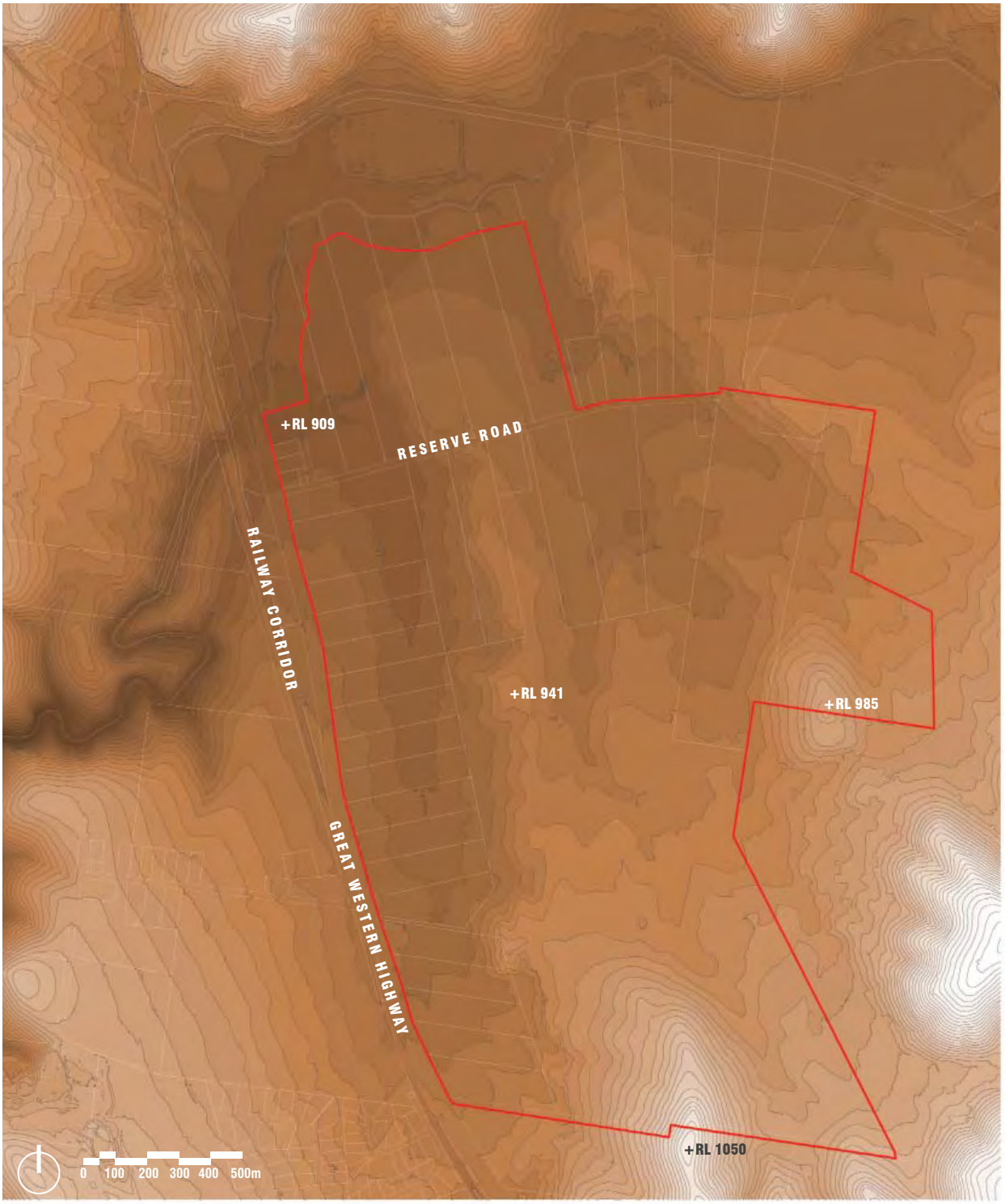


Figure 19: Topography

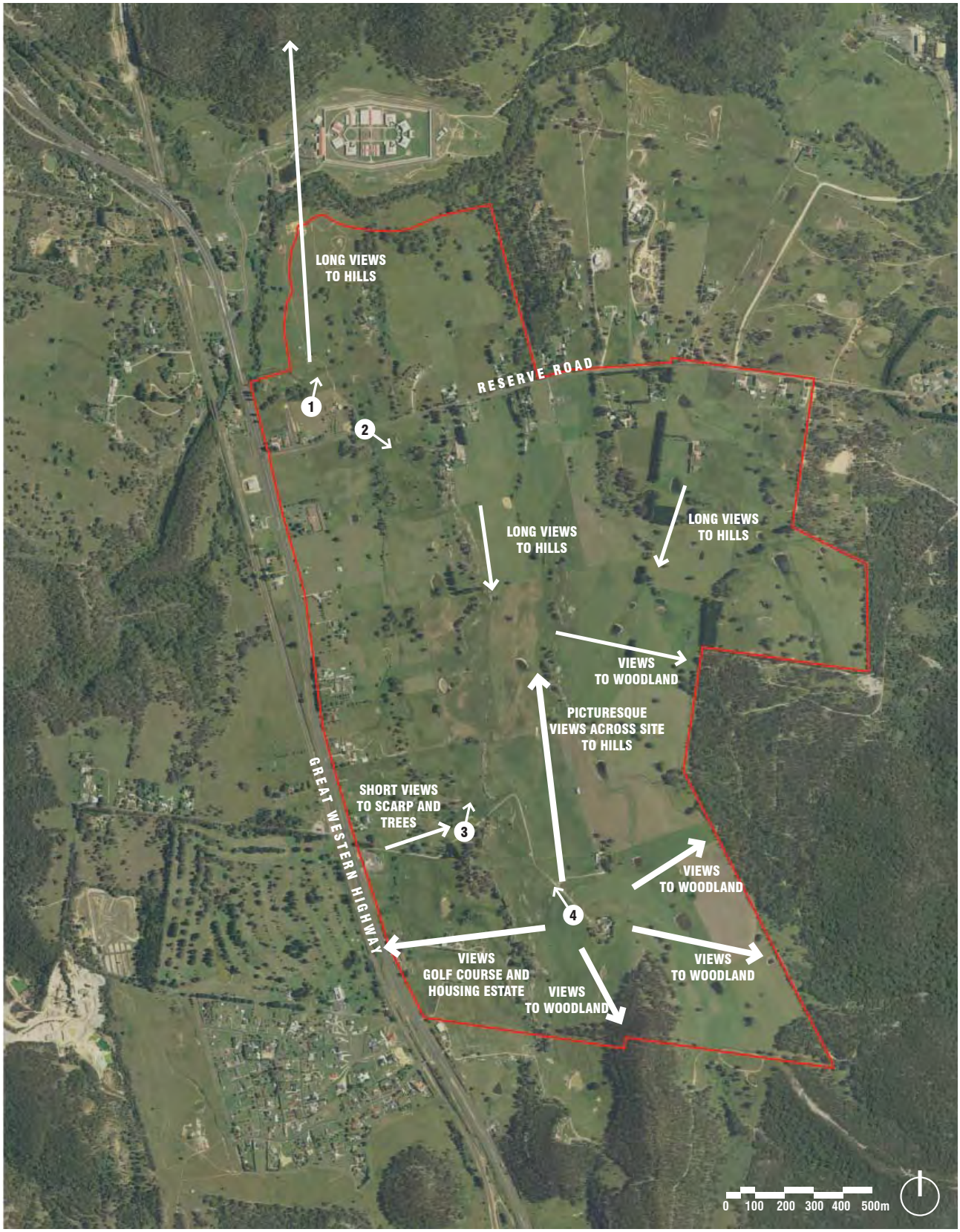


Figure 20: Views

Figure 21: Views

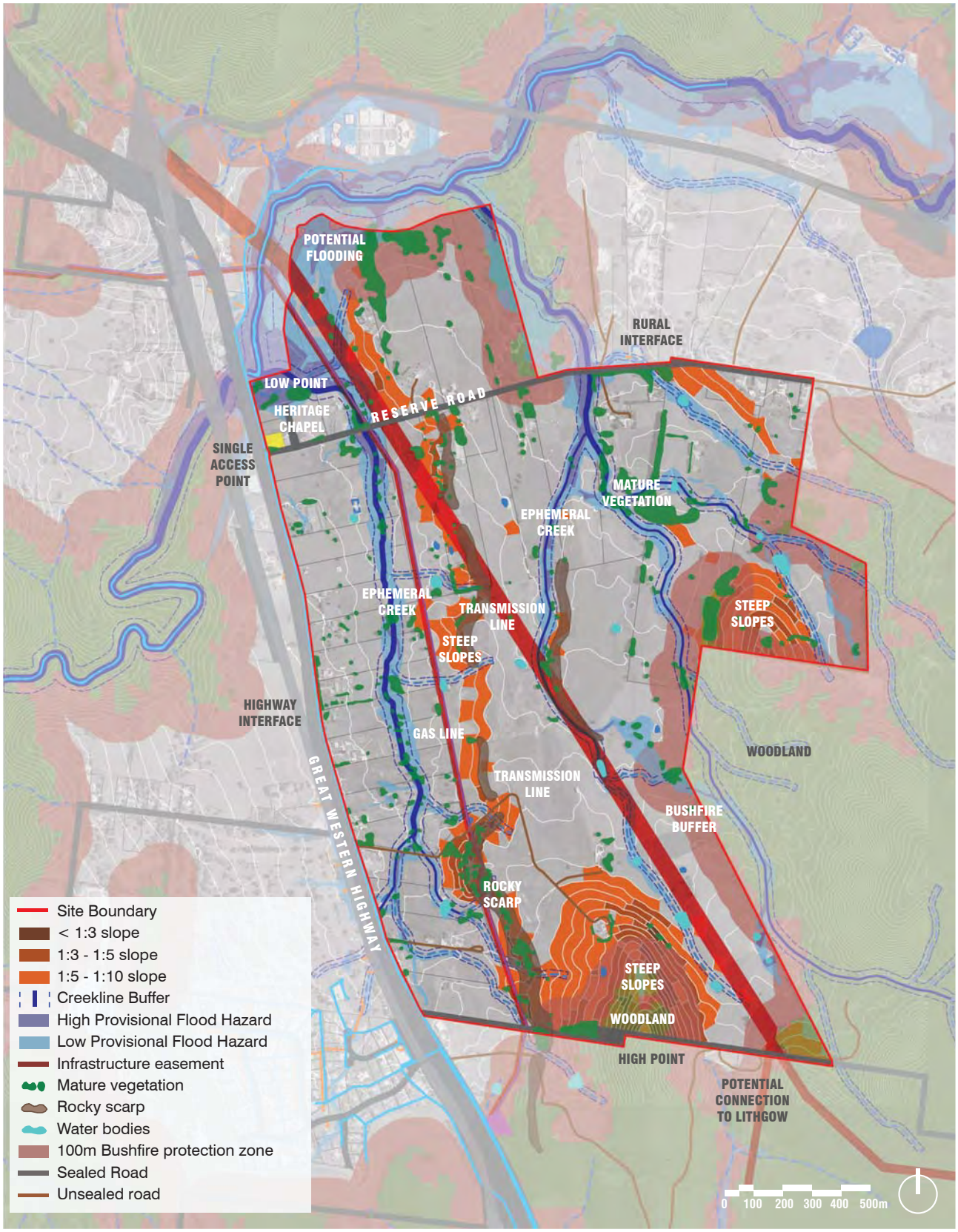


Figure 22: Constraints

Constraints and Considerations

Location and Context

- The site is physically separated from Lithgow with the topography providing a visual and physical barrier and car access available only via the Great Western Highway. This provides the opportunity to make Marrangaroo a distinct place of it's own.
- The site's projected population and proximity to Lithgow mean that the development will rely on Lithgow for many essential services, including schools and community facilities.

Land Ownership

- Existing lot boundaries and ownership will impact on staging and future development boundaries. Individual landowner's stances on development to be acknowledged.
- Having one landowner for 36% of the site area reduces the constraints on the site.

Heritage

- The chapel at the corner of Reserve Road and the highway is the only heritage constraint.

Natural Features

- The site has significant woodland areas to the north, south and east with associated environmental protection and bushfire buffers. These areas also provide a picturesque backdrop to any future development.
- There are a large number of mature trees on site that should be retained where possible.
- Rocky outcrops create a natural feature that should be retained where possible.
- Several ephemeral feeder creeks run north-south across the site. These have associated environmental protection buffers that pose a constraint to development.

Slope and Topography

- Steep slopes occur across parts of the site, including a north-south stretch of land that divides the site as well as two hills to the south and east.
- The topography generally slopes down to the north, resulting in the best views across the site and to surrounding areas from the south.
- The topography creates a natural division between the site and Lithgow, with potential future pedestrian and/or vehicle access via a saddle to the south of the site.

Drainage and Hydrology

- Potential flood zones occur along the creek lines.
- Existing creeks, dams/water bodies and overland flow paths to be incorporated into the overall drainage strategy.
- Any increased drainage load resulting from development will need to be accommodated in water sensitive design measures across the site.

Infrastructure

Roads

- Reserve Road is currently the only sealed road within the site.
- Access from Great Western Highway to be limited to Reserve Road and one other left-in / left-out access point.

Water

- Limited water infrastructure - Current water infrastructure under councils control includes 100mm water main along Reserve Road and 250mm water main along the Great Western Highway.
- Additional reservoir required north of the site (no smaller than 20ML)

Sewer

- Dedicated trunk infrastructure to Lithgow STP required for future development (current infrastructure at capacity)

Gas

- Existing gas line with 20m easement runs N-S through the site and constrains development
- 160m buffer zone to gas line to be confirmed - this would be a major constraint to development

Electricity

- Minor transmission lines run across the site - potential to redirect with development to be explored

2. Infrastructure Report

Infrastructure Strategy Report

Marrangaroo

80217025

Prepared for
OCULUS

November 2017

Cardno
Shaping the Future

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1	22/03/17	Issued for client review	MP			
2	20/10/17	Stormwater Management plan updated, Issued for client review	PL		MP	

Table of Contents

Tables

Figures

1 Introduction

Cardno (NSW/ACT) has been commissioned by OCULUS to develop a concept stormwater management strategy, site access options and carry out initial investigations for the services infrastructure to facilitate development planning of a residential and industrial subdivision at Marrangaroo.

The proposed development site is located within the Marrangaroo Urban Release Area as shown in the LEP Rezoning Map, 2014. The site is bounded by Marrangaroo Creek to the North, Special Purpose Zone to the east, Environmental Management Zone to the south and Great Western Highway to the west. The total site area is approximately 390ha. Majority of the site is currently used for cattle and sheep grazing. There are some rural residential area and commercial developments along the Great Western Highway.

This report documents desktop investigations of the traffic analysis for the future trip generation, site access from GWH, stormwater management strategy for the quality and quantity control, services infrastructure near the site and the services required for the development of Marrangaroo Precinct.

This report is prepared based on the desktop investigation for concept only and detailed modelling was not carried out.

The services infrastructure will require lead7ins to service the proposed development. It should be noted that the lead7in service strategies are concept only and are subject to further investigation and discussion with all services authorities at the detailed planning stage. Lead7in routes for the services documented in the report may be investigated further considering factors such as construction cost, site cost and other existing constraints.

1.1 The Development Site

The proposed site is planned to be predominantly low density rural residential lots.

The site topography is steep with slopes ranging from 57115%. The site has a moderate ecological footprint of native trees and habitats. The site catchment discharges to the Marrangaroo creek through a series of category 1, 2 and 3 streams which traverse through the site South7North and ultimately discharge to Marrangaroo Creek crossing the Great Western Highway. The site is located within the Upper Coxs River Sydney drinking water catchment area.

An existing Jemena gas main and sewage rising main traverse the site North7South. The sewage rising main connects a correctional facility and a two lot industrial sub7division (located north of the development site) to the Lithgow Sewage treatment Plant (STP).

The proposed zoning framework provides a land use footprint for the site, as shown in Figure 1.1.

The site encompasses approximately 390ha of rural land and plans to accommodate:

- A residential precinct;
- An enterprise corridor;
- An industrial Precinct;
- Open space/drainage reserves; and
- Village centre development.

It is proposed to develop approximately 1600 residential lots along with a network of industrial roads, collector roads, local roads, pedestrian footpaths and cycleways.

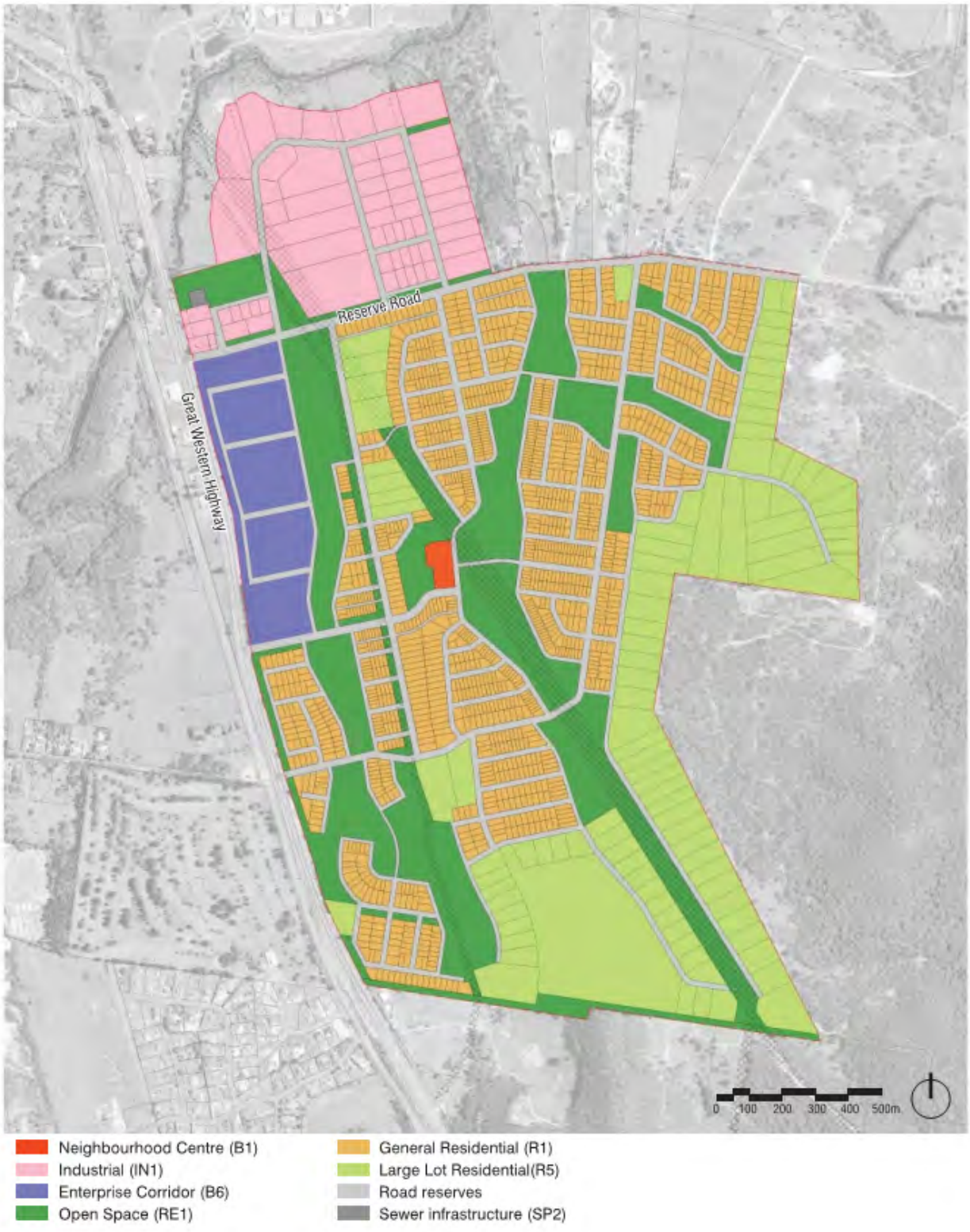


Figure 1-1 Indicative Layout Plan (***Source: Marrangaroo Master Plan)***

2 Existing Road Network

From the initial masterplan layout, a conservative estimation of the vehicle generation has been derived utilising the *Roads and Maritime Services (RMS)* publication *Guide to Traffic Generating Developments* and *Technical Direction TDT 2013/04a*, as detailed in Appendix A.

2.1 Great Western Highway

The Great Western Highway is a State Road under the auspices of the *RMS*.
The prudent characteristics and capacity of the highway, in the vicinity of the site, are outlined below;

- A straight section of formed carriageway connecting Lithgow, to the south, and Wallerawang and Bathurst, to the northwest;
- 2 lanes in each direction divided by a narrow grassed median;
- Paved shoulders accommodating on road bicycle provision;
- A regulated speed limit of 100km/h;
- Provides access to the Lithgow Correctional facility, to the north of the development site;
- The horizontal and vertical alignments along the highway satisfy sight distance requirements;
- An approximate AADT of 4,100 vehicles;
- An approximate hourly volume, each way during the morning (AM) and again during the evening (PM) peak periods, of 260vph; and
- An estimated 15% (approx. 39vph) heavy vehicles in each direction.

2.2 Reserve Road

Reserve Road is a local rural road under the auspices of Lithgow City Council.

The characteristics of the road, in the vicinity of the site, are outlined below;

- Provides access to rural residential properties;
- 1 lane in each direction;
- A regulated speed limit of 80km/h; and
- An approximate hourly traffic volume, each way during the AM and PM peak periods, of 25vph.

(Note: The AADT and hourly traffic volumes quoted in this document have been drawn and interpreted from fixed count location extracted from the RMS Traffic Volume Viewer web site - http://www.rms.nsw.gov.au/about/corporate-publications/statistics/traffic-volumes/aadt-map/index.html#/?z=6.)

2.3 GWH and Reserve Road Intersection

The intersection of GWH and Reserve Road has been constructed as a typical Type 'C' intersection controlled by sign priority. Pavement delineation defines the respective turn lanes and edges of the trafficable carriageways.

Figure 2-1 GWH and Reserve Rd Intersection (*Source: Google Maps Street View, 2017)*

3 Future Trip Distribution

In considering the future proposed site access conditions the distribution of proposed traffic has been taken into account. A sketch of the adopted trip distribution is presented in Appendix A.

The following assumptions have been applied for the various land use generations associated with the proposed development site.

3.1 Residential Commuter Trips

Given the close proximity to Lithgow City, it is envisaged the highest proportion of weekday commuter trips will be focused on employment opportunity within the City, and the immediate surrounds, to the south of the development site. A modest 65% of outbound Journey to Work (JTW) weekday commuter peak vehicle trips are anticipated to travel southbound (SB) in the AM and return from the south in the PM peak period. Conversely, 35% of outbound trips are anticipated to travel northbound (NB) during the AM peak and return from the north during the PM peak. Inbound trips during the AM are estimated to be approx. 65% from the south and 35% from the north.

3.2 Neighbourhood/Village Centre

The Neighbourhood/village Centre is considered to attract patronage primarily from within the precinct (development site) and draw only minimal 'passing' traffic from GWH. Therefore, it has been assumed that a nominal 4% of patronage will come from the north on GWH and 4% from the south, returning to the GWH and continuing their journey in their respective directions, within the peak hour. This pattern has been mirrored during the PM peak period.

3.3 Supermarket

As with the Neighbourhood Centre, only minimal 'passing' traffic is assumed from outside the immediate precinct. Therefore, it has been assumed that a nominal 4% of patronage will come from the north on GWH and 4% from the south, returning to the GWH and continuing their journey in their respective directions, within the peak hour. This pattern has been mirrored during the PM peak period.

3 . 4 Industrial

It is anticipated all trips to and from the Industrial precinct will occur from and to GWH with the majority of inbound trips during the AM peak originating from the south being approx. 55% and the lesser from the north being approx. 45%. Conversely, 45% of outbound trips will travel north and 55% will travel south during the AM peak. This distribution pattern has been mirrored during the PM peak.

3.5 Bulky Goods

It is anticipated all trips to and from the Bulky Goods operations will occur from and to GWH with the majority of inbound trips during the AM peak originating from the south being approx. 65% and the lesser from the north being approx. 35%. Conversely, 35% of outbound trips will travel north and 65% will travel south during the AM peak. This distribution pattern has been mirrored during the PM peak.

3.6 Pre School

It is anticipated that the Pre School will predominantly attract patronage from within the development precinct. A nominal 10 vehicle trips per hour has been adopted as a representation of staff trips from and to Lithgow City during the AM and PM peak periods, respectively. A further 2 staff trips per hour has been applied from and to the north during the AM and PM peaks, respectively.

4 Site Access

4.1 General

The proposed future site access conditions recommended for consideration, in this document, have been generally based on the volume, land use and vehicle classifications of the estimated traffic generated by the development precinct during a typical one hour period during the weekday morning and evening commuter peaks.

The development precinct is anticipated to generate approx. 13,000 vehicle trips per day. A number of these trips will be self-contained as the retail land uses are expected to generally attract the majority of patronage from within the precinct. The AM peak is considered to generate approx. 1,632vph, while the PM, an estimated 1,718vph. The GWH currently accommodates an AADT of approx. 4,100 vehicles and peak hour traffic flows of an estimated 260vph in each direction, of which 15% are considered to be heavy vehicles. The highway operates a statutory speed limit of 100km/h.

4.2 Locations

Adopting a minimalist approach to the access requirements, two (2) access locations are considered satisfactory to provide the necessary entry and exit to the development. One access for the industrial precinct at the current GWH and Reserve Road intersection and a second for the residential, retail and education land uses to the south. If only a single entry to the residential and retail precincts is adopted a traffic signal controlled intersection treatment on GWH should be considered.

4.3 Reserve Road

It is considered the movement of heavy vehicles, in particularly B-Doubles, along the highway, and to and from the industrial precinct, would fundamentally require a dedicated access. While Reserve Road currently services a number of rural properties along its corridor, use of the route by the industrial precinct would alleviate any direct access from the highway and can, with an appropriately designed internal road network within the residential catchment, reduce potential vehicle conflict between the residential and industrial operations.

The current pavement in Reserve Road is in significant disrepair and narrow. To cater for the movement of heavy vehicles, the pavement would require reconstruction with sealed shoulders and the appropriate pavement marking. The estimated vehicle volumes presented in this document, suggest that a single lane in each direction, incorporating widening of the GWH intersection to cater for the storage of right turn vehicles from Reserve Road, is sufficient to service the intended industrial precinct.

The capacity of Reserve Road is dependent upon its future use and the number of intended access points to be adopted for the Marrangaroo development site. If Reserve Road were to be the sole entry and exit to the development two (2) lanes in each direction and significant reconstruction of the GWH intersection, incorporating a speed limit reduction and traffic signalisation, would be required.

Two access points are considered to be the absolute minimum for the development. However, three (3) would significantly reduce the number of turning vehicles at each intersection. The current Type 'C' intersection treatment is considered adequate and capable of managing the estimated traffic with isolated widening in Reserve Road to cater.

Reserve Road may also be capable of serving the intended Bulky Goods operations. While the mix of passenger vehicles and industrial vehicles is not desired, a connection with the bulky goods facility may be possible if the entry and exit on Reserve Road is designed to provide adequate distance from the GWH intersection.

4.4 South of Reserve Road

An access, specifically for residential and retail operations, may be located south of Reserve Road. This proposed access, given the volume and distribution of estimated traffic, should be considered in conjunction with:

- A reduction of the current speed limit on GWH;
- Traffic and pedestrian signalisation to cater for all person movements; and
- Subject to computer base operation analysis.

Left In and Left Out (LILO) control was considered for this access but dismissed given the distribution of traffic to the north and south of the site. Residential traffic returning from Lithgow and surrounds during the evening peak is anticipated to be approx. 808vph. The provision of a LILO treatment at this proposed access would necessitate an unsafe U7Turn provision on a 100km/h highway, further to the north, to enable access.

While the volume of traffic on the highway may provide sufficient gap clearances to allow filtered right turn movements at a Type 'C' intersection, the volume of generated traffic from the development site, speed and presence of heavy vehicles, would invariably increase the severity of any vehicular or pedestrian conflict.
With the Marrangaroo development and inherent increase in traffic movements to and from GWH, it is considered a reduction in the statutory speed limit to 80km/h, along the section of highway adjacent to the site, should be considered and discussed with the NSW Police, Council and key stakeholders at Traffic Committee, with the view to reducing any potential conflict severity.

A reduction in the current speed limit and the achievable sight distances along the aforementioned section of the highway, may allow for the consideration of a roundabout controlled access. However, it is our opinion that given the volume of turning traffic, the number of heavy vehicles, the disparity in approach volumes between the development site and the highway and the isolated nature of such a control type, a roundabout treatment may prove to be unsafe.

4.5 Potential 3rd Access

Provision of two (2) access points, south of Reserve Road, for the residential and retail catchments should also be considered. In conjunction with a reduction in the speed limit, a second access for the residential population may possibly allow for the consideration of Type 'C' intersections for both residential access points, subject to operational, computer based, analysis.

The Bulky Goods operations may also be incorporated into the northern most residential access location, potentially eliminating the need for access onto Reserve Road and reducing the number of passenger vehicles mixing with heavy vehicles along the Reserve Road corridor. A strategically located third intersection would invariably reduce the right and left turn vehicle demands at each of the residential access locations.

4.6 Intersection Analysis

No computer based intersection analysis has been undertaken at this time to confirm the operational function of any access point. Estimated vehicle generation is shown in Appendix A.

5 Stormwater Management Strategy

The stormwater management strategy for the proposed development will be designed to comply with the following:

a. Guidelines for Civil Engineering Design and Construction Development, Lithgow City Council; and

b. Developments in the Drinking Water Catchment – Water Quality Information Requirements, WaterNSW.

5.1 Existing Catchments and Drainage

The development site is surrounded by an existing ridge as shown in Figure 571. Stormwater runoff from the external catchments follow the natural topography and flow onto the development site. Overland flows then drain to the two existing watercourses that are currently traversing the development site from south to north and discharges to the Marrangaroo Creek. There are number of farm dams constructed to provide water for the agricultural usages. The site slope varies between 5% and 15% and falls towards the existing watercourses.

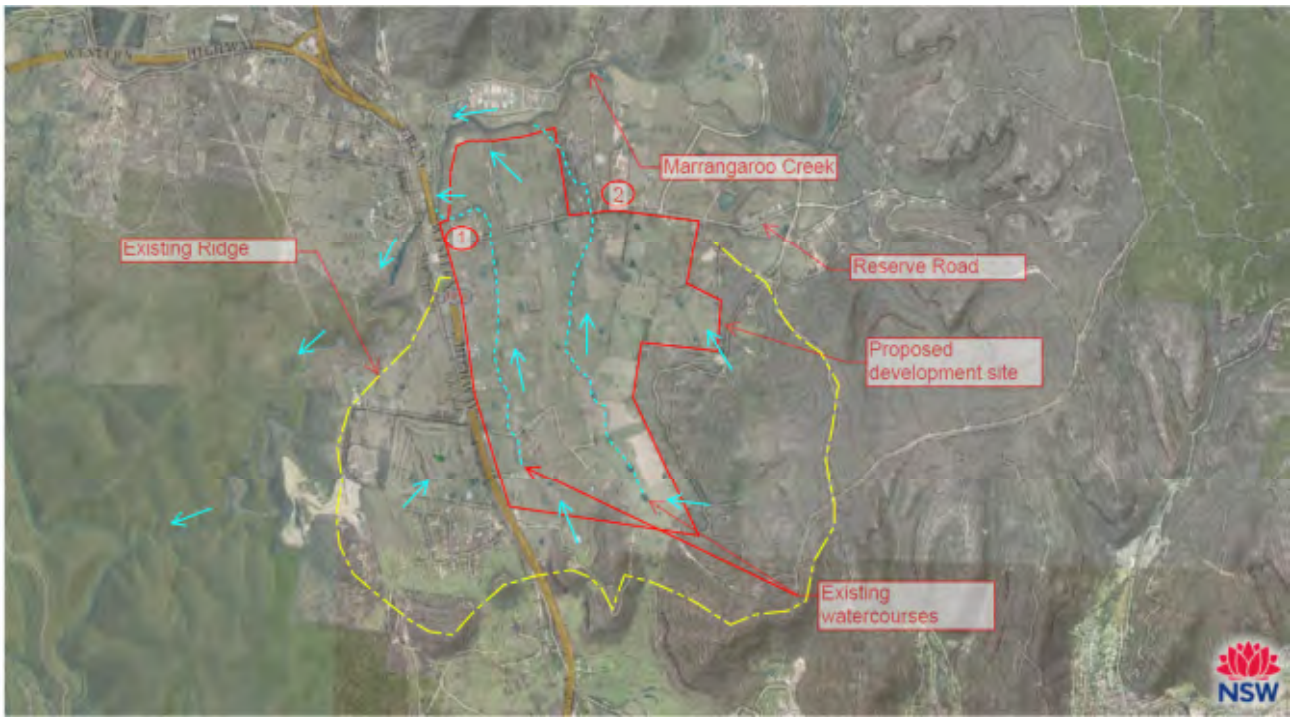


Figure 5-1 Existing condition and site location

5.2 Proposed development and Drainage

The proposed stormwater management strategy comprises the following components:

1. Stormwater detention to ensure post development peak flow do not exceed pre-development peak flow, which will minimise no adverse flooding impact on the downstream properties;
2. Stormwater quality measures such as bio-retention basins to ensure neutral or beneficial effect; and
3. Creek rehabilitation to maintain the function of the existing watercourses and encourage riparian ecology within the riparian corridor.

The stormwater detention requirements and water quality measures are described further in detail in Section 5.3 and Section 5.4. The creek rehabilitation will need to be further investigated and requires hydraulic analysis of the watercourses in the pre-developed condition and the post development condition. The hydraulic modelling of the drainage channels and existing creeks are outside the scope of this investigation. The flood levels in the creek will need to be taken into account at the time of detailed design. The post development condition will require the following inputs:

- Existing Site constraints such as slope, geological feature, ecology significance;
- Future lot and road layout;
- Location of future basins; and
- Other in-line structures such as culverts.

5.2.1 Piped Network

The stormwater drainage network within the proposed development area will consist of an in-ground piped network to collect runoff from the proposed paved areas and buildings.

The in-ground pit and pipe network will be designed to convey the 20% AEP (5 year ARI) storm events. An overland flow path will be provided to drain the additional flows up to the 1% AEP (100 year ARI) storm events.

Pipe sizing and pit spacing will comply with Lithgow City Council's requirements for street flow widths and depth x velocity relationship.

5.2.2 Overland Flow Paths

Major overland flow paths are positioned to coincide with the road reserve and are planned to contain overland flows up to the 1% AEP. Depth x velocity, maximum flow depths and freeboard requirements will be assessed on a hazard / risk basis and will conform to Lithgow City Council requirements.

5.3 Stormwater Quantity

5.3.1 Methodology

The stormwater quantity model has been developed to analyse the detention volume requirements for the development site. The modelling assumed there will be a number of basins along the riparian corridor as shown in Figure 5-2 to control the post developed peak flows.

This model will need to be refined further pending on the lot layout, watercourse alignments and location of the basins. The hydrology and basin sizes were modelled using XP-RAFTS software. Two models have been developed; a pre-development model was established to assess the permissible site discharge (PSD) based on flows from the existing, undeveloped site; and a post development model was established to estimate the detention volume required for the proposed development.

The slopes of the existing catchments were calculated based on the existing site survey, and design rainfall intensity-frequency-duration (IFD) data was obtained from the Bureau of Meteorology website. Table 5-1 summaries the PERN (n) surface roughness values and losses adopted for the catchments.

Table 5;1 XP;RAFTS model parameters

Parameter	Pervious	Impervious	Urban pervious
PERN (n)	0.04 – 0.08 (depending on the vegetation density)	0.015	0.025
Initial Loss (mm)	40	2.5	15
Continuing Loss (mm)	2.5	0.0	2.5

The initial loss and continuing loss for the existing catchment (Pervious) are adopted from the Lithgow Flood Study Review.

The models were developed using the following assumptions:

a. Existing development site condition: 100% pervious; and

b. Post development condition: 65% impervious for residential area, 90% impervious for industrial area and 100% impervious for commercial area.

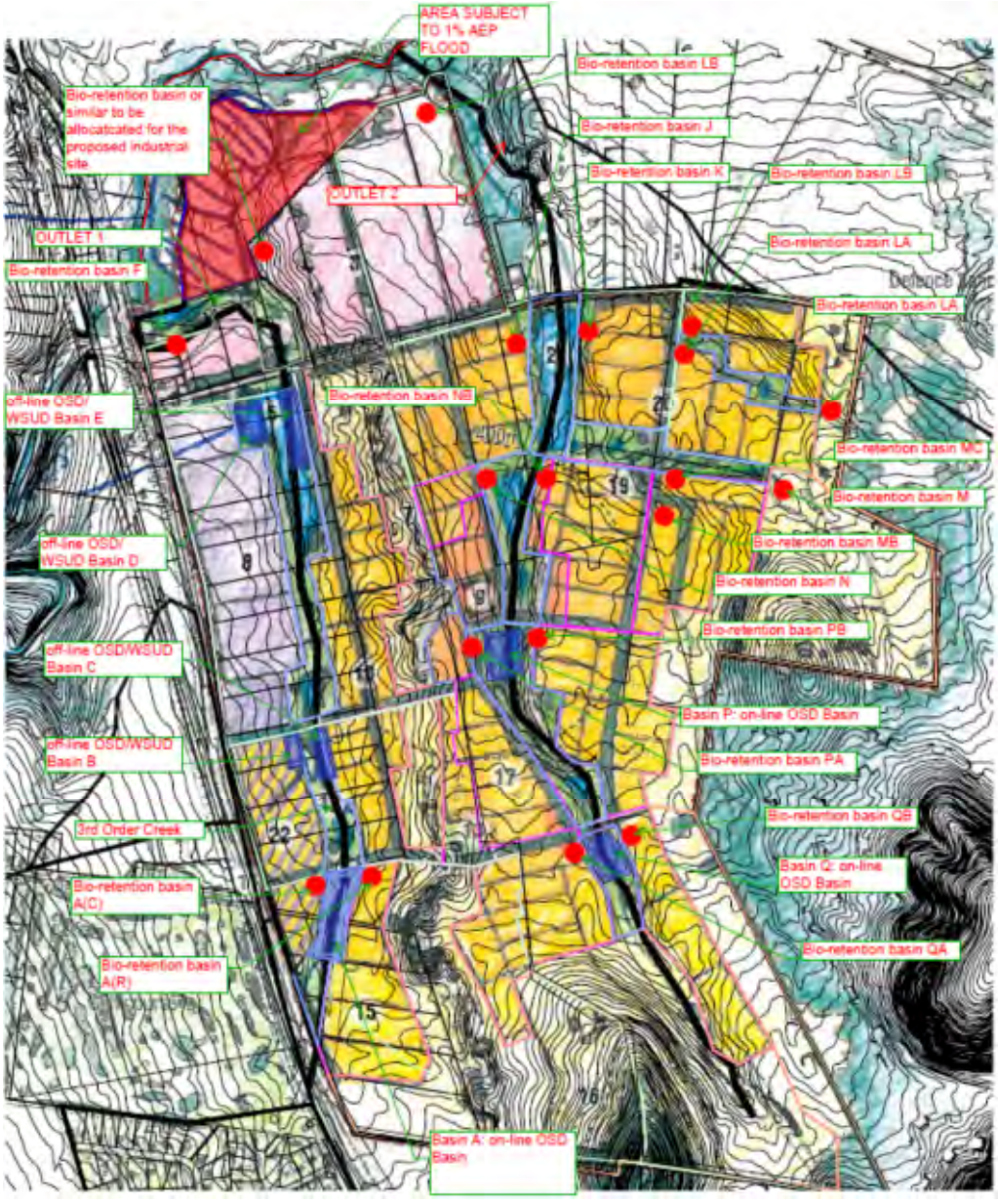


Figure 5-2 Stormwater Management Strategy ; Basin Layout

5.3.2 XP;RAFTS Model Results

Table 5;2 summarise the total peak flows at the outlets.

Table 5;2 Peak flow at Outlets

	Outlet 1		Outlet 2	
Storm Event (ARI)	Existing (m^3/s)	Proposed (m^3/s)	Existing (m^3/s)	Proposed (m^3/s)
5	11.7	11.49	15.85	15.13
100	30.40	30.19	34.25	33.5

The storage volume requirements are presented in Table 573.

Table 5;3 Performance of the OSD basin

	Basin Storage (m^3)	
Basin	5yr ARI Storm Event	100yr ARI Storm
A	28,000	36,000
B	1,750	2,350
C	2,900	4,350
D	4,300	6,200
E	5,650	6,930
Q	10,600	16,500
P	10,800	23,300

The future locations of the basins will depend on the staging of the development, lot and road layout and hydraulic analysis of the riparian corridor. Temporary detention basins may be required based on the staging of the development.

5.4 Stormwater Quality

5.4.1 Stormwater Quality Management Scheme

The stormwater treatment train for the proposed development has three stages of treatment; rainwater tank at each residential dwelling to provide source control; a vortex type gross pollutant trap (GPT), CDS or equivalent will provide primary treatment by capturing gross pollutants and the coarser suspended solids; and secondary treatment is provided by a bio7retention basin with sand filter and vegetation in the basin to remove nutrients such as nitrogen and phosphorous.

The rainwater tanks will also provide additional storage within the catchment and the collected water can be used for irrigation and non7potable use.

5.4.2 Rainfall Data

The proposed development site is located within the Sydney Drinking Water Catchment and within the SCA Climate Zone 4. Figure 573 presents the location of the site in relation to the Sydney Drinking Water Catchment. The rainfall records was obtained from WaterNSW website and the mean annual rainfall from the data provided is 883mm, which is slightly higher than the average rainfall at Lithgow of 781mm.

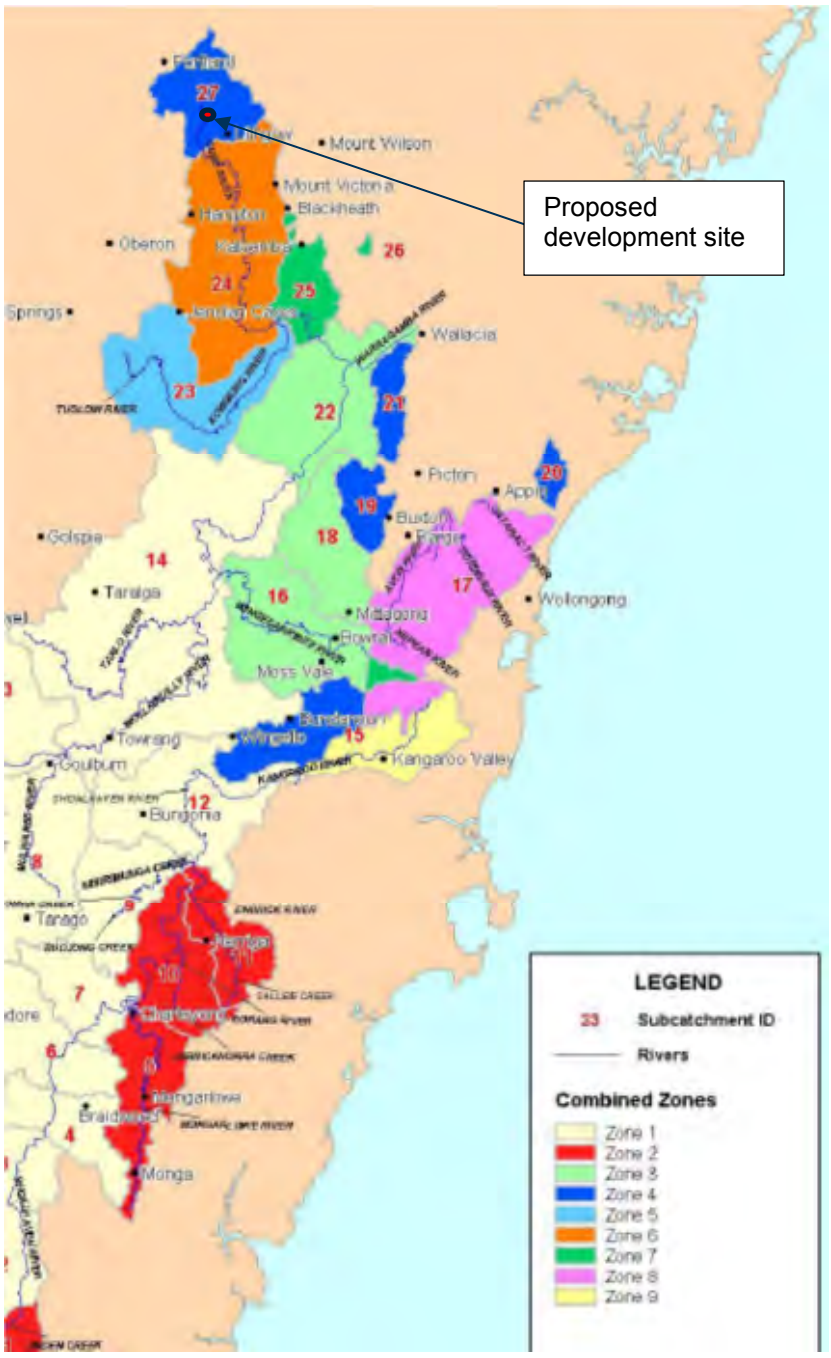


Figure 5-3 SCA Climate Zone (Ref: WaterNSW)

The Evapotranspiration values have also been obtained from WaterNSW.

5.4.3 Methodology

MUSIC v6.2 was used to analyse the minimum treatment train requirement for the site. Appendix B shows the MUSIC node and link diagram to describe the treatment train. The pre-development node calculates the pollutant loading from the existing catchment.

In the post development condition, the model evaluated two treatment trains, one for each watercourse. Each treatment train consists of rainwater tanks (10kL) for each dwelling, vortex type GPT at basin inlet and a bio-retention basin. Appendix B shows the node and link diagram in MUSIC to model a typical stormwater treatment train for the proposed development.

Based on the soil landscape mapping prepared by the NSW Department of Planning and Environment and the soil type present in the area is clayey sand; therefore, the rainfall and runoff parameters shown in Table 5-4 were used.

Table 5-4 Rainfall Runoff Parameters (DRAFT NSW MUSIC Modelling Guidelines)

Rainfall Threshold (mm/day)	1
Soil Storage Capacity (mm)	107
Initial Storage (% of Capacity)	25
Field Capacity (mm)	75
Infiltration Capacity Coefficient – a	250
Infiltration Capacity Exponent – b	1.3
Initial Depth (mm)	10
Daily Recharge Rate (%)	60
Daily Baseflow Rate (%)	45
Daily Deep Seepage Rate (%)	0

The site was divided into different sub-catchments based on the land use. The pollutant concentration parameters used in the model were based on the findings from Fletcher et al, 2004 and can be found in the document "Using MUSIC in Sydney Drinking Water Catchment" published by Sydney Catchment Authority.

The vortex type GPT node is included with the following pollutant removal criteria;

- Total Suspended Solids (TSS) – 70% for inflow concentrations greater than 75mg/L;
- Total Nitrogen (TN) – 0%;
- Total Phosphorus (TP) – 30% for inflow concentration greater than 0.5mg/L; and
- Gross Pollutants – 98%.

The parameters used for the proposed bio-retention basin are summarised in Table 5-5.

Table 5-5 Bio-retention basin parameters

	Basin
Extended Detention Depth (mm)	300
TN Content of filter media (mg/kg)	400
Orthophosphate Content of filter media (mg/kg)	40

The proposed bio-retention basins have a high flow bypass equivalent to the 3 month ARI storm. The following Table 5-6 documents proposed bioretention basins.

Table 5;6 Proposed Bio;retention Basins

Basin ID	Required Bio;retention Surface Area (m^2)
LB	620
LR	490
LA	800
H	2000
K	970
J	1400
MR	1000
MC	800
MB	270
NB	2700
N	650

Basin ID	Required Bio; retention Surface Area (m^2)
PB	1250
PA	950
QBR	2000
QAR	2350
G	1100
F	685
D	1950
E	2650
T	1420
U	5000
V	250

5.4.4 Model Results

Table 7577 below presents the performance of the stormwater treatment train and demonstrates that it is expected that at least 10% improvement from the existing condition.

Table 5;7 Stormwater treatment train performance

Parameter	Pre7development	Post development After Treatment	% improvement
Total Suspended Solids (kg/yr)	96500	27200	72
Total Phosphorus (kg/yr)	326	145	55
Total Nitrogen (kg/yr)	2040	1570	24
Gross Pollutants (kg/yr)	5930	817	82

The MUSIC model results also indicate the pollutant concentration after development will be better than the existing pollutant concentration for 50% 798% of the time. Refer to Figure 574, Figure 575 and Figure 576 for details.

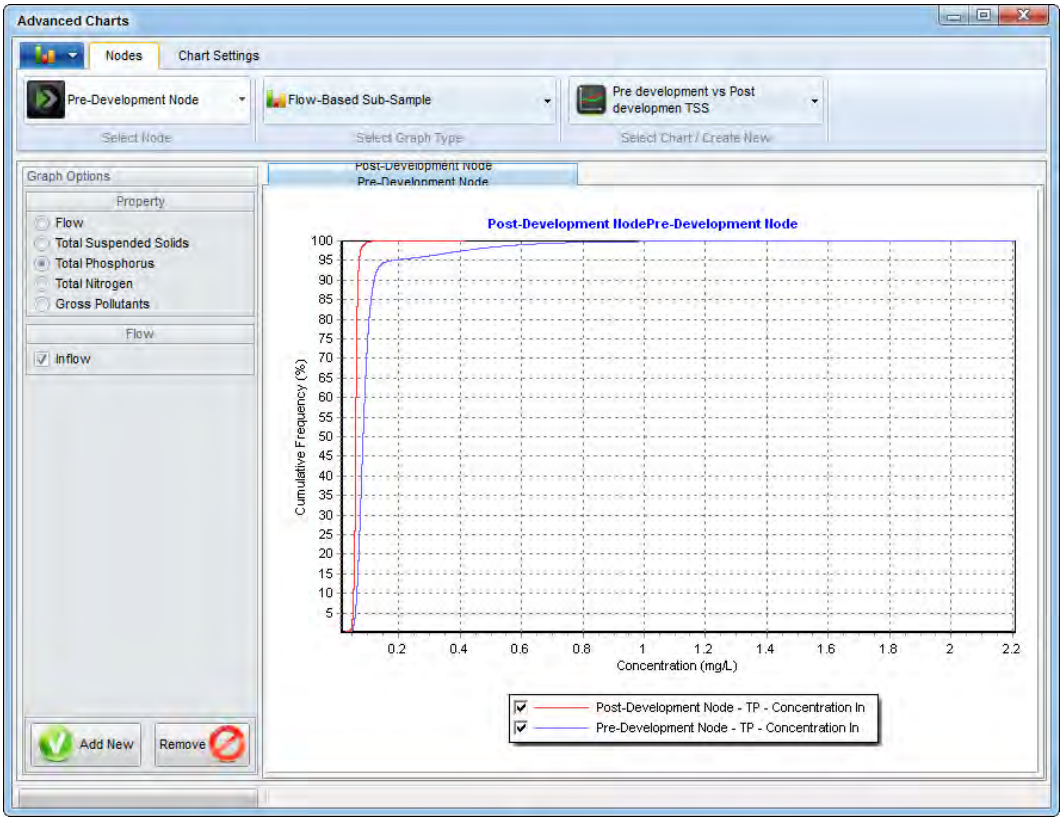


Figure 5-4 Pre and post development cumulative frequency graph for TSS concentrations

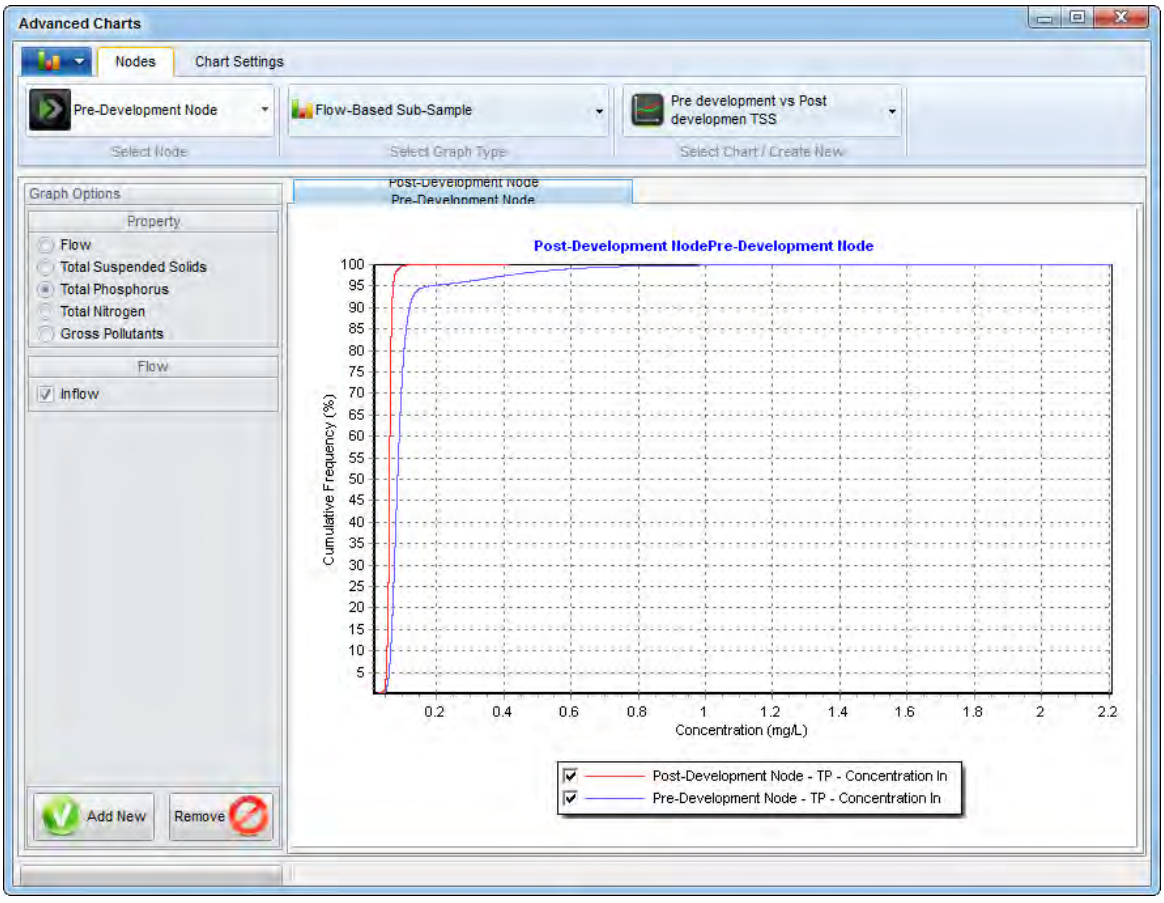


Figure 5-5 Pre and post development cumulative frequency graph for TP concentrations

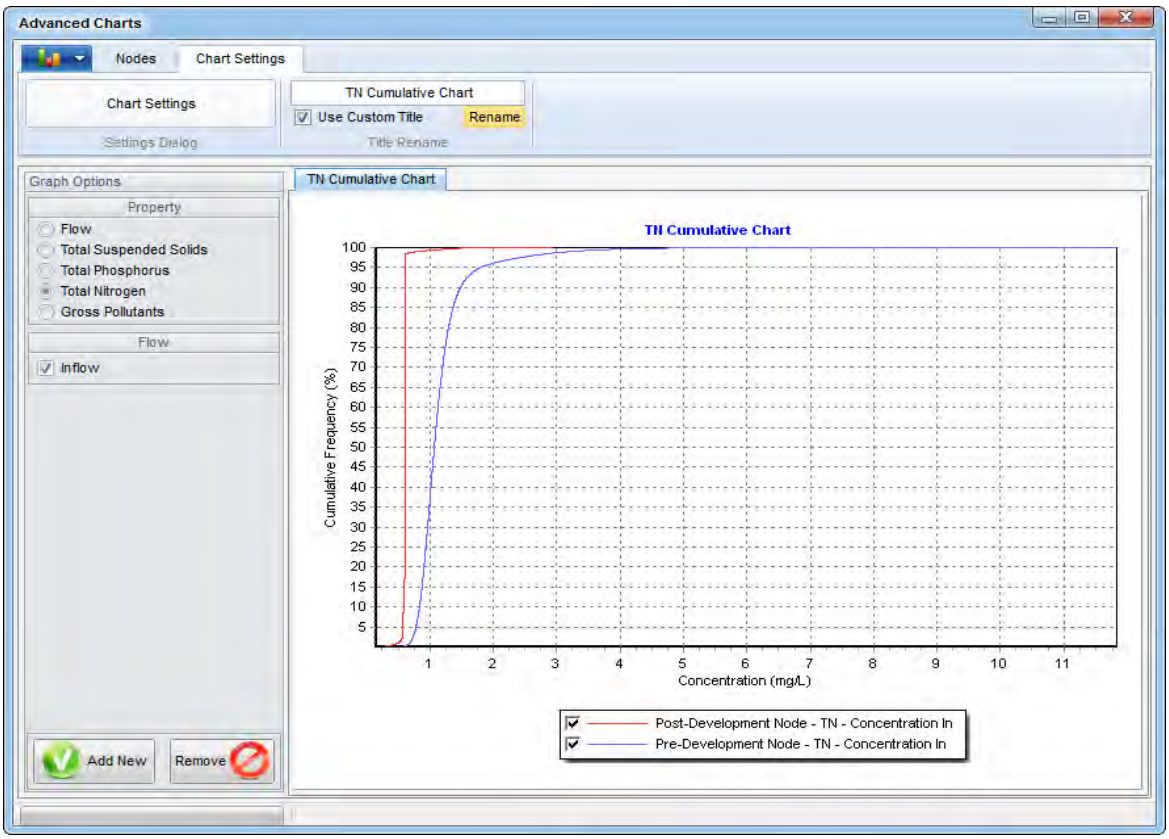


Figure 5-6 Pre and post development cumulative frequency graph for TN concentrations

6 Infrastructure Services

A 'Dial before you dig' services search was carried out and underground services information collected. The current land use is predominately rural residential with the existing utility infrastructure running along the GWH and Reserve Road.

The requirements for utilities infrastructure for potable water, waste water, electricity, telecommunications and natural gas were considered. Waste water and potable water services are provided by the council, electrical services by Endeavour Energy and Gas by Jemena.

The internal servicing strategy will be developed further to provide a framework for the delivery of the stages. A final utility servicing and trunk infrastructure scheme should be formulated in consultation with the relevant utility agencies during the council approvals phase.

The water and sewer services were invested including existing infrastructures and the interim and ultimate servicing strategy for the Marrangaroo development. The strategy is documented in Appendix C.

6.1 Electricity

Endeavour Energy (EE) is the electrical service provider in the Lithgow area. The electrical zone substation (ZS) is located in Lithgow. There are two major electrical feeders passing through the site.

1) 11kV feeder from Lithgow Zone Substation; and
2) 66kV feeder which supplies Lithgow ZS.

High Voltage electrical lines are present in Reserve Road. Endeavour Energy has advised the load for the development including the residential and industrial/ commercial areas will be approximately 15 Mega Volt Amp (MVA). Options to service the development area include a 66/11kV zone substation or an extension of 11kV feeders from Lithgow zone substation. A detailed evaluation of supply options needs to be carried out to determine feasibility of these options.

Zone substations and subtransmission infrastructure are generally funded by EE however, EE has advised there needs to be a clear business case to establish a zone substation and to ensure assets will not be stranded if development does not proceed. Endeavour may fund some upstream works for shared networks.

Endeavour Energy has outlined two options for supply as below. With both options existing use of the infrastructure needs to be maximised.

66kV supply option

- Establish a new 66/11kV 15 MVA zone substation in Marrangaroo area.
- Supply security issues i.e availability of backup supply will need to be considered in terms of the configuration of the zone substation and the 66kV connections;
- A zone substation site will need to be acquired by Endeavour Energy, possibly at the developer's cost. (Unless the area has fragmented land ownership);
- The distance of the zone substation location to the 66kV mains will be a factor in determining zone substation location; and
- Development of up to four new 11kV feeders from the zone substation will be required to supply the total load of the development.

11kV supply option

- Some capacity for initial development may be available from the existing 11kV feeder passing the development site. There may be minor augmentation works required on this feeder;
- Lithgow ZS presently has spare capacity and is presently able to accommodate the development provided 11kV feeders are developed from the zone substation to the development area;
- Up to three 11kV feeders would be required to supply the entire development;
- Development of a new feeder and reconfiguration of an existing feeder would provide further capacity into the area for some time; and
- The new distribution feeders to be constructed overhead or underground will influence the economics of a decision. Voltage drop at the end of these needs to be checked.

The above options presented by Endeavour Energy are to be investigate in detail on the basis of:

- The size of the development;
- The staging of the development;
- The development partners involved; and
- Costs and benefits of both options.

An estimation of substations within the development site are documented in Appendix D.

6.2 Telecommunications

Telecommunications is expected to be provided from the existing network. A backhaul route as indicated below will be required from the exchange. NBN has indicated a backhaul cost of approx. $56,850. Further consultation with NBN regarding timing and staging will be required for the proposed development. Refer Figure 671 below for the expected NBN fibre route.

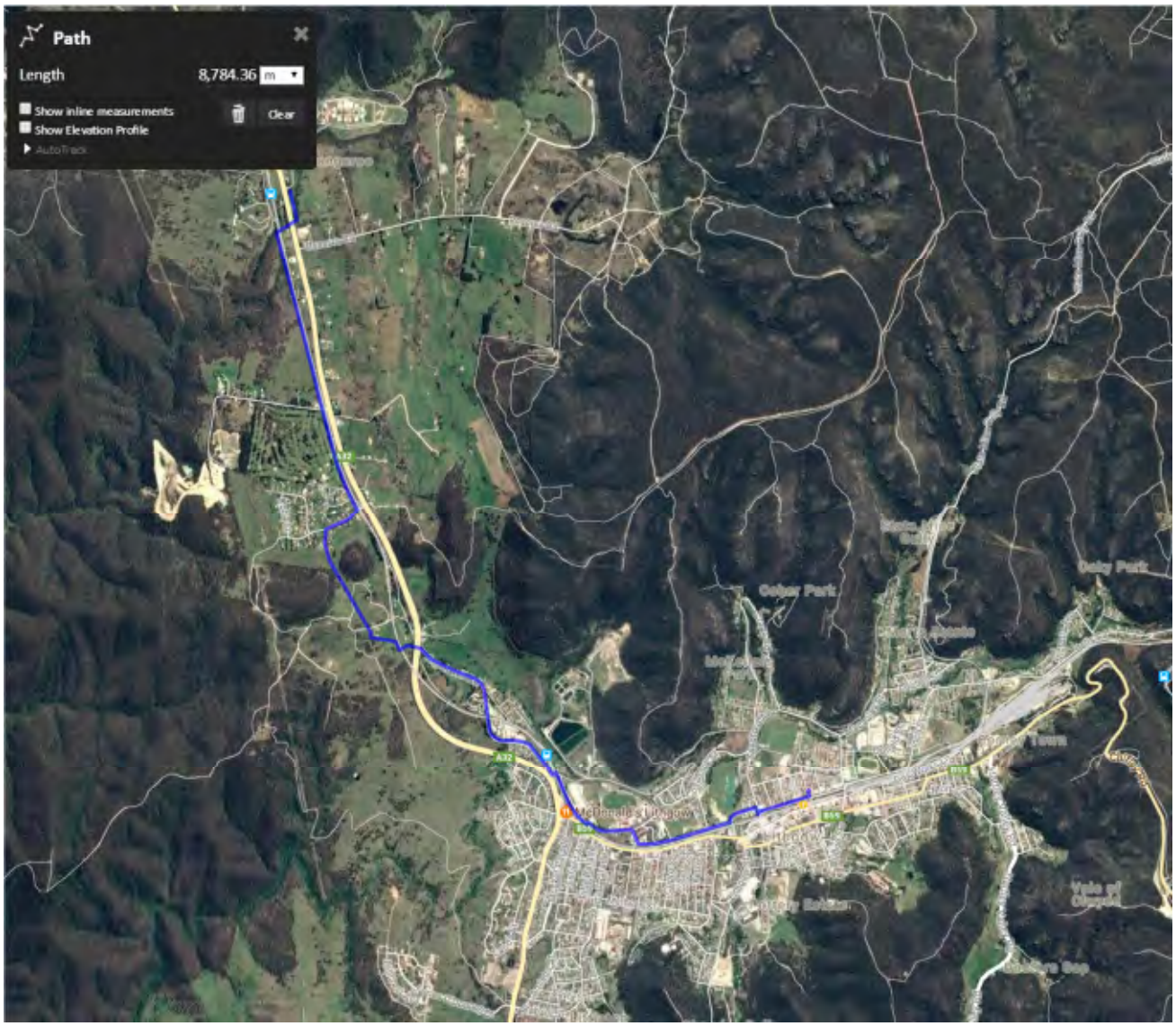


Figure 6-1 NBN Route *(Source: Google Maps)*

6.3 Natural Gas

Jemena has indicated a gas main is present along the Great Western Highway and the development can be serviced from this main.

6.4 Waste Water and Potable Water

Currently a 250mm dia rising main services existing correctional centre and two (2) lot industrial development. It runs through the site in an electrical easement to the Lithgow Sewage Treatment Plant (STP). Lithgow STP is located approx. 4km south of the site. Considering site levels and location of the STP, a rising main and a sewer pump station will be required to service the proposed development.

There are existing 100mm and a 250mm water mains serving existing development. Existing surface of the Marrangaroo Development is approx. 900 – 950 m above AHD. A new Water Pump Station (WPS) would be required to transfer water from Oakley Water Treatment Plant to the proposed reservoir.

A detailed investigation of the existing and proposed waste water and potable water is detailed in Appendix B.

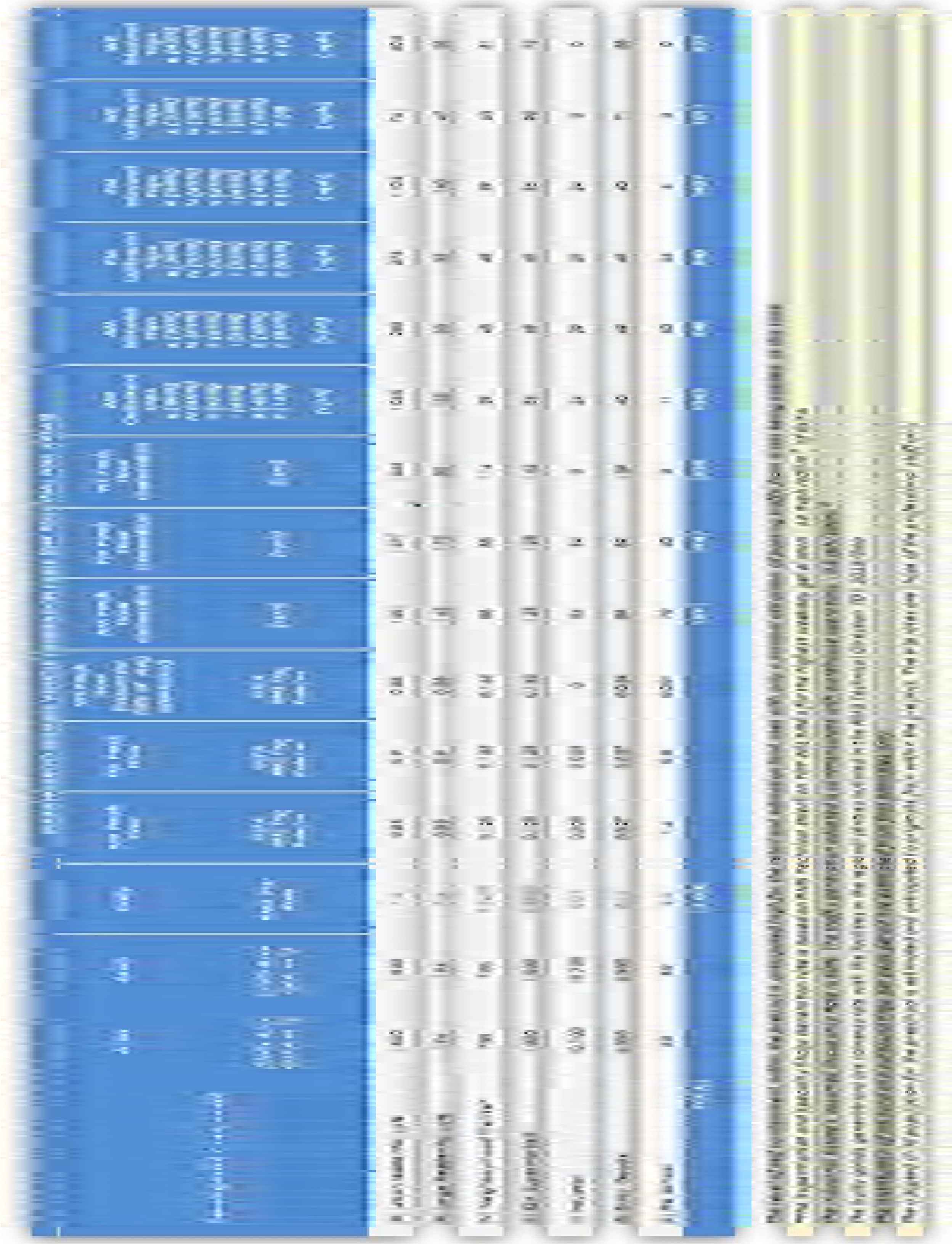
7 Conclusion

This report concludes that considering size and type of the proposed development, at least two entries are required from GWH to enable moderate traffic movements to the site. The proposal need to be further discussed with RMS to achieve feasible traffic solutions without affecting traffic movements of GWR.

Stormwater management for the site will be achieved by providing best management practice for stormwater quality and quantity control. Initial modelling indicates storage volumes of approx. 96,000 m^3 will be required to control stormwater flows to predeveloped conditions. Bioretention basin areas totalling approx. 32,000 m^2 will be required for the stormwater quality control.

A sewer rising main and a pumping station will be required for the proposed development to connect to existing Lithgow STP. A water reservoir and a water pump station will be required to transfer water from Oakley Water Treatment Plant. In case where existing electrical Zone substation does not have enough capacity, a zone substation will be required for the proposed development. Telecommunication and gas will be provided from the existing infrastructure in GWR and Reserve road.

APPENDIX A



APPENDIX B

Marrangaroo Servicing Report

Marrangaroo Study Area

80217025

Prepared for
Lithgow City Council

October 2017

Cardno
Shaping the Future

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01	15/08/17	Draft	Nuno Moreira	Bradley Elliott
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03	20/10/17	Updates as per Council's comments	Nuno Moreira	Steve Bessell

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Appendices

Tables

1 Introduction

The Marrangaroo Structure Plan (2017 – Rev A) has identified seven (7) land use zones located on the eastern side of the Great Western Highway. The seven (7) land use zones comprise the following:

- Land Use 1 – General Industrial – 49 ha
- Land Use 2 – Enterprise Corridor – 22 ha
- Land Use 3 – Urban Residential – 133 ha, 1,250 lots (10/ha)
- Land Use 4 – Large Lot Residential – 127 ha, 262 lots (2/ha)
- Land Use 5 – Open space / drainage reserve – 57 ha
- Land Use 6 – Village Centre – 1 ha
- Land Use 7 – TBC by Council (Enterprise or Residential) – 9 ha
    - For the purposes of this report Enterprise Development has been assumed for this land use as it represents the maximum development yield scenario

The objective of this Servicing Infrastructure Assessment is to determine an economic means of providing infrastructure to the eastern section of the Marrangaroo Study Area (the Study Area) to allow the future development of the land for residential, commercial and industrial purposes. Items of infrastructure such as reservoirs, sewage pump stations and rising mains have been identified to allow the development of the Study Area to occur in a structured and economical manner.

The Servicing Infrastructure Assessment will evaluate the requirements to provide the Study Area, limited to the eastern side of the Great Western Highway with adequate sewerage and water supply to allow the development of the Study Area in accordance with the Marrangaroo Structure Plan - 2017.

To assist with the staging of the Study Area, the development was split into two separate catchments as shown in **Appendix A**. These two catchments are derived based on the topography of the development site, and the drainage characteristics generated by this topography. There are two distinct low points, associated with watercourses, within the study area. Based on a high-level assessment using nearmap photo imagery and existing site contours, the entire site can be serviced by two separate sewage pumping stations (SPS). The two SPS catchments represent the separate stages in development, with water infrastructure staged to reflect these catchments.

These catchments are referred to as stages throughout the report.

The areas of investigation covered by the servicing infrastructure assessment are:

- Trunk sewerage reticulation and associated sewage pump stations and rising mains
- Trunk water reticulation and reservoirs

The calculations presented in this report are based on the following standards;

- WSA 02-2002 Version 2.2 (Sewerage Code of Australia)
- WSA 03-2002 Version 2.2 (Water Supply Code of Australia)
- WSA 04-2005 Version 2.1 (Sewage Pumping Station Code of Australia)
- AS 2419.1 Fire hydrant installations System design, installation and commissioning

2 Existing Infrastructure

2.1 Water

There are two existing water supply mains within the vicinity of the Study Area. These mains are; the existing DN100 to DN150 that borders the western and northern boundary of the Study Area, which services the defence lands along Reserve Road, and the disused DN250 cast iron main that bisects the Study Area, which previously services the defence lands.

These two mains are connected to the greater Lithgow water supply network via a DN250 main that connects to the 20 ML Shaft Street Reservoir. This reservoir is the main water supply reservoir for the region, receiving pumped potable water from the Oakey Park Filtration Plant and Fish River Water Supply Scheme. Due to the elevated height of the Shaft Street Reservoir (BWL 971.06 m AHD and a TWL 978.95 m AHD) potable water is supplied to the Lithgow Township and surrounding areas (including the Marrangaroo Fields Estate) via gravity.

The Fish River Supply scheme provides regional water security and is connected to the Lithgow water network at Shaft Street Reservoir via a DN300 water supply main. This main runs along the Great Western Highway, which is the western boundary to the Study Area, and has an estimated pressure head of 130 m in the vicinity of the Marrangaroo development.

The proximity, available pressure and operational flexibility that the Fish River Supply scheme offers, has been identified by Council, and is considered the preferred long-term water source for the Marrangaroo Development.

The location of the existing water supply network at the Marrangaroo Study Area is shown in **Appendix B.**

2.2 Wastewater

The Study Area is proposed to be within the Lithgow Sewage Treatment Plant (STP) catchment.

The Lithgow STP was upgraded in 2015 to its current capacity of 23,000 EP and future works are planned to improve the quality of the treated effluent, which is discharged to Farmer's Creek. Council's current discharge license is for up to 30,000 kL/d to be discharged from its final tertiary ponds into Farmer's Creek. Council has indicated that the current loading on the plant is 17,000 EP leaving a residual capacity of 6,000 EP for future development in the Marrangaroo Area or other areas within the Lithgow Township.

The Marrangaroo development is the largest proposed development site within the Lithgow STP catchment, based on this, the remaining capacity at the STP (6,000 EP) has been applied as the wastewater population for the first stage of the Marrangaroo development. The capacity of the STP has been calculated using the older standard of 240 L/EP/day, this is significantly higher than the current WSA 02 standard of 150 L/EP/day used to size sewerage infrastructure. As new developments within the Lithgow STP catchment approaches the theoretical capacity of the plant (23,000 EP), it is recommended that an actual capacity and performance assessment be undertaken at the STP, prior to capacity upgrade works at the STP being undertaken. This has the potential to delay significant and unnecessary capital investment.

Council has identified that there is no capacity within the existing wastewater network in the vicinity of the Study Area. They have advised that any interim and ultimate infrastructure would be required to discharge directly to the inlet works of the STP. Based on this advice, no existing network capacity assessment or interim solutions using existing sewer network have been included in this assessment. It is recommended that the potential to incorporate interim servicing, with sewer network renewals be investigated during the next phases of investigation to minimise capital investment and reduce sewage retention times, especially during the initial stages of development.

3 Project Demand

The projected water demands and wastewater contributions have been determined using the Water Services Association of Australia (WSA) standards, based on details provided in the Marrangaroo Structure Plan – Rev A 2017 and using available contour data.

Under the LEP, permitted land uses in zone B6 include motels and hotels. Due to the large variance in sewage discharge and water demands which are based on the size and number of rooms of such hotel or motel, the project demands have been calculated on a site wide commercial assumption of 75 EP/ha as per WSA 02-2002 Version 2.2 (Sewerage Code of Australia). During detailed planning and detailed design, the capacity allowed for can be further refined based on what was assumed and what will be constructed.

3.1 Water

The potable water demand for the Study Area has been calculated based on WSA 03-2002 Version 2.2 (Water Supply Code of Australia). The assumptions used to determine the Average Daily Demand (ADD) are shown in **Table 3-1.**

Table 3-1 Potable Water Average Daily Demand Assumptions

Land Use	Key Metric	Metric Unit	Average Demand (L/Metric unit/Day)_
Residential	Dwelling	Each dwelling	630
Commercial	Net floor area	Square metre	3 [1]
Industrial	Developed floor area	Square metre	3 [2]

Using the ADD coefficients shown in **Table 3-1**, the Average Daily Demand for each land use has been determined, and is shown in **Table 3-2.** The Average Daily Demand has been split into each of the identified stages of the development.

The total residential lot numbers, commercial and industrial land size are as per the Marrangaroo Structure Plan (2017 – Rev A) as detailed in Section 1 of this report.

Table 3-2 Potable Water Average Daily Demand

Stage of development	Residential	Commercial	Industrial	Total (ML / day)
Stage 1	0.28	0.93	1.47	**2.68**
Stage 2	0.67	0.03	-	**0.70**
Ultimate Development	0.95	0.96	1.47	**3.38**

[1] Excludes aged care facilities, hotel / motel / serviced apartments, laundry / dry cleaner and car wash facilities
[2] Excludes heavy process and chemical / print / beverage manufacturing facilities

The Ultimate peak day demand (PDD) is shown in **Table 3-3.** Based on these calculations, a 5 ML reservoir would provide sufficient water supply for the Ultimate developed site. The PDD is calculated by multiplying the ADD by a Peak Day Factor of 1.5, as per Clause 2.2.3.2 in WSA 03-2002 Version 2.2 (Water Supply Code of Australia). The capacity of the reservoir is based on 24 hours' consumption at Peak Day Demand as per Clause 2.7 in WSA 03-2002 Version 2.2 (Water Supply Code of Australia).

The EP's and total area from the Open Space Land Use has been excluded from the potable water demand calculations, as there would be minimal demand from these areas. Irrigation to the open space land use has also been excluded, as it is assumed council will adopt best practice approaches, and irrigate on an as needed basis, during off-peak conditions.

Table 3-3 Potable Water Peak Daily Demand

Stage of development	Average Daily Demand (ML / Day)	Peak Daily Demand (ML / Day)
Stage 1	2.68	4.02
Stage 2	0.70	1.06
Ultimate Development	**3.38**	**5.08**

3.2 Wastewater

The identified staged catchments within the Study Area would be services by a SPS. This would allow the sewage discharge to be collected from within the catchment and either pumped to the next SPS or to Lithgow Sewerage Treatment Plant. It was indicated by Council that the preferred option was to have the General Industrial and Enterprise Corridor serviced initially with the residential development to follow. The General Industrial and Enterprise Corridor lands are entirely within Stage 1, in addition to a section of residential development and open space. This first stage of development has been allowed for in the demand calculations shown in **Table 3-4.**

Council advised there was no preference to which industries were located within the General Industrial area, and would rely on the demand calculations to determine what suitable industry would be constructed based on the network and treatment plant capacity. Proceeding with this direction, the demand from the Enterprise Corridor, Residential area and Open Space that drained within Stage 1, was calculated as shown in **Table 3-4.**

The calculated water demand provided in Section 3.1, was converted to a sewage EP using WSA 02-2002-2.2.

The sewage load from Stage 1 was calculated as 4,596 EP's. The assumptions used to calculate the EP for each land use, is shown in **Table 3-4.** These assumptions are taken from Table A1, A2 and A3 in WSA 02-2002 Version 2.2 (Sewerage Code of Australia).

The uncertainty of the industrial sewage contributions meant that the initial EP calculation excluded the General Industrial area. Knowing the residual capacity of the STP (6,000 EP) it was calculated that the STP would have capacity to treat 1,555 EP from the General Industrial area. This data is represented in **Table 3-4.**

Table 3-4 Calculated Stage 1 Sewage Loads

Stage 1 Development	Ha	Lots	EP's (WSA)	Assumption as per WSA 02
General Industrial	49	-	1,555	
Enterprise Corridor	22	-	1,650	75 EPs per Ha
Urban Res (10/ha)	44	417	1,460	3.5 EPs per lot (1,000m2)
Large Lot Res (2/ha)	13	26	91	3.5 EPs per lot (5,000m2)
Open Space	28.5	-	570	20 EP per ha
Village Centre	0	-	0	Not in Stage 1
TBC (Enterprise or Residential)	9	-	675	Area assumed to be commercial – worst case scenario - 75 EPs per Ha
TOTAL	**165.5**	**443**	**6,000.00**	

There are opportunities to increase the sewage load from the commercial and industrial land uses, but this would restrict the number of residential properties that can be serviced in Stage 1 as the load from the Study area is restricted by the existing capacity at the treatment plant.

Stage 2 of the Marrangaroo development would incorporate the remaining Residential and Open Space areas, in addition to the Village Centre. The projected Eps, based on land–use for Stage 2 are shown in **Table 3-5.**

Table 3-5 Stage 2 Load

Stage 2 Development	Ha	Lots	EP's (WSA)	Assumption as per WSA 02
General Industrial	0	-	0	No industrial in Stage 2
Enterprise Corridor	0	-	0	No commercial in Stage 2
Urban Res (10/ha)	93	833	2916	3. 5EPs per lot (1000m2)
Large Lot Res (2/ha)	114	236	826	3.5 EPs per lot (5000m2)
Open Space	28.5	-	570	20 EPs per ha
Village Centre	1	-	150	Assumption based on pervious developments
TBC (Enterprise or Residential)	0	-	0	Not in Stage 2
TOTAL	**236.5**	**1,069**	**4,462**	

Prior to Stage 2 development upgrade works would be required at the Lithgow STP to increase the treatment capacity of the STP, based on the existing treatment capacity (23,000 EP). As previously stated, the capacity of the STP was calculated using a conservative 240 L/EP/day, compared to the 150 L/EP/day adopted in the WSA 02 sewerage code. It is recommended at an assessment of the hydraulic and load arriving at the STP be undertaken as the theoretical capacity is approached, to understand actual conditions and potentially delay capital investment at the STP.

In the absence of actual flow data, this assessment has assumed that the treatment capacity of the STP would be fully utilised by Stage 1, with upgrade works required to accommodate the additional 4,462 EP from Stage 2.

Once the Marrangaroo Study Area is fully developed the sewage load in the network is equivalent to 10,462 EP, or 1,570 kL/day. The breakdown of sewer contributions per land-use is shown in **Table 3-6.**

Table 3-6 Complete Development Load

Complete Development	Ha	Lots	EP's (WSA)	Assumption as per WSA 02
General Industrial	49	-	1,555	
Enterprise Corridor	22	-	1,650	75 EPs per Ha
Urban Res (10/ha)	133	1,250	4,375	3. 5EPs per lot (1,000m2)
Large Lot Res (2/ha)	127	262	917	3.5 EPs per lot (5,000m2)
Open Space	57	-	1140	20 EPs per ha
Village Centre	1	-	150	Assumption based on pervious developments
TBC (Enterprise or Residential)	9	-	675	Area assumed to be commercial – worst case scenario - 75 EPs per Ha
TOTAL	**398**	**1,512**	**10,462**	

The current wastewater servicing analysis allowed for 1,555 EP to be discharged from the General Industrial land in Stage 1, due to the residual capacity of the Treatment Plan. Depending on the future capacity of the Treatment Plant the load from the General Industrial area could be increased, although this increased sewage load would need to be taken into consideration during the design of Sewerage Pump Station 1 and the associated downstream infrastructure.

4 Interim Servicing Strategies

The serving of the Study Area has been split into two catchments as shown in **Appendix A.** This would allow the development to be staged so that infrastructure can be delivered and upgraded as required.

4.1 Water supply interim servicing

To avoid unnecessary upfront capital costs, the existing infrastructure (DN100 & DN250) was assessed to determine if there is any residual capacity within the existing network to service the Study Area. The existing infrastructure is supplied from the 20 ML Shaft Street reservoir, which council informed had sufficient capacity to support the development of the Study Area.

The base water level at the Shaft Street reservoir is approximately 971 m and is located approximately 7 km from the southern margin of the Study Area. Using a conservative pipe loss of 3 m/km for water mains greater than DN200 and 5 m/km for main less than DN200 (as per Clause 3.2.5.2 in WSA 03-2002 Version 2.2 (Water Supply Code of Australia)), the available pressure at the Study Area from the existing infrastructure is approximately 948 m. This is a conservative calculation, but is considered acceptable for this level of investigation. It is recommended that field pressure testing be undertaken on the DN250 water main near Girraween Drive as part of the next phase of investigation to confirm actual field pressures. This pressure testing/monitoring should be undertaken during the summer peak period to identify actual worst case conditions.

According to this available pressure, and accounting for headlosses within the future reticulation network, it is assumed that any properties located under 930 m could potentially be serviced by the existing main/s. The extent of this area is shown in **Appendix F**. This equates to approximately 60% of the Study Area, including the whole of Stage 1 that can be serviced by existing infrastructure, based on high-level calculation.

The level of calculation is high level, as the demands and actual losses within the water supply mains within the Shaft Street Reservoir supply zone were unknown and unmodelled. Thus, the impacts associated with supplying the study area, on existing customers is unknown. Due to the size of the proposed Marrangaroo development and the reliance on the Shaft Street Reservoir water supply, modelling of the water network is recommended to quantify impacts, stage infrastructure and identify potential solutions.

Based on the calculated available pressure, Stage 1 could be serviced by the Shaft Street Reservoir, with the primary supply line being the existing DN250. The condition of the DN250 main is unknown, but considering the age of the main, and operational condition, this main should be scoured, cleaned and disinfected prior to it being utilised.

The local reticulation water supply network has not been sized as part of this investigation, however this network is required to be sized to provide sufficient firefighting flows, based on AS 2419.1, which specifies a feed hydrant capacity of 10 L/s at 150 kPa (or approximately 15 m head).

For the purpose of this investigation, it is assumed that the condition of the DN250 main is sufficient to support Stage 1 development. If the condition of the existing water mains is not sufficient to support the Study Area, or actual water main pressures are lower than the calculated values, a new reservoir would be needed to service the Study Area. The new reservoir could be located along the high point to the south of the Study Area, or in

the area to the north of the Lithgow Correctional Centre. Based on PDD calculations, **Table 3-3**, a 4 ML reservoir is needed to provide sufficient water security to Stage 1 development.

The reservoir would be supplied directly from the Fish River Scheme (DN300 water main), which has sufficient capacity and pressure to supply the new reservoir. A pressure-deducing valve may be required on the new transfer line to fill the smaller reservoir.

4.2 Wastewater interim servicing

The staging of the Study Area has been derived based on the ability of the area to be drained via gravity. This has identified two key stages, and subsequently two main pumping stations that are required to provide wastewater service to the Study Area.

The largest of the SPS, is also the pumping station that would service Stage 1 of the development. It is proposed that this SPS (SPS01) be located in the parcel of land next to the Marrangaroo Creek crossing under the Great Western Highway, as shown in **Appendix C & D.** SPS01 is the terminal SPS for the development, where it will pump all flows via a 5 km rising main to the inlet works of the STP.

To provide wastewater service to Stage 2 an additional SPS (SPS02) would be needed to lift flows to SPS01.

The Average Dry Weather Flow (ADWF) for Stage 1 (10.46 L/s) is estimated as being 60 % of the Ultimate Development ADWF (17.78 L/s). As the increase in ADWF is not excessive, it is recommended that the wet well at SPS01 be constructed at its ultimate size and capacity. The pumps within the wet well could be upgraded as the development within Stage 1 increases to help reduce operational costs and maximise pump efficiencies.

The projected wastewater load arriving at SPS01 from Stage 1 development is shown in **Table 4-1.**

Table 4-1 Stage 1 - Catchment Analysis

Catchment Data	Stage 1
Total EP's Serviced	6,000
Area Serviced	166 ha
Average Dry Weather Flow (ADWF)	10.5 L/s
Peak Dry Weather Flow (PDWF)	23.9 L/s
Peak Wet Weather Flow (PWWF)	94.5 L/s

To service the proposed Stage 1 development, SPS01 is required to have a capacity of approximately 95 L/s to allow for sufficient conveyance of peak wet weather flow (PWWF). A duty/duty standby pump configuration has been assumed for this station, with both pumps having sufficient capacity to convey PWWF (95 L/s). This provides a sufficient redundancy in capacity of a mechanical failure occurs at the SPS. Pump configuration and selection is required as part of concept and detailed design phase of this SPS.

SPS01 discharges directly to the Lithgow STP via a 5 km rising main. It is recommended that dual DN300 rising mains be installed as part of the initial works. This would allow the signal rising main operation during the initial stages of the development, minimising retention times within the rising main. It should be noted that

excessive retention times (>2 hours) will occur as the development establishes. Based on this, a chemical dosing unit may be necessary at SPS01 to minimise the potential for damage to downstream infrastructure.

The dual rising mains also provide SPS01 with greater operational flexibility for maintenance and in times of failure.

The identified SPS01 requirements to service the Stage 1 development is shown in **Table 4-2.**

Table 4-2 SPS 1 - Catchment Analysis

Catchment Data	Sewage Pump Station 1
Total EP's Serviced	6,000
Average Dry Weather Flow (ADWF	10.5 L/s
Peak Wet Weather Flow (PWWF)	94.5 L/s
Approx Ground Level at Pump Station	910 m AHD
Pump Duty	94.5 L/s
Rising Main Length	5,000 m
Rising Main Diameter	DN300

Stage 2 development of the Study Area comprises of an addition 4,462 EP, across 237 ha. Based on the capacity of the existing Lithgow STP, this development can only be serviced once the capacity of the STP has been upgraded.

Stage 2 of the Study Area would require its own SPS (SPS02), which will discharge into the SPS01 catchment. SPS02 is to be located at the lowest point within the Stage 2 catchment, to the south of Marrangaroo Creek. The proposed location of SPS02 is shown in **Appendix C & D**.

The capacity requirement identified for SPS02 is provided in **Table 4-3.**

Table 4-3 Stage 2 - Catchment Analysis

Catchment Data	Stage 2
Total EP's Serviced	4,462
Area Serviced	237 ha
Average Dry Weather Flow (ADWF)	7.6 L/s
Peak Dry Weather Flow (PDWF)	16.5 L/s
Peak Wet Weather Flow (PWWF)	89.1 L/s

The SPS02 capacity calculation based on the contributing flows from 4,462 EP being pumped from SPS02 to SPS01, is shown in **Table 4-4.** The rising main between the two SPS's would be a DN300 main. Although there is a potential to construct this rising main as a dual DN225 main, the benefits are negligible.

A Duty/Duty Standby pump configuration has been assumed at SPS02. The optimised pump configuration and selection should be assessed as part of concept and detailed design of this SPS.

Table 4-4 SPS 2 Catchment Analysis

Catchment Data	Sewage Pump Station 2
Total EP's Serviced	4,462
Average Dry Weather Flow (ADWF)	7.6 L/s
Peak Wet Weather Flow (PWWF) – L/s	89.1 L/s
Approx Ground Level at Pump Station - m	919 m AHD
Pump Duty	89.1 L/s
Rising Main Length - m	1,350 m
Rising Main Diameter - mm	DN300

Each individual pump station would be provided with two (2) submersible pumps operating in duty and standby mode and be connected to a SCADA telemetry control. The pump station sites and rising mains are indicated in **Appendix C & D.**

Appendix E details the calculation breakdown for each stage and pump station.

5 Ultimate Servicing Strategies

5.1 Water ultimate servicing

The full demand from the Marrangaroo Study Area would require a 5 ML reservoir as outlined in **Table 3-3** to be constructed on the ridgeline at the southern section of the development site. The construction of the 5 ML reservoir would allow for the proposed interim water supply from the Shaft Street Reservoir to be disconnected, with the entire Study Area supplied from the reservoir.

The proposed 5 ML reservoir would be constructed at a minimum level of 1,050m AHD, which would have sufficient pressure to service the entire development. Considering Stage 2, requires an additional 1.06 ML of storage, it is recommenced to construct the reservoir for Stage 1 at its ultimate capacity of 5 ML, ensuring sufficient offtakes are installed to cater for future growth.

If the existing potable water infrastructure is used to service Stage 1 of the development a small reservoir would still be required to service the remaining area of Stage 2 that cannot be fed from the existing mains. It is expected that the reservoir would need to be 1 ML in size to service the remaining development within Stage 2. As stated in Section 4.1, it is noted further analysis would be required for Stage 2 to determine the capacity within the network, which will determine the size of the reservoir required.

Council had initially raised the possibility of constructing a 20 ML to service the Marrangaroo Study Area, and to provide water security to the villages that make up the greater Lithgow region. On its own, a 20 ML reservoir is excessively oversized for this development. It is recommended that a 5 ML be constructed for the Marrangaroo Study Area and a separate 20 ML reservoir be constructed for the drought proofing of the Lithgow area. The 20 ML reservoir could be linked to the 5 ML reservoir for the Marrangaroo Area along with other reservoirs in the Lithgow town ship, but this has not been assessed in this study.

The pressure within the Fish River Scheme which is estimated at 130 m would be sufficient to supply the 5 ML reservoir. It is councils preference to connect the reservoir directly to the DN300 Fish River Scheme transfer main that runs along the Greater Western Highway. A pressure reducing valve may be required on the new transfer line to fill the reservoir due to the large pressure in the Fish River Transfer Main, which should be confirmed as part of concept design.

The other alternative is to supply water to the reservoir from the Oakey Park Water Plant. This would require a new 8 km transfer main to be constructed through Lithgow. Considering it is Councils preference for water supply to come from the Fish River Scheme, and the costs associated with the 8 km supply main, this option has not been considered further. It should be noted that, it would be recommended that when the 20 ML water security reservoir is constructed, a connection to the Fish River Scheme and Oakley Park Water Plant would provide additional water security and enhanced drought resistance to the region.

5.2 Wastewater ultimate servicing

Once the Marrangaroo Study Area is fully developed the sewage load being pumped to the treatment plant is outlined in **Table 5-1**. As discussed in Section 4 of this report, it is recommenced that dual DN300 rising mains be constructed from SPS01 to the treatment plant. The basis of this recommendation is that constructing the

rising main, as a single DN450 for the interim development would lead to performance issues within the network. The sewage retention time within the DN450 rising main will also be impacted. Constructing dual DN300 rising mains would give Council greater control over its network and would also allow the rising mains to be alternately used, which can allow maintenance to be carried out on one main while the other is operational.

Table 5-1 Ultimate Catchment Analysis

Catchment Data	Sewage Pump Station 1	Sewage Pump Station 2
Total EP's Serviced	10,462	4,462
Average Dry Weather Flow (ADWF) – L/s	17.8 L/s	7.6 L/s
Peak Wet Weather Flow (PWWF) – L/s	168.1 L/s	89.1 L/s
Approx Ground Level at Pump Station - m	910 m AHD	919 m AHD
Pump Duty	168.1 L/s	89.1 L/s
Rising Main Length - m	5,000 m (10,000 m total pipe length)	1,350 m
Rising Main Diameter - mm	DN450 (or dual DN300)	DN300

6 Cost

The costs provided in Section 6 are based on FY18 cost projections. Once the staging and release dates of the Study Area are determined the costs provided can be indexed to reflect actual costs of when the infrastructure is required. Land acquisition and detailed design costs have also been omitted due to the alignments provided only being indicative. The rising main from SPS01 to the treatment is proposed to be constructed in the existing easement, removing the need to acquire a new easement. Sewer lead-ins and trunk water mains to be constructed in road reserves to reduce land purchase costs.

6.1 Water

The costs have been calculated based off industry unit rates for water utility planning and Cardno's extensive experience in pricing water based utility infrastructure for government and private organisation. The provision of trunk water supply infrastructure for the Marrangaroo Study Area is $2,969,000, with the breakdown provided in **Table 6-1.**

Table 6-1 Water supply infrastructure costs

Infrastructure	Stage 1	Stage 2
Clean and refurbishment of existing DN250 water main	$54,000	
Supply and construction of a 5 ML reservoir		$2,750,000
Supply and construction of transfer main from Fish River Scheme (500 m DN300 transfer main)		$165,000
Total	**$54,000**	**$2,915,000**

6.2 Wastewater

The provision of trunk wastewater infrastructure for the Marrangaroo Study Area is $7,245,020, with the breakdown provided in **Table 6-2.** The costs associated with the wastewater servicing do not include any upgrades that may be required at the Lithgow STP.

Table 6-2 Wastewater infrastructure costs

Infrastructure	Stage 1	Stage 2
Pressure systems		
Stage 1		
SPS (5.5 m diameter at 6 m deep)	$450,000	
Dual DN300 rising mains to STP (5 km)	$2,520,000	
Stage 2		
SPS (3.5 m diameter at 6 m deep)		$350,000
DN300 rising main from SPS02 to SPS01 (1.35 km)		$453,600
Trunk lead in sewers		
Stage 1		
DN225	$1,375,350	
DN300	$268,950	
Stage 2		
DN225		$1,494,600
DN300		$332,520
Total	**$4,614,300**	**$2,630,720**

Marrangaroo Study Area

APPENDIX A

CATCHMENT PLANS

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1:15,000 Scale at A3

Metres

0 250 500 750 1,000

Catchment Plan

MARRANGAROO DEVELOPMENT

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2017-10-24 | Project: 80217025
Coordinate System: GDA 1994 MGA Zone 56
Map: 80217025-GS-006-CatchmentPlan.mxd 02
Aerial image supplied by Land and Property Information (2015)

Marrangaroo Study Area

APPENDIX B

POTABLE WATER NETWORK

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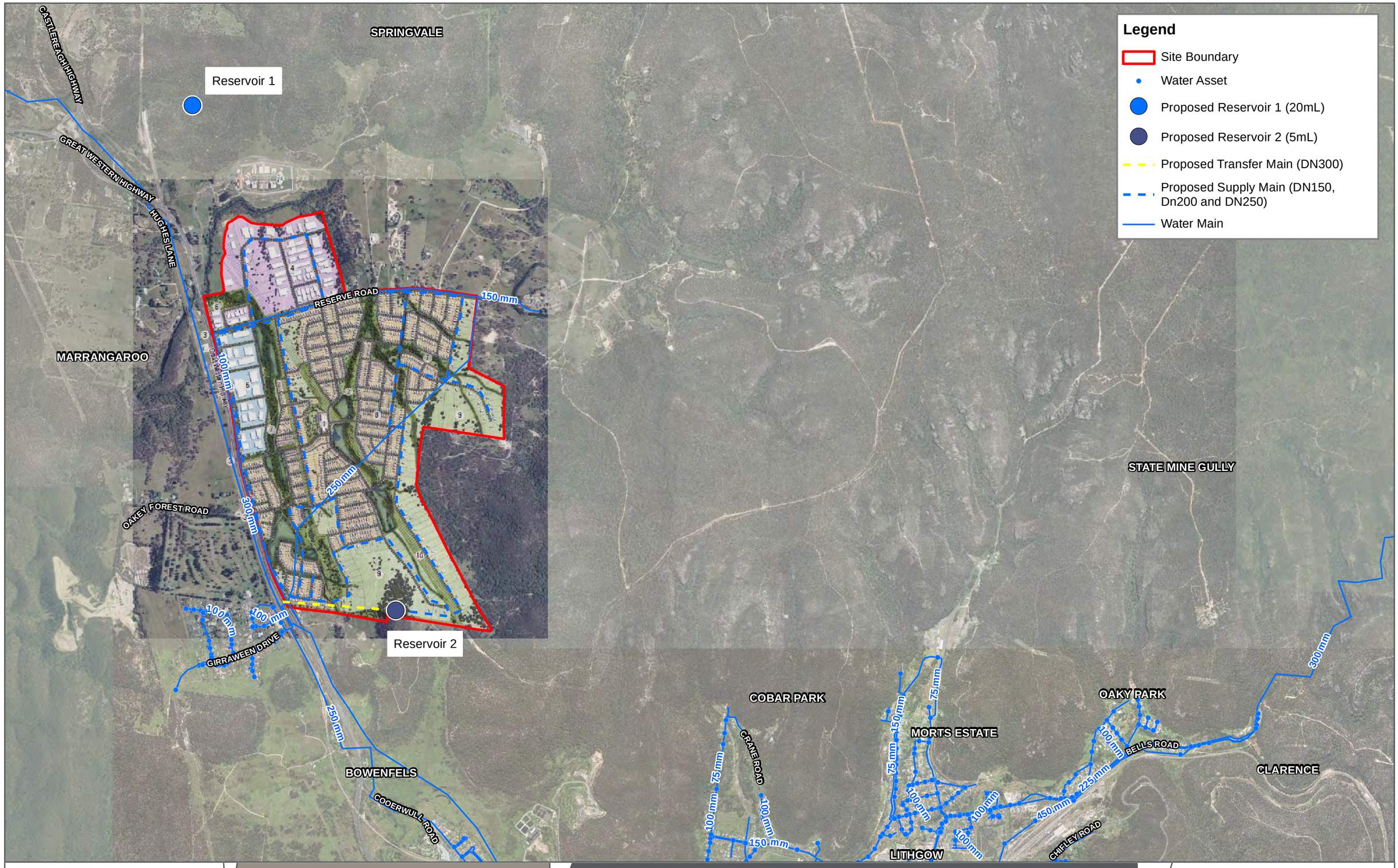

1:25,000 Scale at A3

Metres

0 250 500 750 1,000

Existing Water Infrastructure

MARRANGAROO DEVELOPMENT

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2017-10-24 | Project: 80217025
Coordinate System: GDA 1994 MGA Zone 56
Map: 80217025-GS-003-WaterMains.mxd 04
Aerial image supplied by Land and Property Information (2015)

Marrangaroo Study Area

APPENDIX C

WASTE WATER NETWORK

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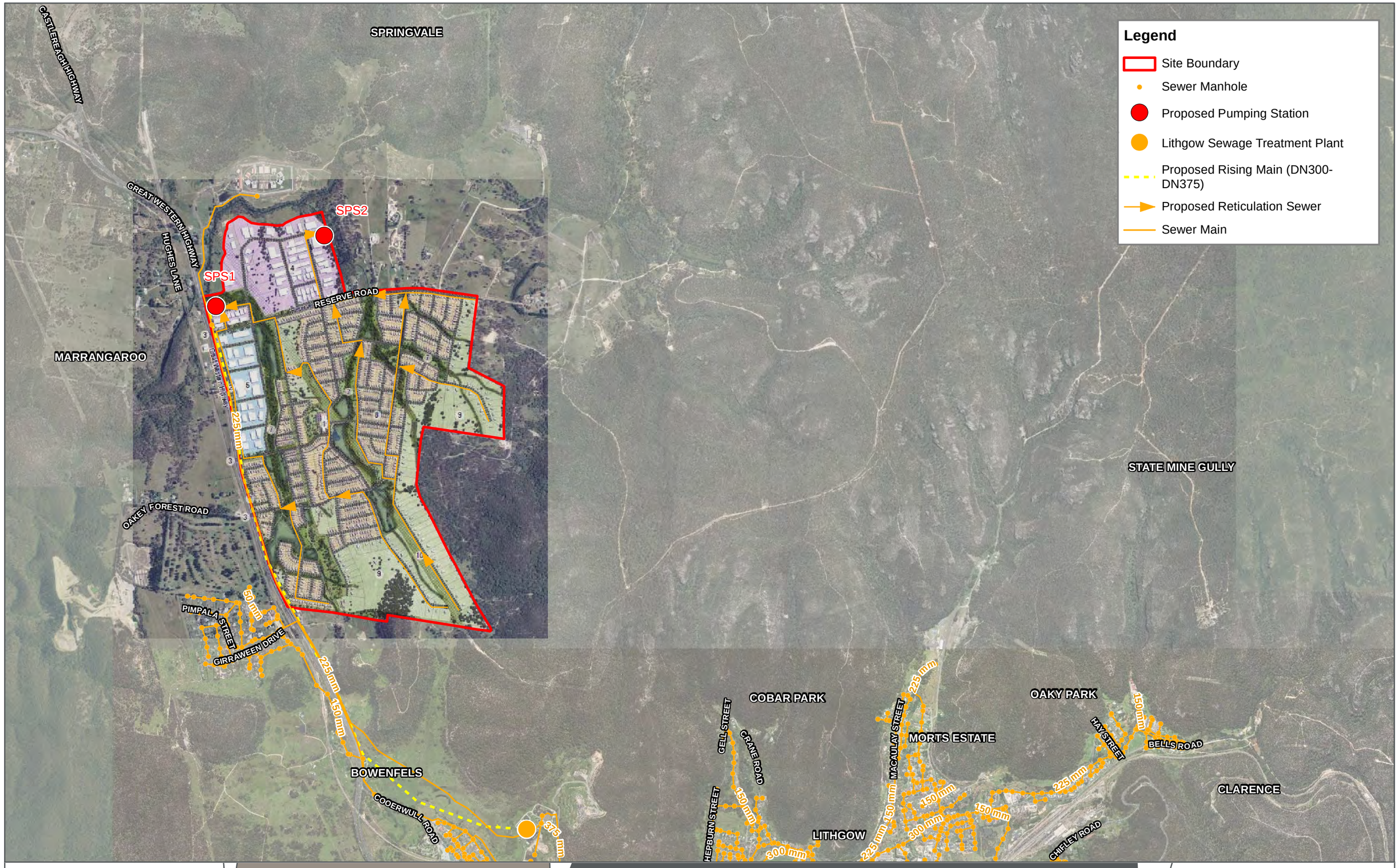

1:25,000 Scale at A3

Metres

0 250 500 750 1,000

Existing Sewer Infrastructure

MARRANGAROO DEVELOPMENT

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2017-10-24 | Project: 80217025
Coordinate System: GDA 1994 MGA Zone 56
Map: 80217025-GS-002-SewerMains.mxd 04
Aerial image supplied by Land and Property Information (2015)

Marrangaroo Study Area

APPENDIX D

COMBINED NETWORK SKETCH

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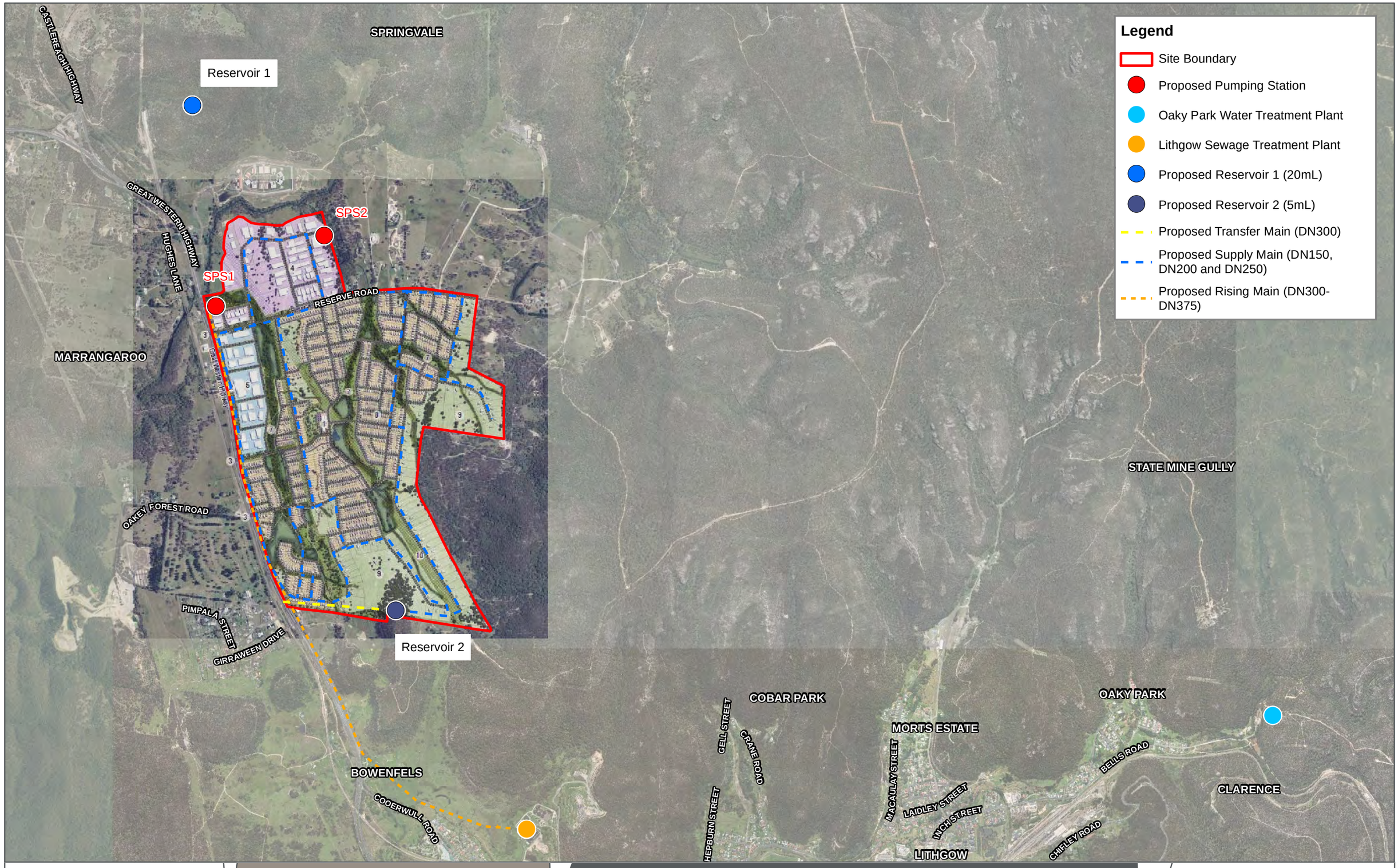

1:25,000 Scale at A3

Metres

0 250 500 750 1,000

Master Plan

MARRANGAROO DEVLOPMENT

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2017-10-24 | Project: 80217025
Coordinate System: GDA 1994 MGA Zone 56
Map: 80217025-GS-001-MarrangarooMasterPlan.mxd 03
Aerial image supplied by Land and Property Information (2015)

Marrangaroo Study Area

APPENDIX E

POTABLE AND WASTE WATER CALCUL TIONS

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DESIGN FLOW = PDWF + GWI + IIF
PDWF = d x ADWF (ADWF = 0.0017 x EP) 150L/Ep/day
GWI = 0.025 x A x Portion Wet
RDI = 0.028 x A eff x C x I

Public Works	240L/day	0.0028	Treated plant capacity designed to Public Works Standard
WSA	150L/day	0.0017	

PEAK DRY WEATHER FLOW (PDWF)

Res Catchment Size	260	Ha		Comm Catchment Size	32	Ha		Open Space Catchment Size	57	Ha		Industrial Catchment Size	49	Ha
Lots	1512													
EP per Unit	3.5	Density		EP per Unit		Density		EP per Unit		Density		EP per Unit	1554.5	Density
Design EP	5292.00	EP		Design EP	2475.00	EP		Design EP	1140.00	EP		Design EP	1554.50	EP
Density (EP/Ha)	20.35			Density (EP/Ha)	77.34			Density (EP/Ha)	20.00			Density (EP/Ha)	31.72	
ADWF	17.78	L/s	size WW											
d	2.04													

PDWF	**36.20**	**L/s**	**Pump Capacity**	**168.11**	**L/s**
			Flow Rate	**0.168**	**m3/s**
			Rising Main Dia	**463**	**mm**
			Rising Main Length	**5000**	**m**

Assume velocity of 1m/s
Std Size (m) **0.5**

GROUNDWATER INFILTRATION (GWI)

Portion (Wet) 1.00 ground water table unknown (assumed 100%)

GWI	**9.95**	**L/s**	**No Pump Starts/hr**	**8**	
			Detention Time (T)	**55.23**	
			Vww	**18.91**	**m3**
			WW Operation Level	**1**	**m**
			Dia WW	**4.91**	**m**

PEAK (RAINFALL DEPENDENT) INFLOW (IIF)

C = S aspect + N aspect

S aspect	0.5	Table C1
N aspect	0.5	Table C1
C	1.00	

I = I(1,2) * Factor (size) * Factor (cont)

I (1,2)	23.6	BOM website - http://www.bom.gov.au/hydro/has/cdirswebx/cdirswebx.shtml.
Factor (size)	0.759	
Factor (cont)	1.50	Table C3
I	26.87	

A(eff) 162.10 Ha

IIF **121.96** **L/s**

DESIGN FLOW **168.11** **L/s**

Full Development	Ha	Lots	EPs (WSA)	Comments
General Industrial	49		1554.5	
Enterprise Corridor	22		1650	75EPs per Ha
Urban Res (10/ha)	133	1250	4375	3.5EPs per lot (1000m2)
Large Lot Res (2/ha)	127	262	917	3.5EPs per lot (5000m2)
Open Space	57		1140	20EP per ha
Village Centre	1		150	assumption
TBC	9		675	75EPs per Ha = assumed to be commerical
TOTAL	**398**	**1512**	**10,461.50**	

Res 260 1512

DESIGN FLOW = PDWF + GWI + IIF
PDWF = d x ADWF (ADWF = 0.0017 x EP) 150L/Ep/day
GWI = 0.025 x A x Portion Wet
RDI = 0.028 x A eff x C x I

PEAK DRY WEATHER FLOW (PDWF)

Res Catchment Size (A)	57	Ha		Com Catchment Size (A)	31	Ha		Open Space Catchment Size	28.5	Ha		Industrial Catchment Size	49	Ha
Lots	443													
EP per Unit	3.5	Density		EP per Unit		Density		EP per Unit	20	Density		EP per Unit	1554.5	Density
Design EP	1550.50	EP		Design EP	2475.00	EP		Design EP	570.00	EP		Design EP	1554.50	EP
Density (EP/Ha)	27.20			Density (EP/Ha)	77.34			Density (EP/Ha)	20.00			Density (EP/Ha)	31.72	
ADWF	10.46	L/s	size WW											
d	2.29													

PDWF	**23.94**	**L/s**

Pump Capacity	**94.51**	**L/s**	
Flow Rate	**0.09**	**m3/s**	Assume velocity of 1m/s
Rising Main Dia	**347**	**mm**	**Std Size (m)** **0.375**
Rising Main Length	**5000**	**m**	

GROUNDWATER INFILTRATION (GWI)

Portion (Wet) 1.00 ground water table unknown (assumed 100%)

GWI	**4.14**	**L/s**

No Pump Starts/hr	**8.00**	
Detention Time (T)	**52.85**	
Vww	**10.63**	**m3**
WW Operation Level	**1.00**	**m**
Dia WW	**3.68**	**m**

PEAK (RAINFALL DEPENDENT) INFLOW (IIF)

C = S aspect + N aspect

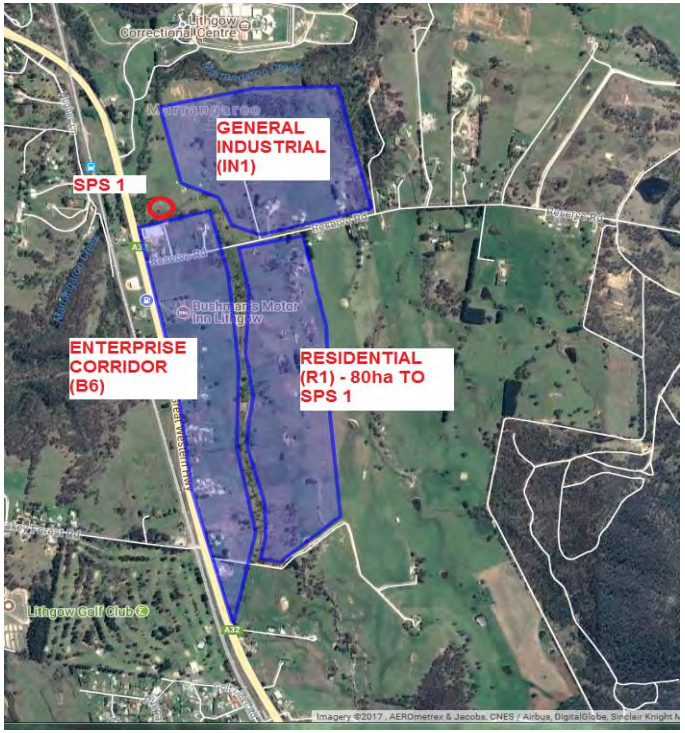
S aspect	0.5	Table C1
N aspect	0.5	Table C1
C	1.00	

I = I(1,2) * Factor (size) * Factor (cont)

I (1,2)	23.6	BOM website - http://www.bom.gov.au/hydro/has/cdirswebx/cdirswebx.shtml.
Factor (size)	0.843	
Factor (cont)	1.50	Table C3
I	29.85	
A(eff)	79.47	Ha

IIF	**66.43**	**L/s**
DESIGN FLOW	**94.51**	**L/s**

Stage 1 Development	Ha	Lots	EPs (WSA)	Comments
General Industrial	49		1554.5	
Enterprise Corridor	22		1650	75EPs per Ha
Urban Res (10/ha)	44	417	1459.5	3.5EPs per lot (1000m2)
Large Lot Res (2/ha)	13	26	91	3.5EPs per lot (5000m2)
Open Space	28.5		570	20EP per ha
Village Centre	0		0	assumption
TBC	9		675	75EPs per Ha = assumed to be commerical
TOTAL	**165.5**	**443**	**6,000.00**	



DESIGN FLOW = PDWF + GWI + IIF

PDWF = d x ADWF (ADWF = 0.0017 x EP) 150L/Ep/day

GWI = 0.025 x A x Portion Wet

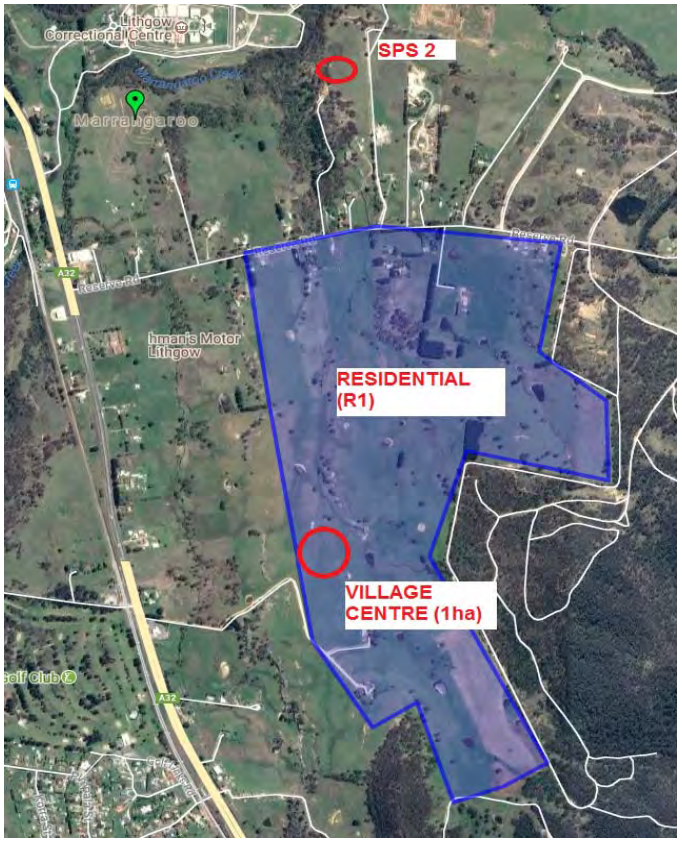
RDI = 0.028 x A eff x C x I

PEAK DRY WEATHER FLOW (PDWF)

Res Catchment Size (A)	207	Ha		Com Catchment Size (A)	1	Ha		Open Space Catchment Size	28.5	Ha		Industrial Catchment Size	0	Ha
Lots	1069													
EP per Unit	3.5	Density		EP per Unit		Density		EP per Unit	20	Density		EP per Unit		Density
Design EP	3741.50	EP		Design EP	150.00	EP		Design EP	570.00	EP		Design EP	0.00	EP
Density (EP/Ha)	18.07			Density (EP/Ha)	150			Density (EP/Ha)	20.00			Density (EP/Ha)	0.00	
ADWF	7.58	L/s	size WW											
d	2.17													

PDWF	**16.48**	**L/s**	**Pump Capacity**	**89.07**	**L/s**	
			Flow Rate	**0.09**	**m3/s**	Assume velocity of 1m/s
GROUNDWATER INFILTRATION (GWI)			**Rising Main Dia**	**337**	**mm**	**Std Size (m) 0.375**
			Rising Main Length	**1350**	**m**	
Portion (Wet)	1.00		ground water table unknown (assumed 100%)			
GWI	**5.91**	**L/s**	**No Pump Starts/hr**	**8.00**		
			Detention Time (T)	**19.69**		
PEAK (RAINFALL DEPENDENT) INFLOW (IIF)			**Vww**	**10.02**	**m3**	
			WW Operation Level	**1.00**	**m**	
			Dia WW	**3.57**	**m**	
C = S aspect + N aspect						
S aspect	0.5		Table C1			
N aspect	0.5		Table C1			
C	1.00					
I = I(1,2) * Factor (size) * Factor (cont)						
I (1,2)	23.6		BOM website - http://www.bom.gov.au/hydro/has/cdirswebx/cdirswebx.shtml.			
Factor (size)	0.808					
Factor (cont)	1.50		Table C3			
I	28.60					
A(eff)	83.26	Ha				
IIF	**66.68**	**L/s**				
DESIGN FLOW	**89.07**	**L/s**				

Stage 2 Development	Ha	Lots	EPs (WSA)	Comments
General Industrial	0		0	No industrial in Stage 2
Enterprise Corridor	0		0	No commercial in Stage 2
Urban Res (10/ha)	93	833	2915.5	3.5EPs per lot (1000m2)
Large Lot Res (2/ha)	114	236	826	3.5EPs per lot (5000m2)
Open Space	28.5		570	20EP per ha
Village Centre	1		150	assumption
TBC	0		0	No commercial in Stage 2
TOTAL	**236.5**	**1069**	**4,461.50**	



STAGE 1		
EP's	5,580	
A.D.D	2.68	ML/day
P.D.D	4.02	ML/day
Pump Rate	**139.5**	**(L/s)**

STAGE 2		
EP's	3,892	
A.D.D	0.70	ML/day
P.D.D	1.06	ML/day
Pump Rate (L/s)	**36.64**	**(L/s)**

ULTIMATE		
EP's	9,472	
A.D.D	3.38	ML/day
P.D.D	5.07	ML/day
Pump Rate (L/s)	**176.18**	**(L/s)**

Residential Lots	443		Residential Lots	1069		Residential Lots	1512	
Residential PW Demand	0.28	ML/day	Residential PW Demand	0.67	ML/day	Residential PW Demand	0.95	ML/day
Commercial Area (ha)	31		Commercial Area (ha)	1		Commercial Area (ha)	32	
Commercial PW Demand	0.93	ML/day	Commercial PW Demand	0.03	ML/day	Commercial PW Demand	0.96	ML/day
Industrial Area (ha)	49		Industrial Area (ha)	0		Industrial Area (ha)	49	
Industrial PW Demand	1.47	ML/day	Industrial PW Demand	0.00	ML/day	Industrial PW Demand	1.47	ML/day
TOTAL	**2.68**	**ML/day**	**TOTAL**	**0.70**	**ML/day**	**TOTAL**	**3.38**	**ML/day**

Shaft St Reservior BWL	971	
Loses in main	3	m/km
Pressure at Marrang	948	m

Assumptions			
MDD	1.6 ADD		
PDD	2.5 ADD		
Pump Rate	assumed 8hrs of storage required		
ADD - Residential	630	L/lot/day	
ADD - Commercial	3	L/sq.m/day	
ADD - Industrial	3	L/sq.m/day	
Peak Day Demand	***for design of a distribution system upstream of balancing storage - over a 12 month period***		
	PDD = ADD x PDF	Peak Day Factor (PDF)	1.5 population over 10,000
		PDF	2 under 2,000
Peak Hour Demand	***for design of a distribution system downstream of balancing storage - over a 24 hr period***		
	PHD = ADD x PHF	Peak Hour Factor (PDF)	2 population over 10,000
		PDF	5 population under 2,000

Reservior Storage Operating Storage + Reserve Storage

Operating Storage cater for demands exceeding the max avalibale inflow rate
Reserve Storage system failure
Reserve Storage 1/3 x PDD

Reservior Storage min of 8 - 24hrs consupmtion at peak day demand

Marrangaroo Study Area

APPENDIX F

STAGE 1 – POTABLE WATER ZONE

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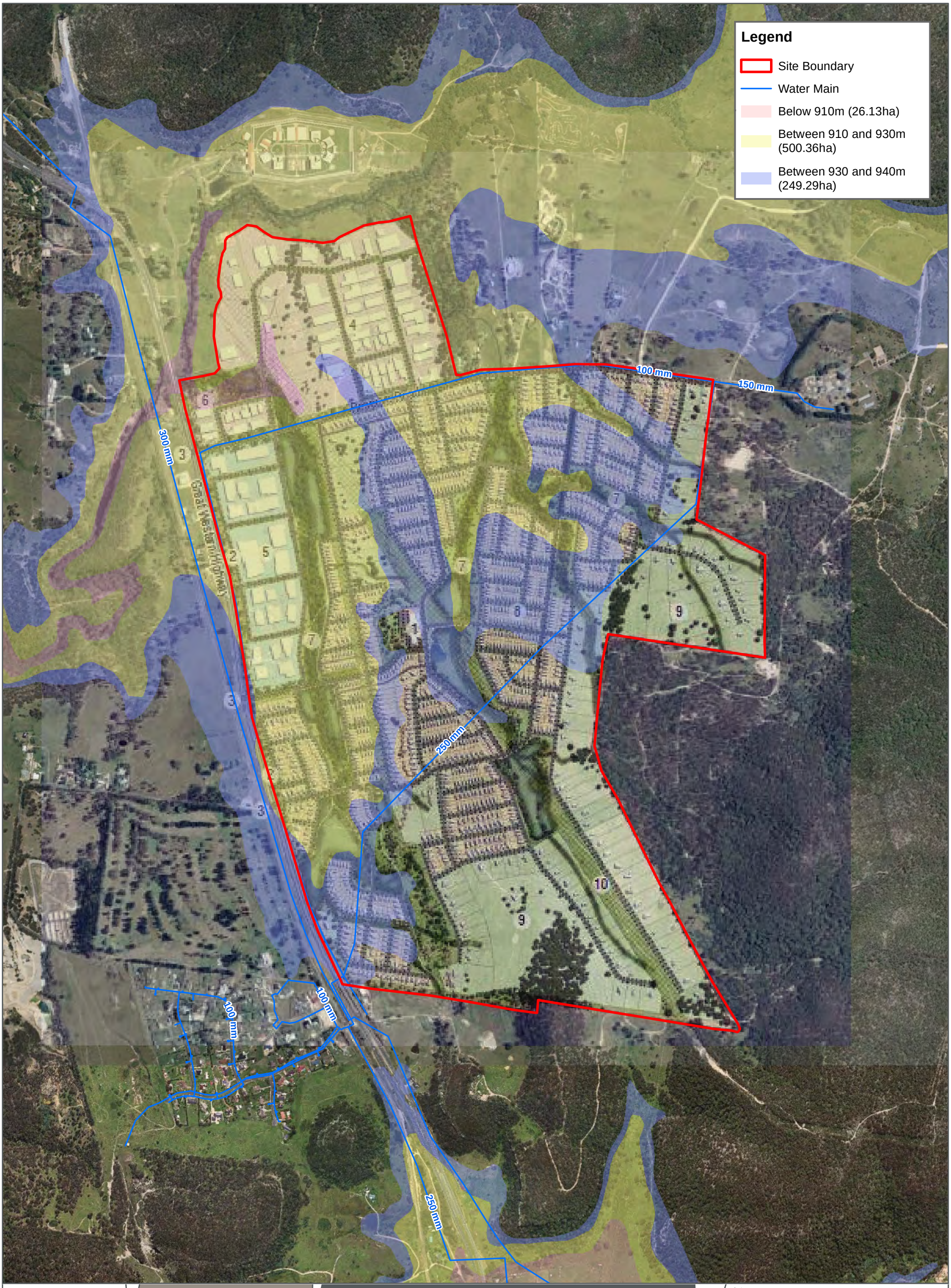
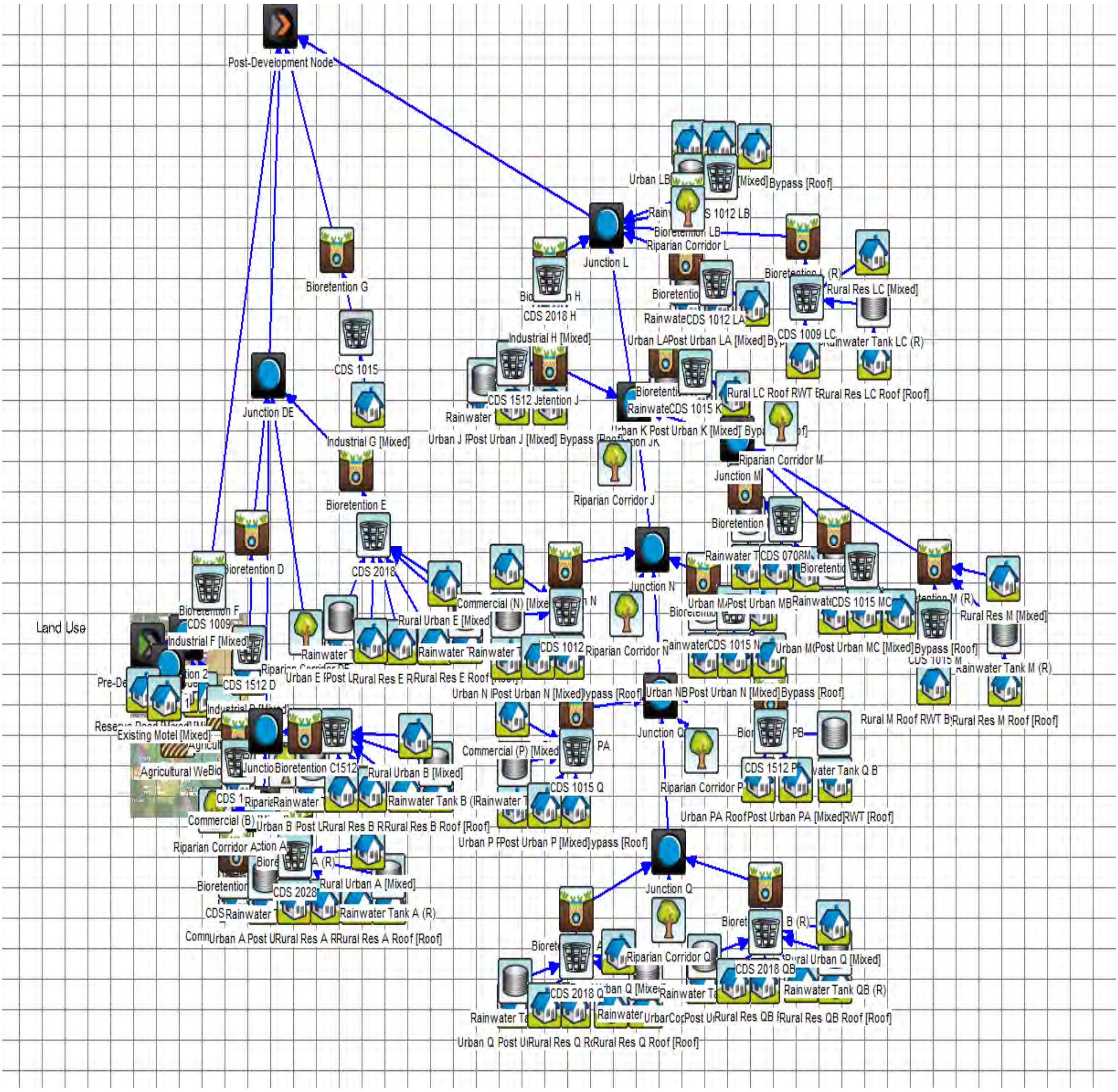

Legend
Site Boundary
Water Main
Below 910m (26.13ha)
Between 910 and 930m (500.36ha)
Between 930 and 940m (249.29ha)
100 mm
150 mm
300 mm
250 mm
100 mm
100 mm
250 mm
Great Western Highway
1:12,500 Scale at A3
Metres
0 100 200 300 400 500
Water Servicing
MARRANGAROO DEVELOPMENT
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2017-10-24 | Project: 80217025
Coordinate System: GDA 1994 MGA Zone 56
Map: 80217025-GS-005-WaterServicing.mxd 02
Aerial imagery supplied by DFSI-SS (2015)

APPENDIX C


Post-Development Node
Junction L
Bioretention G
CDS 1015
Junction DE
Industrial G [Mixed]
Bioretention E
CDS 2018
Bioretention D
Land Use
Existing Motel [Mixed]
CDS 1512 D
Riparian Corridor J
Riparian Corridor L
Riparian Corridor M
Riparian Corridor N
Riparian Corridor P
Riparian Corridor Q
Junction N
Junction Q
CDS 2018 H
Industrial H [Mixed]
Rural Res LC [Mixed]
Rural LC Roof RWT B
Rural Res LC Roof [Roof]
CDS 1009 LC
Rural Urban E [Mixed]
Rural Urban B [Mixed]
Rural Urban A [Mixed]
Rainwater Tank A (R)
Rural Res M [Mixed]
Rainwater Tank M (R)
Rural M Roof RWT B
Rural Res M Roof [Roof]
CDS 1015 Q
CDS 1512 P
Urban PA Roof
Post Urban PA [Mixed]
Urban N
Post Urban N [Mixed]
Urban NB
Post Urban N [Mixed] Bypass [Roof]
Post Urban MC [Mixed] Bypass [Roof]
CDS 2018 QB
Rainwater Tank QB (R)
Rural Res QB Roof [Roof]
CDS 2018 Q
Rural Res Q Roof [Roof]
Rural Res A Roof [Roof]
Rural Res B Roof [Roof]
Rural Res E Roof [Roof]
CDS 2028
Commercial (B)
Commercial (P) [Mixed]
Commercial (N) [Mixed]
CDS 1012
CDS 1015 K
CDS 1015 MC
CDS 1015 N
CDS 1012 LA
Post Urban LA [Mixed]
Post Urban K [Mixed]
Post Urban J [Mixed] Bypass
Industrial F [Mixed]
CDS 1009
Agricultural