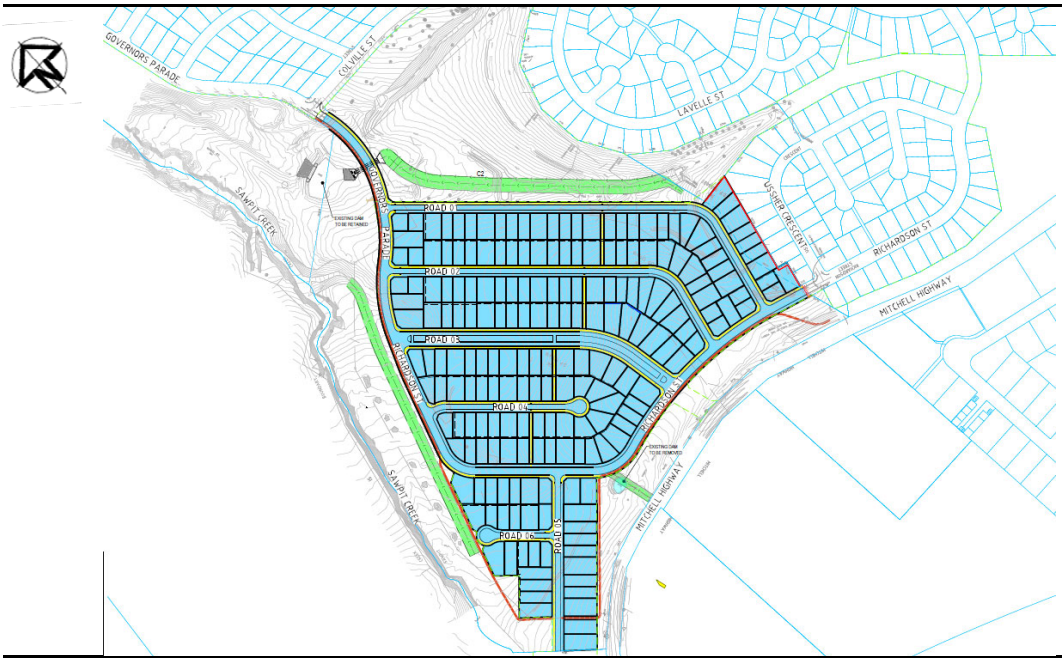
Windradyne Subdivision 1100



Civil Development Application Report

Author: Glen James

Approver: Andrew Tweedie

Report no: 17-465-R001 **Revision:** 07 **Date:** May 2020

Document information

Level 7, 153 Walker Street, North Sydney, NSW 2060

Document registration

Document title	Civil Development Application Report
Document file name	17-465-R001-06_Windradyne_Subdivision_1100 .docx
Section	Civil Engineering
Document author	Glen James

Finalisation signatures

The design described in this report is considered to have been finalised.

Signature		**Date**
Andrew Tweedie Civil Engineer		21/05/20
Glen James Civil Engineer (Author)		21/05/20

Notes: The finalisation signatures shown above do not provide evidence of approval to the design. Approval signatures are shown on the title sheet of the design plans.

Contents

Appendices

Figures

Tables

Executive Summary

Bathurst Regional Council is developing the Windradyne 1100 site for the purposes of providing a new low density residential subdivision. The new subdivision will subdivide the existing lot into a total of 205 lots, comprising 162 residential lots and 43 dual-occupancy residential lots.

The original Civil DA report described a two staged development for the Windradryne 1100 and sought approval for only Stage 1. This revised Civil DA report seeks approval for the entirety of the Windradyne 1100.

The Windradyne 1100 development comprises bulk earthworks, civil works, services infrastructure and stormwater management.

This report has been prepared to address the Bathurst Regional Council's requirements for the project relevant to earthworks, stormwater, roadworks and infrastructure servicing. This report outlines the proposed components of the design including Civil Design and Infrastructure, Road geometry and pavement design, Sedimentation and Erosion Control, Stormwater Management (Piped and Overland Flows, Water Sensitive Urban Design and On-Site Detention).

The site is located outside of flood planning areas as defined by the Bathurst Regional Council LEP. Impacts to external overland flow catchments will minimised by the proposed development.

This report also identifies the strategy for infrastructure services required to service the site including potable water, sewer, power, telecommunications and gas. The infrastructure to service this development forms part of an overall strategy for infrastructure delivery to the site. Generally, the site will be serviced by extending existing services at Richardson Street to the south and at Governors Parade to the north of the site.

1 Introduction

This Civil Development Application Report supports the proposed development of Windradyne 1100, Bathurst. Refer to Figure 1 for location of the proposed development.

AT&L have been engaged by Bathurst Regional Council (BRC) to prepare a Civil Development Application Report on the civil and stormwater management requirements for the proposed development.

The original Civil Development Application report described a two staged development for the Windradryne 1100 and sought approval for only Stage 1.

This revised Civil DA report supports the entirety of the Windradyne 1100 marked in blue in Figure 1.

The aim of the report is to assess the potential impacts of the proposed development with respect to civil, infrastructure and services.

This report has been prepared in accordance with the:

- Bathurst Regional Council Guidelines for Engineering Works 2011,
- Bathurst Regional Local Environmental Plan (LEP) 2014,
- Bathurst Regional Development Control Plan (DCP) 2014,
- Bathurst Regional Council Standard Drawings;
- Windradyne Estate and Proposed Seaman Development Traffic Impact Assessment 2016 (Bathurst Regional Council); and
- OEH's Managing Urban Stormwater: Soils and Construction Guideline.

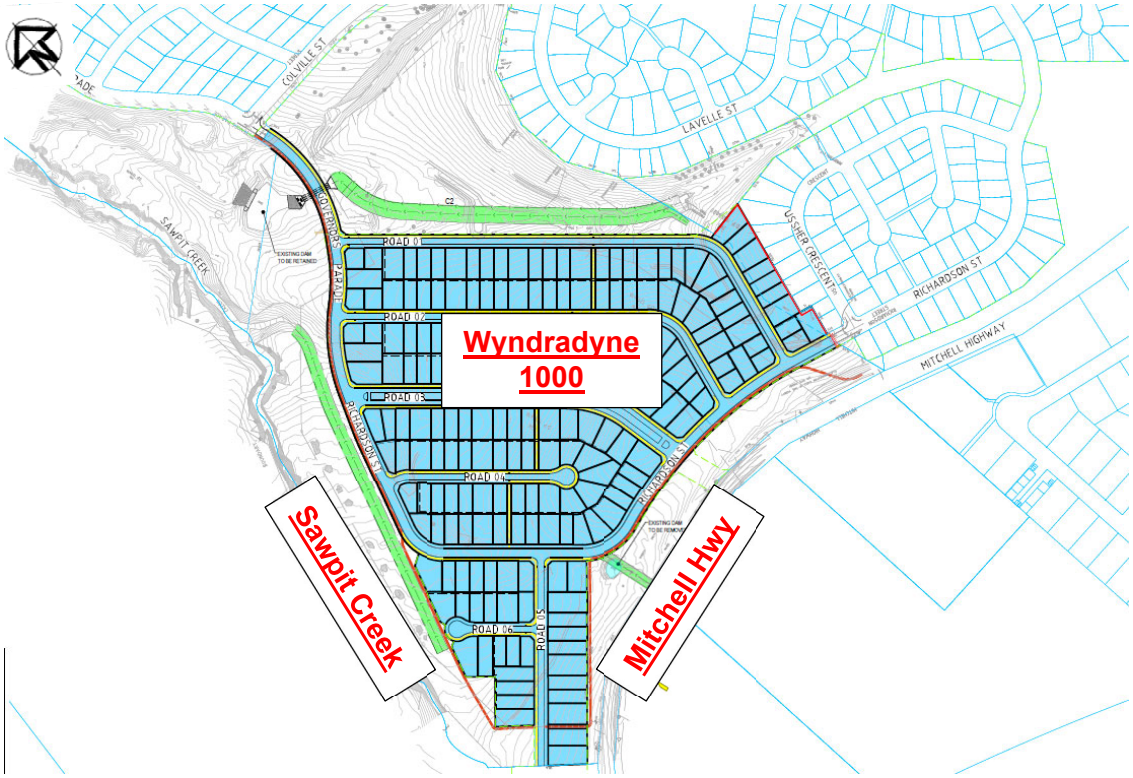


Figure 1: Locality Plan

This report should be read in conjunction with the Statement of Environmental Effects prepared By Anthony Daintith Town Planning and the Civil DA Drawings.

The Development Application (DA) for Windradyne 1100 seeks approval for the development of low-density residential lots and associated infrastructure. This DA does not seek approval of the on-lot works. It is assumed any on-lot/building works will require separate DA's.

1.1 Existing Site

The site is located on Lots 138 DP 1123180, located within the Bathurst Regional Council LGA and the total site area is approximately 40.65 Ha. Refer to Figure 2 for site location. Existing access to the site is via Richardson Street to the south and Governors Parade to the north.

The existing site is bound by:

- Mitchell Highway to the south;
- Sawpit Creek to the west; and
- Existing residential properties to the east and north.

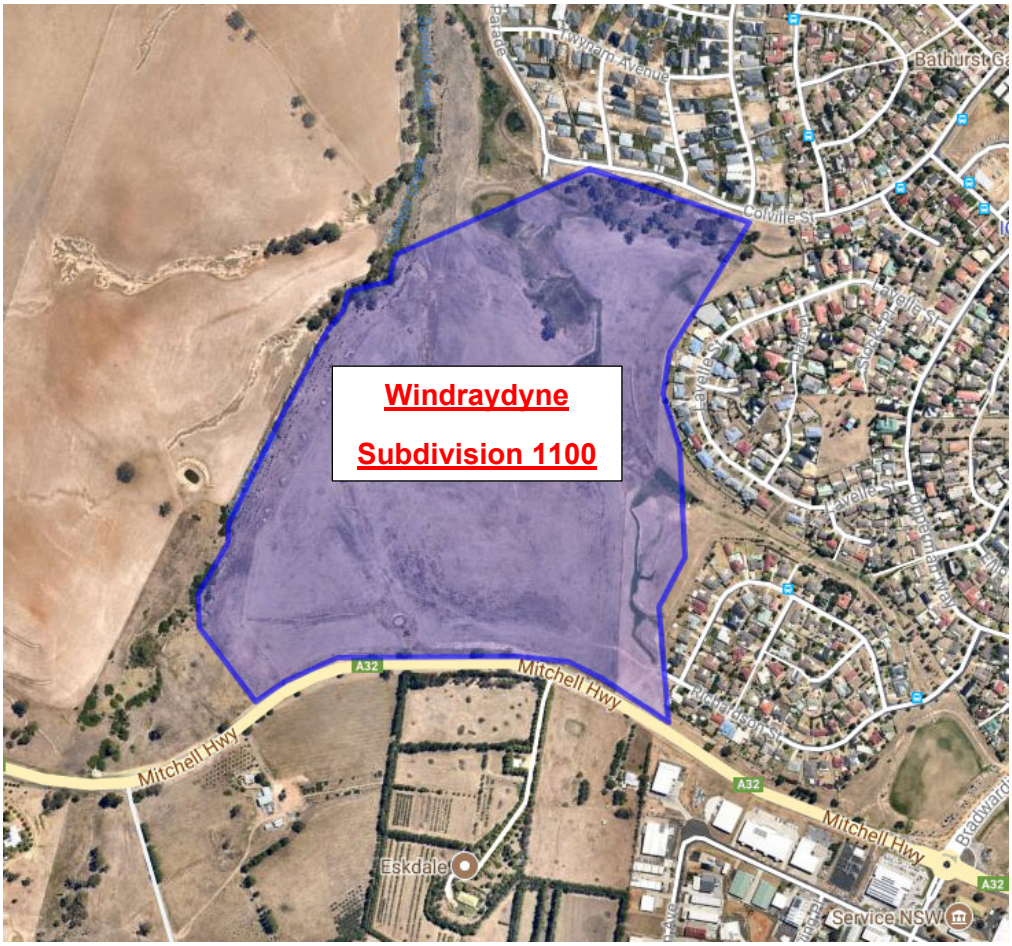


Figure 2: Aerial Image (Courtesy of Nearmap)

The site generally slopes down from south-east (approximate RL 708.5) to the north and Sawpit Creek (approximate RL 685.5). Refer to the Survey drawings within Appendix A for all features on site along with existing contour levels.

Currently, the majority of the site is unoccupied and covered by grassed paddocks with high-voltage electrical aerial cables traversing the site. There is a relatively small dam close to Mitchell Highway, south of the site and a larger dam at the northern boundary of the site adjacent to Sawpit Creek. The site can be classified as a “greenfield” site.

The site is zoned as R1, General Residential, under the provisions of Bathurst Regional Council Local Environmental Plan 2014. Refer to Figure 3 below for Zoning Map. Refer to Appendix B Civil Drawings for extent of R1 zoning.

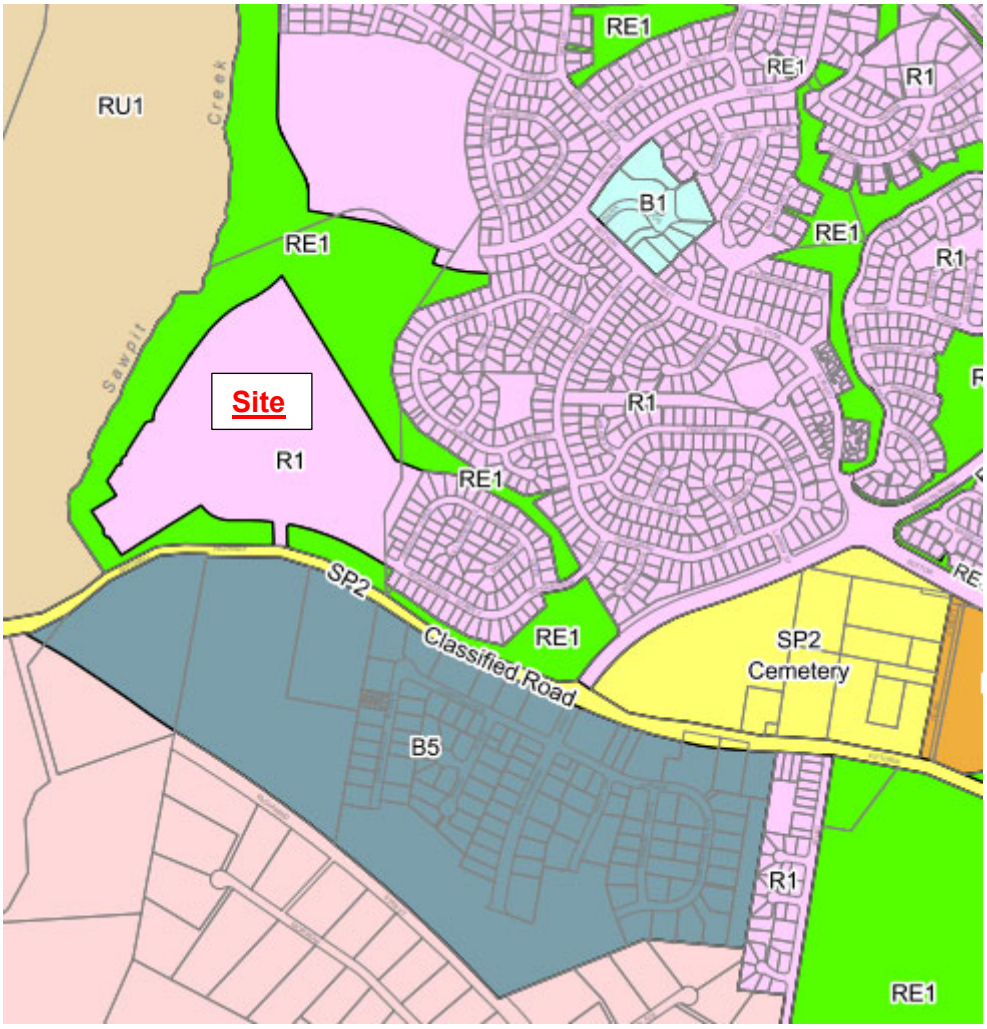


Figure 3: Zoning Map (Courtesy of BRC LEP 2014)

1.2 Project Description

The proposed development of Windradyne 1100 involves the construction of:

- 162 residential lots ranging in size from 550m2 to 1,200m2, refer AT&L drawing 17-465-DA030-31, and Figure 4;
- 43 dual-occupancy residential lots, refer AT&L drawing 17-465-DA025, and Figure 4;
- 5 x 8.0m wide Local Streets (Proposed Roads 1, 2, 4, 5 and 6);
- 1 x 21m wide Collector Roads (Proposed Road 3); and
- Continuation of Richardson Street to the east and Governors Parade to the north.

The proposed lot layout is shown within Figure 4 and the civil package contained within Appendix B.

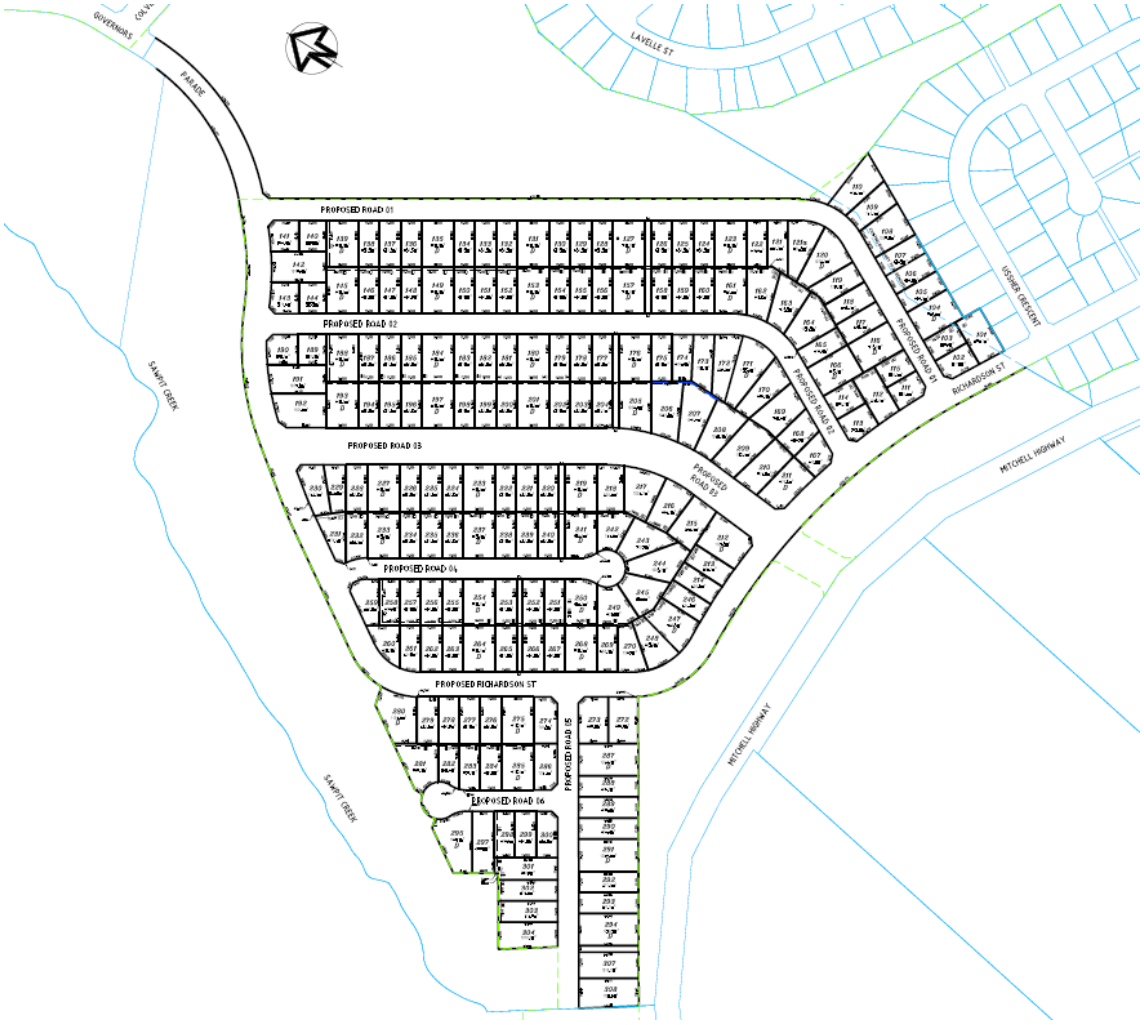


Figure 4 : Proposed Lot Layout

1.3 Scope of Report

This report outlines the design criteria for the proposed civil works for this development and how stormwater is managed across the site. It also identifies all existing utility infrastructure that currently service the site and the requirements for supplying utility services to the proposed development.

This report should be read in conjunction with the associated AT&L Civil Documentation drawings 17-465 drawings dated April 2020. Refer to Appendix B for Civil Drawings and Details.

This report has been prepared to satisfy the requirements and conditions of the documents listed above.

The report includes:

- Earthworks;
- Sedimentation and Erosion Control
- Road Design;
- Stormwater Management:

    - On Site Detention (OSD);
    - Piped and Overland Flows; and
    - Water Sensitive Urban Design (WSUD).
- Dial Before You Dig (DBYD) information; and
- Infrastructure Services, including:
    - Sewer;
    - Water Supply (Potable);
    - Electricity
    - Gas and
    - Telecommunications.

2 Earthworks

2.1 Geotechnical Investigation

A Geotechnical Report prepared by Macquarie Geotech in March 2018 based on field testing completed in February and March 2018, included:

- 16 boreholes;
- 12 Maximum Dry Density and Optimum Moisture Content Rations (RMS T111); and
- 12 California Bearing Ratio (CBR) Tests (RMS T117).

2.1.1 Regional Geology

Based on the 1:250,000 Geological Maps prepared by Geoscience Australia, the proposed development site is underlain by:

- Bathurst Granite (Coarse grained and porphyritic biotite granite).

2.1.2 Subsurface Soils

The following sub-surface soils were encountered across the site (refer Appendix C) based on the drilling of sixteen boreholes located across Windradyne Subdivision 1100 (refer Figure 5 for locality):

- Topsoil – Sandy Clay: Depth 0.0-0.2m;
- Residual Soil - Clayey Sand (Dense to very Dense): Depth 0.2 – 1.0m; and
- Residual Soil – Sandy Clay: Depth 0.2 – 1.0m.

No groundwater was observed within the boreholes at the time of testing.

Figure 5 : Borehole Locations (Courtesy of Macquarie Geotech)

2.2 Pavement Design

Based on the laboratory results from Macquarie Geotech (refer to Appendix C), a design subgrade CBR of 4.0 has been adopted for the pavement design. The proposed development consists of two (2) road types:

- Collector with Buses
  - Streets: Road 3, Governors Parade, Richardson Street
  - Traffic Loading: 8.0 x 10^5 Equivalent Standard Axles (ESA's).
- Local access with Buses
  - Streets: Roads 1, 2, 4, 5 and 6
  - Traffic Loading: 8.0 x 10^4 ESA's.

2.2.1 Pavement Design

Pavement design as specified by Macquarie Geotech;

- Collector with Buses
  - Wearing Course: 40mm Asphaltic Concrete;
  - Base: 160mm thick DGB20 (RMS 3051); and
  - Sub-Base: 260mm thick DGS40 (RMS 3051).
- Local Access with Buses
  - Wearing Course: 40mm Asphaltic Concrete;
  - Base: 160mm thick DGB20 (RMS 3051); and
  - Sub-Base: 180mm thick DGS40 (RMS 3051).

2.3 Cut/Fill Requirements

The site will require bulk and detail earthworks.

Topsoil stripped from the site will be stockpiled and used for landscaped areas. The volumes presented in Table 1 below accounts for 200mm stripping of topsoil of the entire site area.

Total Site Area	Site Stripping (Assumed 200mm)
233,383m^2	46,768m^3

Table 1: Topsoil Stripping Analysis

A preliminary cut/fill analysis was carried out with the results presented in Table 1 below.

Parameter	Volume (m^3)
Cut	-146,270
Fill	+146,464
Balance	**+194 (IMPORT)**

Table 2: Cut/Fill Summary Overall Site

The volumes do not consider the following:

- Bulking factors of removed cut;
- Stormwater and services trenching;

- Removal and/or remediation of any exiting uncontrolled fill;
- Landscaping;
- Pavement thickness; and
- Depth of existing dams.

2.4 Retaining Walls

Where possible, batter slopes will be provided to accommodate level changes. Where batter slopes are not possible, retaining walls will be constructed based on the current civil and earthworks design. A masonry wall will be adopted for all retaining walls as detailed on the civil drawings and located within private property.

At this stage there is only one retaining wall proposed within Windradyne 1100, this is in the north-eastern corner of the site within proposed lots 101-110. This wall has been proposed to limit the amount of cut required and to protect the existing lots within Ussher Crescent.

3 Staging

Whilst this Development Application seeks approval for the entirety of Windradyne 1100, staging of the works will be at the discretion of the developer to suit market conditions. This will be clarified during detailed design and subsequent Construction Certificate applications.

4 Dam Dewatering

4.1 Existing Conditions

There is two (2) existing farm dams within the site which are currently used to store water. This water is not currently used. It is proposed one dam will remain to act as a retarding basin and one dam will be removed. This dam will need to be dewatered and filled as part of the proposed development works.

The dams are spread across the entire site, generally along the alignment of drainage gullies. Refer to Appendix A for a plan showing existing dam locations and the proposed irrigation areas.

In the absence of detailed hydrographic survey data, for design purposes it has been assumed that the average depth of the existing dam is 1.5m. Approximate dam area and volumes are shown below in Table 12 below

The dam volume would be expected to vary seasonally, subject to the effects of evaporation, seepage and rainfall.

Dam	Location	Surface Area (m^2)	Assumed Volume (m^3)	Action
1	Adjacent the Mitchell Highway	310	465	To be removed
2	Adjacent Governors Parade	1953	2929.5	To Remain, but water used for erosion control

Table 3: Existing Dams

4.2 Dewatering Discharge Method

It is proposed to pump out the water from the dam and gradually discharge it over the designated irrigation areas in a controlled manner to avoid saturation of the ground surface and any downstream inundation.

Due to the large volume of water involved, irrigation will be conducted over the entirety of the site. Refer to Appendix A for the location of the dam and the proposed irrigation areas.

A submersible pump will be installed in the dam with a pump line leading to a sprinkler system installed at the top of the slope in designated irrigation areas.

Flows will be managed so that runoff onto downstream areas does not exceed the maximum flow rate from a 1 in 1-year ARI storm event. Due attention must be given to the weather

forecast to ensure that dewatering operations are not scheduled to coincide with anticipated rain events.

To prevent the dam from refilling with upstream flows over the duration of the dewatering process, diversion bunds will be installed around the upstream perimeter of each dam.

The proposed steps for dewatering the existing dam are as follows:

- Install erosion and sediment controls around the site including cut-off drains, diversion bunds and silt fences at low-points;
- Commission pumps and commence dewatering;
- Progressively lower spillway so that rainwater and ground seepage does not refill dam;
- Undertake fauna recovery if required;
- Desilt the existing dam and test sediments;
- Fill the existing dams and stabilise finished surface; and
- Remove sediment erosion control measures.

Refer to Section 4.4 below and Appendix B for more information.

The dewatering works will be undertaken by the civil contractor (yet to be confirmed) prior to commencing development civil works.

4.3 Water Quality Testing

Water quality testing of the existing dam will need to be conducted prior to dewatering for submission to the PCA in accordance with ANZECC Guidelines.

4.4 Dewatering Discharge Rate

The dewatering program for the site has been developed on the basis of the anticipated absorption capacity of the soil, using the Design Irrigation Rate (DIR) method specified in AS1547:2012.

Based on the geotechnical composition as discussed in Section 2, a soil category of 5 (for light clays) has been conservatively assumed in this instance for the purposes of calculation. This can be refined once more geotechnical investigation data is available, during detailed design (CC stage).

Based on the criteria displayed in Figure 6 below, utilising a spray irrigation method in Category 5 soils corresponds to a DIR of 3 mm/day.

TABLE M1
RECOMMENDED DESIGN IRRIGATION RATE (DIR) FOR IRRIGATION SYSTEMS

Soil Category (see Note 1)	Soil texture	Structure	Indicative permeability (K_{sat}) (m/d)	Design irrigation rate (DIR) (mm/day)		
				Drip irrigation	Spray irrigation	LPED irrigation
1	Gravels and sands	Structureless (massive)	> 3.0	5 (see Note 2)	5	(see Note 3)
2	Sandy loams	Weakly structured massive	> 3.0			4
			1.4 – 3.0			
3	Loams	High/ moderate structured	1.5 – 3.0	4 (see Note 1)	4	3.5
		Weakly structured or massive	0.5 – 1.5			
4	Clay loams	High/ moderate structured	0.5 – 1.5	3.5 (see Note 1)	3.5	3
		Weakly structured	0.12 – 0.5			
		Massive	0.06 – 0.12			
5	Light clays	Strongly structured	0.12 – 0.5	3 (see Note 1)	3	2.5 (see Note 4)
		Moderately structured	0.06 – 0.12			
		Weakly structured or massive	< 0.06			
6	Medium to heavy clays	Strongly structured	0.06 – 0.5	2 (see Note 2)	2	(see Note 3)
		Moderately structured	< 0.06			
		Weakly structured or massive	< 0.06			

NOTES:
1 For Category 3 to 5 soils (loams to light clays), the drip irrigation system needs to be installed in an adequate depth of topsoil (in the order of 150 – 250 mm of *in situ* or imported good quality topsoil) to slow the soakage and assist with nutrient reduction.
2 For Category 1, 2, and 6 soils, the drip irrigation system has a depth of 100 – 150 mm in good quality topsoil (see CM1 and M3.1).
3 LPED irrigation is not advised for Category 1 or Category 6 soils – drip irrigation of secondary effluent is the preferred irrigation method.
4 LPED irrigation for Category 5 soils needs a minimum depth of 250 mm of good quality topsoil (see M5 and CM7.1).

Figure 6 : Design Irrigation Rate Criteria from AS1547:2012

The formula below provides the total volume of water that can be discharged in the designated irrigation areas per day:

Irrigation Volume (IV) = DIR x Area (m^2)

= 3 x 2,226,958m^2 (area of lots and roads)

= 680,874 L/day

4.5 Indicative Dewatering Program

Based on the Irrigation Volume above and the total volume of water held in the existing dams (3,394,500 L) the number of days required to discharge the water can be calculated:

No. of days = 3,394,500/680,874

= 4.98 days

The program spans a total of 1 week, this should be considered approximate until the staging requirements are confirmed during detailed design.

4.6 Fauna Recovery

Should aquatic fauna be encountered during the dewatering process, specialist ecological consultants and/or fauna recovery personnel will be consulted. The recovery process will ensure that the fauna is recovered and appropriately relocated in accordance with the relevant guidelines.

4.7 Sediment Testing and Removal

Residual sediment from the dewatered dams is to be tested by a NATA registered laboratory prior to re-use. This testing must occur prior to disturbance of the sediment. The results will be compared against the safe levels stated by the National Environmental Protection Measure (NEPM) 2013 for residential lots.

If the results of the testing indicate higher levels than those specified in NEPM 2013, the results shall be referred to EPA and Council (or other relevant authorities) for confirmation on whether the material is acceptable for re-use or on-site treatment. Any material that is considered unsuitable for re-use on site shall be removed and disposed of at a suitable waste management facility.

4.8 Filling of Dam

Once dewatering and desilting has occurred, the embankments surrounding dam 1 are to be removed and used as fill for bulk earthwork's operations.

Pending the results of sediment testing, any saturated material located at the base of the dams will be excavated, dried and mixed with other site-won material for re-use as general fill on the site, subject to geotechnical assessment and advice. If the material is deemed unsuitable by the geotechnical engineer, it will be disposed of at a suitable off-site facility.

Excavated material from cut areas on the wider site will then be used to fill the voids where the dams were. Refer to the civil engineering DA drawing (DA003) for proposed finished earthworks levels.

Refer to Appendix B for the proposed construction sequence for removing the dams.

4.9 Environmental Protection Measures

The discharge of poor-quality water can have a severe impact on the receiving environment. To minimise the risk of this occurring, environmental protection measures will be implemented across the site both for the dam dewatering process and for general engineering works.

Water from the dams will be irrigated across the designated areas at a flow rate that prevents the surface from eroding. Diversion bunds will also be installed across the top of dams to prevent potential upstream flows from entering the dams. Silt fences or straw bales will be installed at low points downstream to slow runoff and capture sediment.

4.10 Salinity

Saline soils can have an adverse effect on the durability of common building products such as concrete and steel and can therefore pose issues with building foundations and underground services. Geotechnical advice will be sought prior to the commenment of construction regarding salinity potential, mainly in areas of lower slopes adjacent to Sawpit Creek and existing drainage systems where water has accumulated.

In relation to the dam dewatering process, the main risk mitigation measures required are as follows:

- Avoiding concentrated flows of discharged water which could scour the surface and expose any underlying saline soils present;
- Restricting flow rates to those calculated in Section 3.4 above (i.e. based on the permeability of the soils) to avoid waterlogging the soil in the irrigation areas;
- Maintaining good drainage downstream of irrigation areas to avoid ponding of runoff in low-lying areas of the site; and
- Maintaining existing vegetation where possible during the dewatering process to reduce erosion.

4.11 Contingency Plan

The civil contractor engaged to complete the works will be required to prepare a contingency plan to account for any issues which arise during the dewatering process.

For example, the following actions may be required:

- Halting dewatering operations;
- Changing dewatering methods or equipment;
- Changing/swapping irrigation areas; or
- Additional monitoring.

Some float should be allowed in the dewatering program to allow for contingencies.

4.12 Conclusion

The methodology, program and environmental requirements for dewatering the dam have been set out in this report and must be complied with by the contractor appointed to undertake the works. Detailed Geotechnical investigation is to be undertaken prior to commencement of works to ensure compliance with the relevant guidelines to the satisfaction of the PCA, Council and the EPA.

5 Sedimentation and Erosion Control

5.1 Sedimentation and Erosion Control (Construction)

A Soil and Water Management Plan (SWMP) will be prepared in accordance with the NSW Department of Housing Publication titled: Managing Urban Stormwater – Soils and Construction (2004) for the whole site.

The key objective of the SWMP are:

- Acknowledging the activities on a construction site which may contribute to erosion, sedimentation and water quality impacts;
- The implementation of industry best management practices to minimise adverse water quality and sedimentation impacts brought about through construction activities on waterbodies surrounding the work; and
- Establishment of processes that effectively manage erosion, sedimentation and water quality practices during the life of the project.

5.1.1 Sources of Pollution

The activities and aspects of the works that have potential to lead to erosion, sediment transport, siltation and contamination of natural waters include:

- Earthworks undertaken immediately prior to rainfall periods;
- Work areas that have not been stabilised;
- Extraction of construction water from waterways during low rainfall periods;
- Clearing of vegetation and the methods adopted, particularly in advance of construction works;
- Stripping of topsoil, particularly in advance of construction works;
- Bulk earthworks and construction of pavements;
- Works within drainage paths, including depressions and waterways;
- Stockpiling of excavated materials;
- Storage and transfer of oils, fuels, fertilisers and chemicals;
- Maintenance of plant and equipment;
- Ineffective implementation of erosion and sediment control measures;
- Inadequate maintenance of environmental control measures; and
- Time taken for the rehabilitation / revegetation of disturbed areas.

5.1.2 Potential Impacts

The major potential impacts on the riparian environment relate to erosion of distributed areas or stockpiles and sediment transportation. Potential adverse impacts from erosion and sediment transportation can include:

- Loss of topsoil;
- Increased water turbidity;
- Decreased levels of dissolved oxygen;
- Changed salinity and pH levels;
- Smothering of stream beds and aquatic vegetation;

- Reduction in aquatic habitat diversity;
- Increased maintenance costs; and
- Decrease in waterway capacity leading to increased flood levels and durations;

5.2 RUSLE Analysis

Prior to the design of the SWMP, a Revised Universal Soil Loss Equation (RUSLE) has been undertaken in accordance with the "Blue Book". This analysis has been undertaken to predict the long term, average and annual soil loss from sheet and rill flow from the site under specified management conditions.

Estimating soil loss for a proposed development has four important applications to soil and water management. These are to:

1. Assess the erosion risk at a site;
2. Identify suitable measures to overcome the erosion risk;
3. Estimate the required capacity of sediment retarding basins; and
4. Compare the effectiveness of various erosion control measured.

Refer to Table below for the RUSLE analysis undertaken for this site. It should be noted the following parameters/assumptions were used for the analysis of this site:

- Rainfall Erosivity Factor (R) = 1,270 from (Equation 2, Appendix A2 Blue Book)
- Soil Erodibility Factor (K) = 0.072 (0.060 based on advice received from Council and a 20% penalty for dispersive soils);
- Slope Length (LS): Is assumed to not exceed 80m immediately before forecast rainfall or during shutdown periods and a maximum grade of 10% (from Appendix A4 of Blue Book);
- Erosion Control Factor (P): Is the ratio of soil loss with a nominated surface condition ploughed up and down the slope (from Appendix A5, Blue Book); and
- Cover Factor (C): Is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from continuously tilled, bare soil. With the proposed ESC measures being installed post bulk earthworks, it is assumed that all soil is recently disturbed, thus a C factor of 1 is chosen (from Appendix A6, Blue Book).

Parameter	Item (Blue Book Reference)
Rainfall Erosivity Factor, R	1,270
Soil Erodibility Factor, K (Table C20, Blue Book)	0.072
Slope Length/Gradient Factor, LS	2.81
Erosion Control Practice Factor, P	1.30
Ground Cover and Management Factor, C	1
Computed Soil Loss (tonnes/ha/year), A	**334.03**
Soil Loss Class	**3 (Table 4.2 Blue Book)**

Table 4: RUSLE Analysis

The erosion hazard potential of the site is considered low-moderate, due to the calculated soil loss lying in the range of 226 to 350 tonnes/ha/year as per Table 4.2 of the Blue Book. Refer to Figure 7.

Table 4.2 The Soil Loss Classes (adapted from Morse and Rosewell, 1996)

Soil Loss Class	Calculated soil loss (tonnes/ha/yr)	Erosion hazard
1	0 to 150	very low
2	151 to 225	low
3	226 to 350	low-moderate
4	351 to 500	moderate
5	501 to 750	high
6	751 to 1,500	very high
7	>1,500	extremely high

Figure 7: Table 4.2 from the Blue Book

5.3 Soil and Water Management Plan

5.3.1 Overall Strategy

The following construction methodology will be followed to minimise the impact of sedimentation due to construction works:

- Diversion of "clean" water away from the disturbed areas and discharge via suitable scour protection;
- Provision of hay bale type flow diverters to catch drainage and divert to "clean" water drains;
- Diversion of sediment-laden water into temporary sediment control basins to capture the design storm volume and undertake flocculation (if required);
- Provision of construction traffic shaker grids and wash-down to prevent vehicles carrying soils beyond the site;
- Provision of catch drains to carry sediment-laden water to sediment basins;
- Provision of silt fences to filter and retain sediments at source; and
- Rapid stabilisation of disturbed and exposed ground surfaces with hydro-seeding areas where future construction and building works are not currently proposed.

Erosion and Sediment Control Plans, for all proposed control and protection measures across the site, will be detailed within the Construction Documentation prepared by AT&L in accordance with BRC requirements.

5.3.2 Design of Sediment and Erosion Control Measures

Suitable erosion and sediment controls shall be provided by the Contractor and maintained throughout all stages of works, including at completion of the bulk earthworks.

All design, documentation, installation and maintenance of sediment and erosion controls will be in accordance with the requirements of:

- Protection of the Environment Operations Act;
- Bathurst Regional Council specifications; and
- Office of Environment and Heritage's 'Managing Urban Stormwater: Soils and Construction. Landcom, (4th Edition) (The "Blue Book") Volume 1 and Volume 2.

Ultimately, the final temporary sediment basin locations and sizes will be provided to suit development staging requirements, and will be sized and maintained in accordance with the requirements of the above-mentioned authority documents.

With the proposed site being larger than 2,500m^2 in disturbed area, a sediment basin system is required. The following temporary sediment basins are to be in-place at the commencement of demolition works, subject to detailed design.

Parameter	Item (Blue Book Reference)
Soil Type	Type D (Appendix C, Table C20, Blue Book)
Design Rainfall Depth (Days)	5
Design Rainfall Depth (Percentile)	85
x-day, y-percentile rainfall event	24.90 (Table 6.3a)
Rainfall Intensity: 2 year, 6-hour storm	7.03
Rainfall Erosivity (R-factor)	**1,270**

Table 4: Site Data

A preliminary catchment analysis has separated the site into 8 catchments:

- Basin A includes lots 101-110;
- Basin B includes lots 111-166;
- Basin C includes lots 167-211;
- Basin D includes lots 212 – 244
- Basin E includes lots 245-270;
- Basin F includes lots 274-286;
- Basin G includes lots 272-273, 287-294 and 307-308; and
- Basin H includes lots 295-304.

Refer Figure 7 for basin catchment areas.

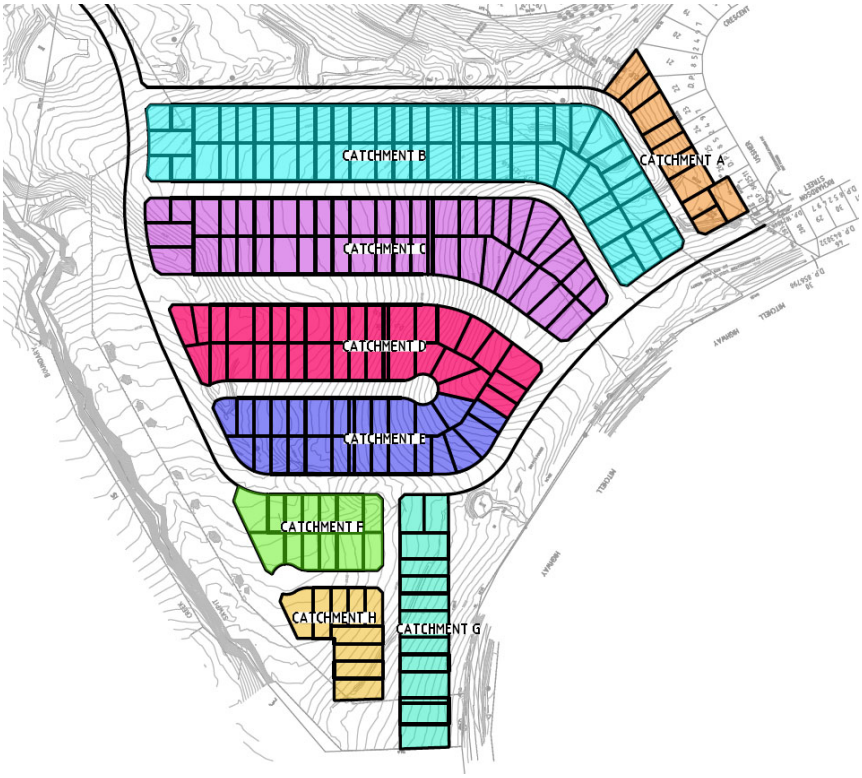


Figure 8: Sediment Basin Catchment Areas

Parameter	A	B	C	D	E	F	G	H
Volumetric Runoff Coefficient, C_v (Appendix F3, Blue Book)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Contributing Area, A (ha)	0.76	4.27	3.64	2.56	1.94	0.98	0.95	.73
$R_{(85\ \%ile,\ 5\ day)}$	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9
Settling Zone Volume, (m^3)	95.3	532	454	319	242	123	118	91
Sediment Storage Zone Volume, (m^3)	7	41	35	24	18	9	9	7
Total Sediment Basin Volume, (m^3)	102	573	489	343	260	132	127	98

Table 5: Temporary Sediment Basins

5.4 Site Inspection and Maintenance

The inspection and maintenance requirements outlined in this section must be carried out while either earthworks or quarrying is being conducted, and all areas re-established.

The Contractor will be required to inspect the site after every rainfall event and at least weekly, and will:

- Inspect and assess the effectiveness of the SWMP and identify any inadequacies that may arise during normal work activities or from a revised construction methodology;
- Construct additional erosion and sediment control works as necessary to ensure the desired protection is given to downstream lands and waterways;
- Ensure that drains operate properly and to affect any repairs;

- Remove spilled sand or other materials from hazard areas, including lands closer than 5 metres from areas of likely concentrated or high velocity flows especially waterways and paved areas;
- Remove trapped sediment whenever less than design capacity remains within the structure;
- Ensure rehabilitated lands have affectively reduced the erosion hazard and to initiate upgrading or repair as appropriate;
- Maintain erosion and sediment control measures in a fully functioning condition until all construction activity is completed and the site has been rehabilitated;
- Remove temporary soil conservation structures as the last activity in the rehabilitation.
- Inspect the sediment basin during the following periods:
    - During construction to determine whether machinery, falling trees, or construction activity has damaged and components of the sediment basin. If damage has occurred, repair it;
    - After each runoff event, inspect the erosion damage at flow entry and exit points. If damage has occurred, make the necessary repairs;
    - At least weekly during the nominated wet season (if any), otherwise at least fortnightly; and
    - Prior to, and immediately after, periods of 'stop work' or site shutdown.
- Clean out accumulated sediment when it reaches the marker board/post, and restore the original volume. Place sediment in a disposal area or, if appropriate, mix with dry soil on the site;
- Do not dispose of sediment in a manner that will create an erosion or pollution hazard;
- Check all visible pipe connections for leaks, and repair as necessary;
- Check all embankments for excessive settlement, slumping of the slopes or piping between the conduit and the embankment, make all necessary repairs;
- Remove the trash and other debris from the basin and riser; and
- Submerged inflow pipes must be inspected and de-silted (as required) after each inflow event.

5.5 Conclusion

The erosion control measures proposed for the site will comply with the requirements of Bathurst Regional Council Engineering Guidelines and The Department of Environment, Climate Change and Water (DECC).

The proposed SWMP will ensure that the best management practice is applied to the development site in controlling and minimising the negative impacts of soil erosion.

6 Road Design

6.1 General Design Principles

The roads have been generally designed in accordance with:

- Bathurst Regional Council Guidelines for Engineering Works 2011,
- Bathurst Regional Local Environmental Plan (LEP) 2014,
- Bathurst Regional Development Control Plan (DCP) 2014,
- Bathurst Regional Council Standard Drawings; and
- Austroads Guide to Road Design Part 3: Road Design.

The layout and function of the road is consistent with the DCP and the existing surrounding roads.

The roads have been designed in accordance with the Engineering Guidelines and relevant Standards.

6.2 Horizontal and Vertical Geometry

Governors Parade (Collector Road)

- 20.3m wide Road Reserve;
- 11.0m wide Carriageway comprising:
    - 2 x 3.0m wide traffic lanes; and
    - 2 x 2.5m parking lanes.
- Verge as follows:
        - 2.0m landscape zone between boundary and footpath;
        - 1.2m wide footpath network, designed at 2.0% crossfall; and
        - 1.45m wide landscape zone between footpath and face of kerb.
- Design Speed: 60 km/hr; and
- Design Vehicle: 8.8m Service Vehicle

Richardson Road (Collector Road)

- 20.0m wide Road Reserve;
- 11.0m wide Carriageway comprising:
    - 2 x 3.0m wide traffic lanes; and
    - 2 x 2.5m parking lanes.
- Verge as follows:
        - 2.0m landscape zone between boundary and footpath;
        - 1.2m wide footpath network, designed at 2.0% crossfall; and
        - 1.30m wide landscape zone between footpath and face of kerb.
- Design Speed: 60 km/hr; and
- Design Vehicle: 12.5m Heavy Rigid Vehicle (HRV)

Road 3 (Collector Road)

- 30.0m wide Road Reserve;
- 21.0m wide Carriageway comprising:

    - 2 x 3.0m wide traffic lanes;
    - 2 x 2.5m parking lanes; and
    - 10m median island
- Verge as follows:
    - 2.0m landscape zone between boundary and footpath;
    - 1.2m wide footpath network, designed at 2.0% crossfall; and
    - 1.30m wide landscape zone between footpath and face of kerb.
- Design Speed: 60 km/hr; and
- Design Vehicle: 12.5m Heavy Rigid Vehicle (HRV)

Road 1, 2, 4, 5 and 6 (Local Access Roads)

- 17.0m wide Road Reserve;
- 8.0m wide Carriageway comprising:
    - 2 x 3.0m wide traffic lanes; and
    - 1 x 2.0m parking lanes.
- Verge as follows:
    - 2.0m landscape zone between boundary and footpath;
    - 1.2m wide footpath network, designed at 2.0% crossfall; and
    - 1.30m wide landscape zone between footpath and face of kerb.
- Design Speed: 60 km/hr; and
- Design Vehicle: 5.2m B99 Car

7 Stormwater Management

7.1 Existing Stormwater Drainage

The site is classed as greenfield and have no existing pit and pipe network, stormwater infiltrates the grassed paddocks.

The site generally slopes down from south-east to the north and Sawpit Creek with the site draining via overland flow into Sawpit Creek west of the site.

7.2 Proposed Site Stormwater Drainage

All proposed stormwater drainage from the development will be designed in accordance with the Bathurst Regional Council engineering requirements and guidelines. A preliminary design has been provided in Appendix B, in accordance with BRC a detailed hydraulic design will be completed during detailed design.

Based on the Stormwater and OSD report, and in accordance with BRC plans and policy, On-Site Detention (OSD) is not required for this development.

All stormwater on the lots and within the road reserve is proposed to be collected via pits and pipes, and ultimately connect into Sawpit Creek to the west of the site. Gross Pollutant Traps (GPTs) are proposed prior to discharge points.

Refer to the Civil Drawings in Appendix B for preliminary layout of the proposed stormwater network.

7.3 Hydrology

- Pipe drainage shall be designed in accordance with BRC requirements to accommodate:
    - On-Lots: 20% AEP; and
    - Local/Collector Roads: 20% AEP.
- The combined piped and overland flow paths shall be designed to accommodate the 1% AEP storm event in accordance with BRC requirements for Major System drainage;
- Where trapped low points are unavoidable and potential for flooding private property is a concern, an overland flowpath capable of carrying the total 100-year ARI storm event shall be provided. Alternatively, the pipe and inlet system may be upgraded to accommodate the 100 year ARI storm event;
- Rainfall intensities are as per the RFFE data, in accordance with ARR 2016;
- Times of concentration for each sub catchment shall be determined using the kinematic wave equation. Minimum time of concentration is 5 mins and the maximum is 20 mins.
- Runoff coefficients shall be calculated in accordance with ARR 2016;
- Flow width in gutter shall not exceed 2.5m for the minor design storm event;
- Velocity depth ratios shall not exceed $0.4m^2/s$ for all storms up to and including the 100-year ARI event;
- Bypass from any pit on grade shall not exceed 15% of the total flow at the pit;
- Maximum pit spacing shall not exceed 85m;
- Minimum internal lintel size on a sag should be 2.4m;
- Blockage factors for stormwater pits shall be:

- Minor Storms:
  - Sag Pit – 0.5
  - On-Grade Pit – 0.2
- Major Storms:
  - Sag Pit - 0.5
  - On-Grade Pit – 0.2

- All pits deeper than 1.8m to be reinforced and structurally designed.

7.4 Hydraulics

- A hydraulic grade line HGL design method shall be adopted for all road pipe drainage design. The HGL shall be shown on all drainage long sections;
- The minimum pipe size shall be 375mm diameter RCP Class 3 (external) and 150mm uPVC (internal);
- Maximum spacing between pits shall not exceed 85m;
- The minimum pipe grade shall be 1%;
- Velocity of flow within pipe should be greater than 0.6 m/s but not more than 8 m/s;
- All pipes shall be Rubber Ring Jointed unless noted otherwise;
- Minimum clearance between stormwater pipes and other services is 75mm;
- The minimum cover over pipes shall be 300mm in grassed areas and 600mm within carriageways;
- Where minimum cover cannot be achieved due to physical constraints the pipe class shall be suitably increased;
- All trafficable pipes shall be a minimum Class 3 Reinforced Concrete Pipes or Fibre Reinforced Cement equivalent;
- The pipe friction coefficients to be adopted shall be 0.013 for RCP, per the BRC Engineering Guidelines:

Materials	Mannings – n	Colebrook-White – k	Min. Pipe Class
RCP	0.013	0.3	3
FRC	0.011	0.015	3

Table 6: Pipe Details

- All pipes classes shall be designed for the ultimate service loads and where applicable, construction loads will be designed for;
- Pipes discharging to the overland flow path shall adopt a minimum tailwater level equivalent to respective overland flow level. If this level is known, a tailwater level of 150mm below the natural surface/invert kerb level is to be adopted;
- Pit Loss coefficients shall be calculated in accordance with Missouri Charts;
- A minimum 150mm freeboard shall be maintained between pit HGL and pit surface levels;
- All residential lots to be located above the 1% AEP design level plus 500mm freeboard
- Pits deeper than 1.2m shall contain step irons at 300 mm centres.

7.5 External Catchments

The proposed development has upstream catchments draining through the site from the east to ultimately Sawpit Creek. The two catchments are:

- Minor upstream catchment draining through the eastern lots which will be collected into the ultimate stormwater system, ensuring no effects to upstream properties.

7.5.1 S94 Stormwater Diversion Channels

As part of the development's S94 contribution, 4 stormwater diversion channels C2 – C5 with low flow pipes are required to be constructed to capture runoff from the upstream catchments with the Governor's Parade crossing sized to cater for the 1% AEP stormwater flow. This is in accordance with Bathurst Council's Section 94 Contribution Plan, Stormwater Catchment Plan and comments.

However, in order to maintain the natural characteristics of the drainage corridors and to minimise impacts to the existing environment the following works are proposed for the S94 channels:

- C2 be constructed as per S94 specification;
- C3 be piped underground through the development site, with the upstream catchment collected via a headwall at the existing dam located adjacent the Mitchell Highway;
- C4 not be constructed as the existing topography forms a naturalised channel, it is proposed that the this area be rejuvenated through landscape means; and
- C5 current location is proposed through environmentally sensitive areas, it is proposed in-lieu of this channel the existing dam is upgraded with a larger low-flow pipe and spillway to accommodate larger storms.

Refer Figure 9 below for an excerpt from Bathurst Stormwater Catchment Plan showing creeks C2-C5.

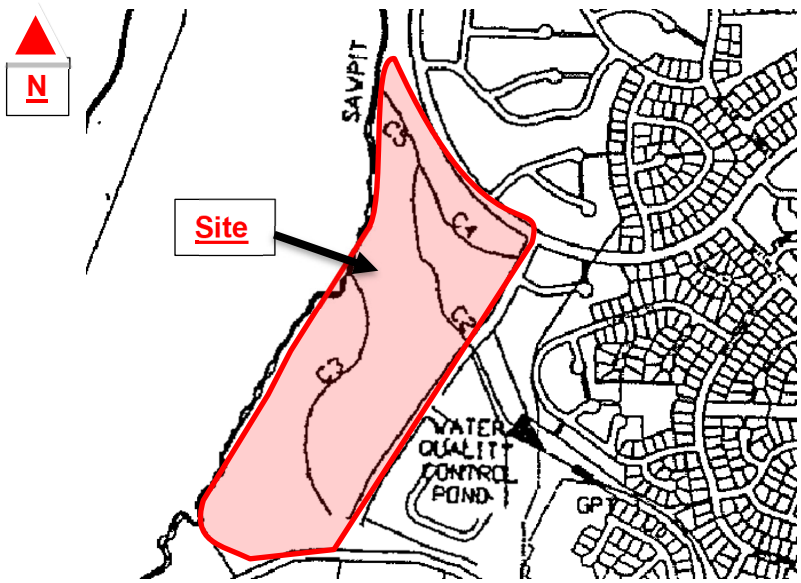


Figure 9 : S94 Contribution Plan Excerpt (Courtesy of Bathurst Regional Council)

Stormwater generated within the proposed development will discharge via the S94 infrastructure mentioned above or directly to Sawpit Creek.

7.6 Sawpit Creek Connections

In addition to the Section 94 Stormwater channels discussed above, there will also be additional stormwater outlet locations along Sawpit Creek. During detailed design the stormwater outlets will be designed in accordance with the BRC Engineering Guidelines with appropriate scour protection and energy dissipation to ensure no impacts to Sawpit Creek. Engineering measures will be designed to ensure that the Sawpit Creek connections have:

- Product x velocity shall not exceed 1.0m^2/s in the 1% AEP storm event; and
- Maximum velocity is limited to 2m/s in the 5% AEP storm event.

7.7 Water Sensitive Urban Design

The integration of urban water cycle management with urban planning and design is known as Water Sensitive Urban Design (WSUD). WSUD is a holistic approach to the planning and design of urban development that aims to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems. WSUD promoted the integration of stormwater, water supply and wastewater management at the development stage. WSUD requires the consideration of the urban water cycle at the early planning stage to ensure all possible opportunities for application of best practice water cycle management solutions can be realised. The urban water cycle involves the cycling of water through the urban environment.

The main objectives of WSUD within the Windradyne Estate are:

- Reducing potable water demand through water efficient appliances, rainwater and greywater reuse;
- Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities and/or release to receiving waters;
- Treating urban stormwater to meet water quality objectives for reuse and/or discharge to surface waters; and
- Preserving the natural hydrological regime of catchments.

Urban development will generally result in an increased level of export of a wide range of non-point source pollutants. To protect the quality of local streams, lakes and river systems, the provision of stormwater quality control strategies acceptable to Bathurst Regional Council shall be considered. These may include but not limited to the following:

- Rainwater tanks on individual allotments (subject to separate approval) which are not implemented within the original documentation;
- Establishment of stormwater diversional channels, for primary and secondary treatment;
- Incorporation of WSUD into Road 3 median island to assist with the removal of Gross Pollutants and Coarse Sediments;
- Incorporation of gross pollutant traps (GPTs) on inlets to Sawpit Creek and stormwater channels to intercept trash and debris and the coarser fractions of sediment;
- Incorporation of ‘off-stream’ sediment interception ponds (SIP) in land development works to intercept and treat runoff prior to its discharge to the stormwater system (during construction); and
- Signs/tags (imprinted on the concrete lintel) at pit entry “No dumping to drains” or similar.

7.7.1 WSUD Modelling - Music Model

The MUSIC Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 6.2.0) will be used to evaluate pollutants loads from the site during detailed design.

MUSIC model input parameters for this site included rainfall-runoff, base-flow concentration and storm-flow concentration parameters will be obtained from 'Using MUSIC in Sydney's Drinking Water Catchment'.

Based on this the stormwater quality targets recommended for the Windradyne Development are:

- 50 per cent reduction in the post development average annual gross pollutant (greater than 5 millimetres) load;
- 50 per cent reduction in the post development mean annual load of TSS;
- 25 per cent reduction in the post development mean annual of TP; and
- 10 per cent reduction in the post development mean annual load of TN.

8 Flooding

The site is located outside of flood planning areas as defined by the Bathurst Regional Council Local Environmental Plan Maps 2014, refer to Figure 10 for details, and is subsequently not affected by mainstream flooding.

As discussed above external overland flow catchments will not be affected by the proposed development.

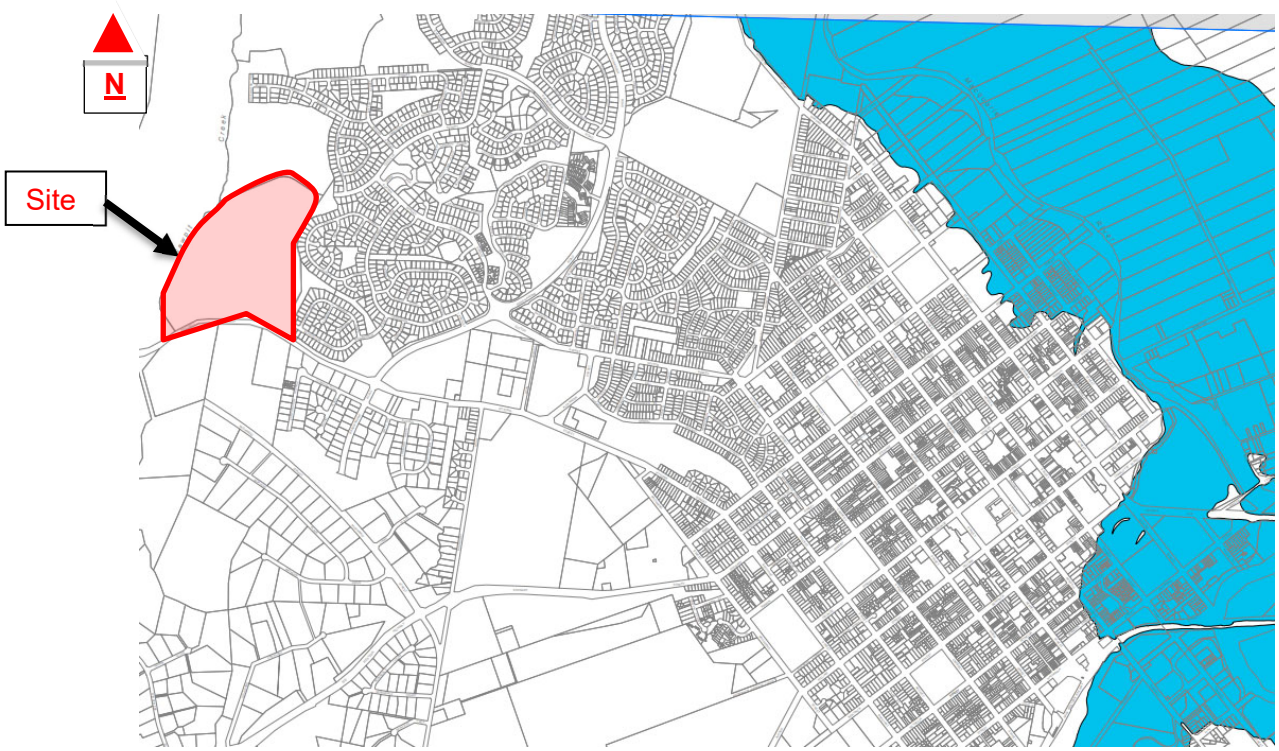


Figure 10 : Flood Planning Map (BRC LEP 2014)

9 Services

This development will incorporate full servicing for the proposed lots.

9.1 Water and Sewerage

9.1.1 Water Supply

From information obtained from BRC there is existing potable water mains owned by BRC within Richardson Street to the east and in Governors Parade to the north of the site. These are proposed to be extended into the proposed street network. Internal reticulation network design will be completed during detailed design in conjunction with BRC.

Final approval will need to be sought from BRC prior to connecting into any system, to confirm adequate capacity and sizing.

Refer to drawing 17-465-DA020 within Appendix B for preliminary potable water layout.

9.1.2 Sewerage

From information obtained from BRC there is an existing sewer main to the west of the site, adjacent Sawpit Creek, draining towards the north.

Final approval will need to be sought from BRC prior to connecting into this main.

Refer to drawing 17-465-DA020 within Appendix B for a preliminary sewer layout.

9.2 Communications

From Dial Before You Dig (DBYD) information, there are Telstra telecommunications cables located within Richardson Street to the east of the site.

Refer to DBYD records within Appendix D for details.

Confirmation will need to be sought from Telstra as owners of these telecommunications cables within the area for all connections into their network.

9.3 Gas

From Dial Before You Dig (DBYD) information, there is a 32mm diameter 210 kPa gas main located within Richardson Street to the east of the site and a 110mm diameter 210 kPa gas main located within Governors Parade to the north of the site.

A lead-in main will need to be designed and constructed to service the development.

Approval will need to be sought by Jemena as owners of these gas mains within the area for all connections into their network.

9.4 Electrical

From Dial Before You Dig (DBYD) information there is overhead cables running north to south and low voltage underground cables in Richardson Street to the east and in Governors Parade to the north of the site.

The overhead cables across the site will require relocation.

Approval will need to be sought by Essential Energy as owners of these electrical cables within the area for all connections into their network and relocations.

9.5 Conclusion

This section demonstrates that services including sewer, water, power, telecommunications and gas can be made available to the site.

Internal reticulation will be coordinated at the Construction Certificate (CC) stage of works and applications to the relevant authorities made.

10 Conclusion

As highlighted within this report all civil/stormwater drainage for the development of Windradyne Subdivision 1100, located in Bathurst, has been designed in accordance with Bathurst Regional Council requirements and guidelines.

Appendix A Detailed Site Survey

Appendix B Civil Development Application Drawings

Appendix C Geotechnical Report

Appendix D Dial Before You Dig (DBYD)

Appendix E SEE