Equinox Marulan – Stage 3

Development Application

Stormwater Management Report

Darraby Pty Ltd

16/10/2023

23-1098

Commercial in Confidence

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1. Introduction

This Civil Design Report has been prepared by AT&L on behalf of Darraby Pty Ltd in support of a Development Application for the proposed development of Equinox Marulan – Stage 3 (the Site).

1.1. Site Description

The site is located 26km east of Goulburn at Wilson Drive, Marulan, is in the Goulburn Mulwaree Council LGA and is bound by existing residential lots and public open space to the east, Wilson Drive to the south, the Main Southern Rail line to the north and Marulan Waste Management Centre to the west. The site is currently farmland and includes a small watercourse and several dams.

Refer to **Figure 1** below for the site location.

Figure 1: Site Locality (Source: Google Earth)

The site has been the subject to two previous Development Applications with the scope of this report relating to a third stage of development at the north eastern corner of the site immediately south of the Main Southern Railway.

1.2. Scope of DA

This Development Application seeks approval for the following scope of development:

- Site infrastructure works, including:
  - Demolition, vegetation clearing and removal of existing farm dams.
  - Bulk earthworks to establish residential lots and box out for proposed road network.
  - Construction of internal roads including kerb and gutter, vehicle pavement footpaths and verge landscaping
  - Construction of stormwater infrastructure, utility services and landscaping.
- Implementation of construction-phase erosion and sediment controls.
- Subdivision to create 125 residential lots, 1 drainage lot and 1 residual lot
- Extension of Goulburn Street from Portland Avenue to the site

Figure 2 below presents the proposed subdivision layout.

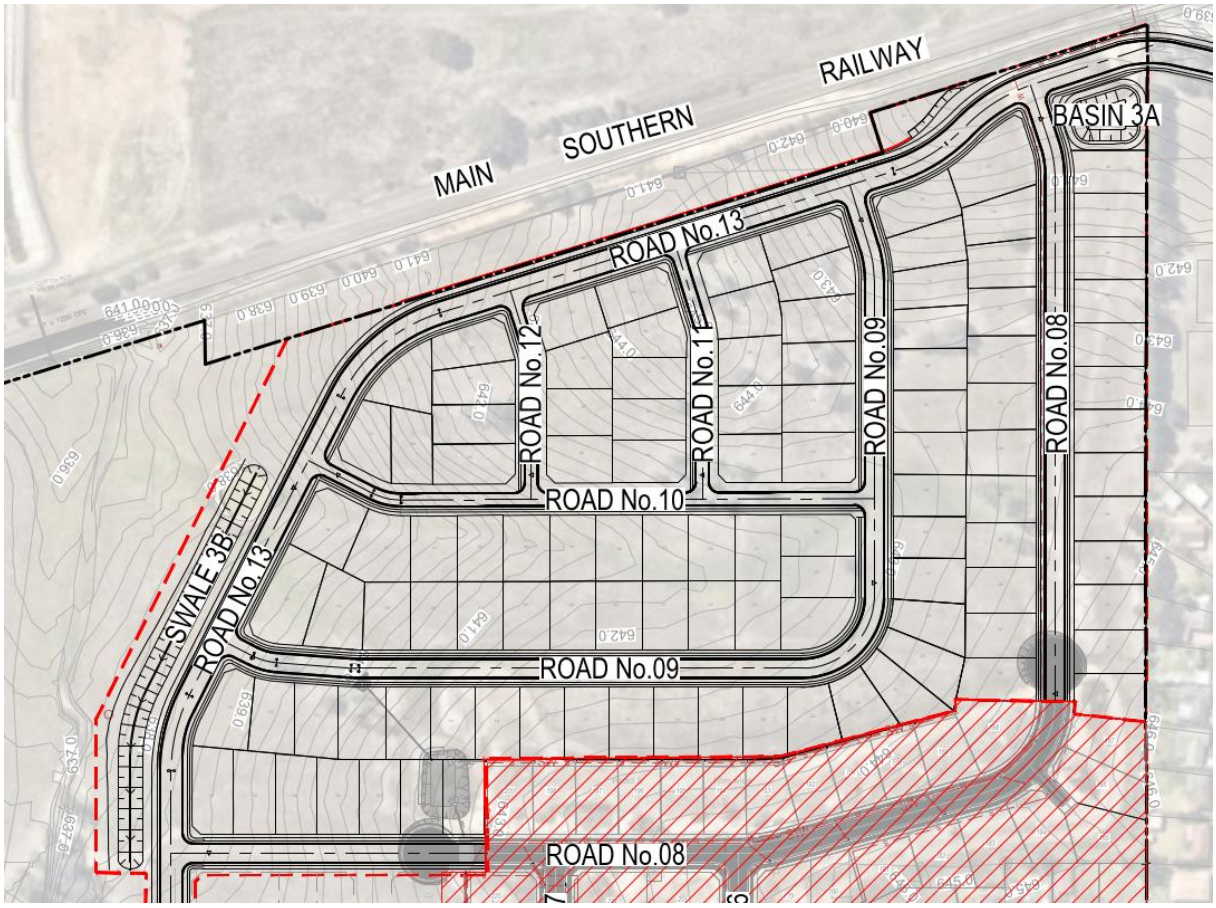

Figure 2: Proposed subdivision layout

1.3. Supporting Documentation

This report should be read in conjunction with Civil Drawings (AT&L), 23-1098-C1000 and Civil Design Report (AT&L), REP002.

1.4. Design Criteria

Table 1: Stormwater Design Criteria

Item	Design Criteria
Flooding	NSW Floodplain Development Manual Goulburn Mulwaree Council Development Control Plan 2009
Stormwater Drainage	Australian Rainfall and Runoff (ARR) 2019 AS/NZS 3500.3-2015 – Stormwater Drainage Goulburn Mulwaree Council Development Control Plan 2009 Goulburn Mulwaree Council – Stormwater Drainage Design Handbook revised 2020 Goulburn Mulwaree Council - Standards for Engineering Works 2013 D5
On-Site Detention (OSD)	Australian Rainfall and Runoff (ARR) 2019 Goulburn Mulwaree Council Development Control Plan 2009 Goulburn Mulwaree Council - Standards for Engineering Works 2013 D5
Stormwater Quality	WaterNSW NorBE Water Quality Assessment Guideline 2022 Adoption Guidelines for Stormwater Biofiltration Systems Version 2 Goulburn Mulwaree Standards for Engineering Works 2013 D5 and D7 Landcom's Soils and Construction: Managing Urban Stormwater (2004)

2. Flooding

Goulburn Mulwaree Council have recently commissioned the *Marulan Flood Study* by grc. This study is currently on exhibition as a final draft dated January 2023. **Figure 7** below presents the 1% AEP flood extent within the site.

The figure below shows a gully through the western side of the site before turning north and flowing under the Main Southern Railway through an existing DN1200 culvert. This gully is considered a riparian corridor and will be retained and enhanced as part of the proposed subdivision.

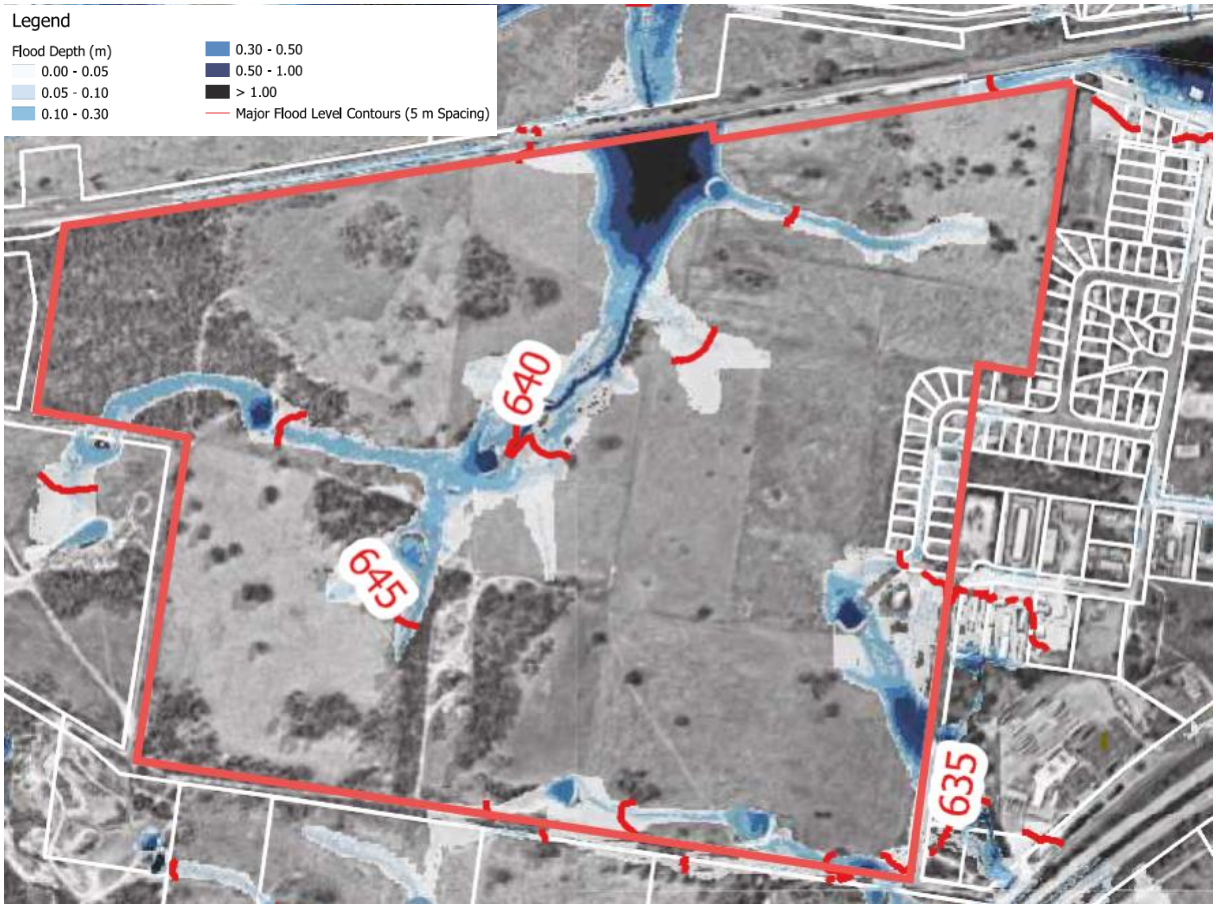

Figure 3: 1% AEP flood map excerpt, Marulan Flood Study (grc, Jan 2023)

The area immediately upstream of the culvert ponds to a depth greater than 1.0m with minor depressions through the north eastern portion of the site showing ponding up to 0.5m. The proposed stage of this subdivision partially encroaches on the eastern edge of the flood extent however this has been managed by building up earthworks levels to be 500mm above the 1% AEP flood level of 637.00 to adhere to NSW flood planning requirements. Earthworks will be undertaken along the western edge of the flood extent to compensate for any volume of flood storage lost by earthworks filling to facilitate the subdivision.

3. Stormwater Drainage

3.1. Stormwater Drainage Design Criteria

Design criteria and requirements for the proposed site stormwater management are outlined in the following documents:

- AS 3500.3 – Plumbing and drainage – Stormwater drainage
- Commonwealth of Australia (Geoscience Australia), *Australian Rainfall and Runoff*, 2019.
- Goulburn Mulwaree Council Development Control Plan 2009
- Goulburn Mulwaree Council – Stormwater Drainage Design Handbook revised 2020
- Goulburn Mulwaree Council - Standards for Engineering Works 2013 D5 and D7
- WaterNSW NorBE Water Quality Assessment Guideline 2022
- Adoption Guidelines for Stormwater Biofiltration Systems Version 2 (FAWB, 2009)

An extract of the prescriptive controls adopted for the site are summarised in **Table 2**.

Table 2: General stormwater drainage design criteria

Stormwater Component	Design Criteria
Hydrology	▪ Time of concentration values 5 minutes (minimum) and 20 minutes (maximum). ▪ Design Storm events: 20% AEP, 10% AEP, 5% AEP, 2% AEP and 1% AEP.
Minor and Major System	▪ Minor system: 20% AEP conveyed by way of pit and pipe drainage. ▪ Major system: 1% AEP conveyed by way of pit and pipe drainage and overland flow.
Pipes	▪ Minimum pipe diameter (road reserve): 375mm ▪ Minimum pipe diameter (inter allotment): 150mm ▪ Minimum pipe grade: 1% (desirable), 0.5% (absolute minimum) ▪ Minimum pipe cover: 450mm (grassed area), 600mm (under carriageway) ▪ Where minimum cover cannot be achieved due to physical constraints the pipe class shall be suitably increased. ▪ All pipes in trafficable areas will be Reinforced Concrete Pipes (RCP) or Fibre Reinforced Cement (FRC) equivalent. ▪ Pipes discharging to an overland flow path shall adopt a minimum tailwater level equivalent to respective overland flow level. ▪ A hydraulic grade line HGL design method shall be adopted for all road pipe drainage design.
Pits	▪ Minimum pit freeboard: 150mm from HGL to surface level in the minor event. ▪ Where trapped low points are unavoidable and potential for flooding private property is a concern, an overland flow path capable of carrying the total 1% AEP storm event has been provided. Alternatively, the pipe and inlet system has been upgraded to accommodate the 1% AEP storm event. ▪ Maximum pit spacing: 100 metre intervals. ▪ Blockage factors of 20% and 50% shall be adopted for on-grade and sag pits respectively.
Gutter flow widths	▪ Maximum flow width: 2.5m

Stormwater Component	Design Criteria
Overland flow paths	▪ Velocity x depth product shall not exceed 0.4 m^2/s for all storms up to and including the 1% AEP event.
Scour Protection	▪ D_{50} = 200mm rock rip rap to all stormwater outlets up to DN600, spillways and emergency overland flows paths with flow velocities of up to 3.5m/sec.

3.2. Existing Site Stormwater Drainage

This stage of the subdivision has a crest dividing the site into two catchments falling to the north east and north west. Existing external catchments discharge across the southern boundary which consists of the current Stage 2 and future stage of the subdivision. These catchments are characterised by either residential lots or agricultural land.

An existing gully is located along the western edge of the site which forms the western boundary of the subdivision. Stormwater runoff flows across the site towards the gully in the west before discharging under the Main Southern Railway through a DN1200 culvert. The north eastern catchment sheet flows across the north eastern boundary towards the Main Southern Railway. Refer to 23-1098-C1070 for a pre-development stormwater catchment plan and **Figure 8** below for existing catchment details.

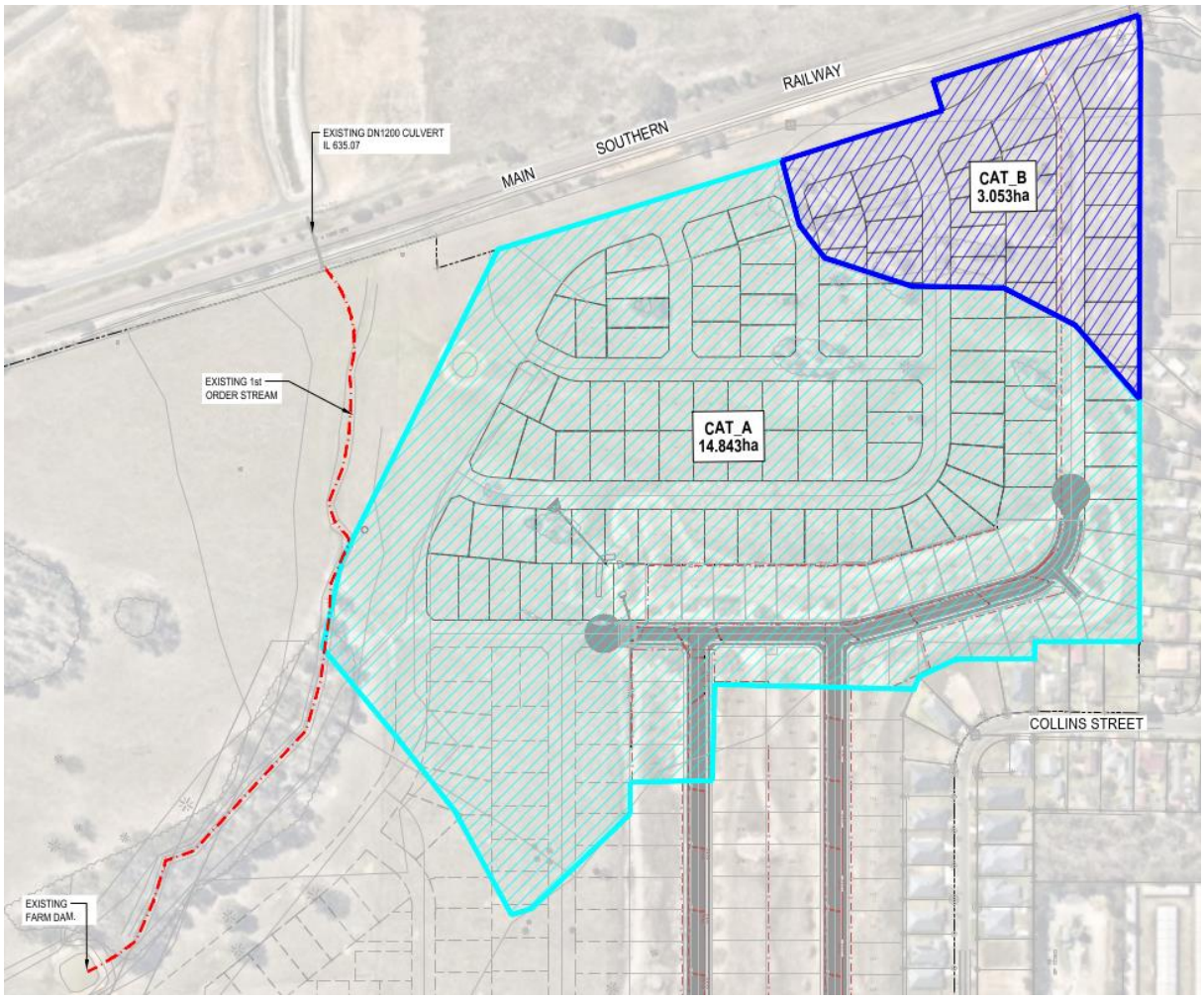

Figure 4: Pre-development catchment plan

3.3. Proposed Site Stormwater Drainage

The proposed drainage network within the estate has been designed to safely convey major and minor flows prior to discharging to adjacent lands to the north east and north west. The following criteria have been adopted for the proposed drainage system:

- Major system (pit and pipe network, overland flow paths and channels): 1% AEP
- Minor system (pit and pipe network): minimum 20% AEP and increased where required to address major system design requirements.

The site is divided into two broad catchments with the following configuration as shown in **Figure 9**:

- Catchment 1 discharges north east to the proposed Goulburn Road extension and through to an existing culvert under the Main Southern Railway, north of the existing fire station.
- Catchments 2, part of previous stage (catchment 3) and future catchment 4 discharges north west to the western gully and through the existing culvert under the Main Southern Railway

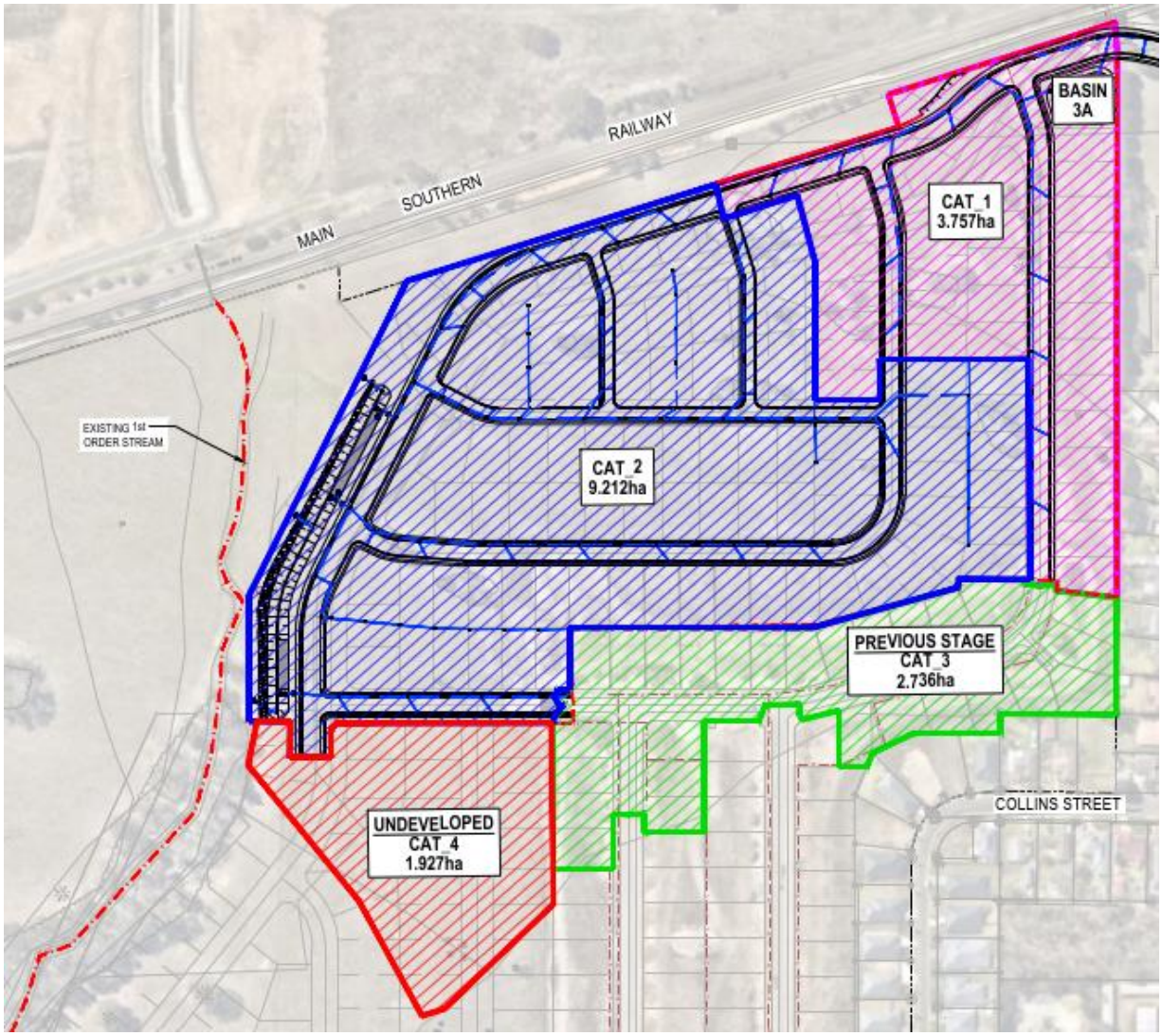

Figure 5: Post development catchment plan

3.4. On-Site Detention

Due to the increase in impervious area On-Site Detention is required to restrict the post development flow rates to pre-development flows.

The current proposal provides an OSD basin in the north eastern corner of the site immediately adjacent the Goulburn Street extension. A water quality swale with flow control for frequent storm events up to the 5% AEP storm has been provided for the western catchment.

Larger storm events will overtop the swale into the existing gully which already experiences flooding due to the culvert under the Main Southern Railway being undersized for larger storm events. The swale still achieves pre-development flows for all storms up to the 1% AEP as presented in Table 7.

Key parameters relating to the proposed OSD infrastructure are described in **Table 3**.

Table 3: Key detention basin parameters

OSD ID	Location	Collects stormwater from:	Discharges to:
3A	North eastern corner	96% of Catchment 1	Pit and pipe network in Goulburn Road extension
3B (Swale)	Western edge	100% of catchments 2, 3, 4 and 5.	Existing DN1200 culvert under Main Southern Railway

All pre development flows are based on 100% pervious area. All post development flows are based on a 70% impervious area for all residential lots, 70% impervious area for all road reserves and 0% impervious area for drainage reserves.

3.4.1. OSD Basin 3A

Basin 3A is located in the north eastern corner of the site immediately adjacent to the Goulburn Street extension.

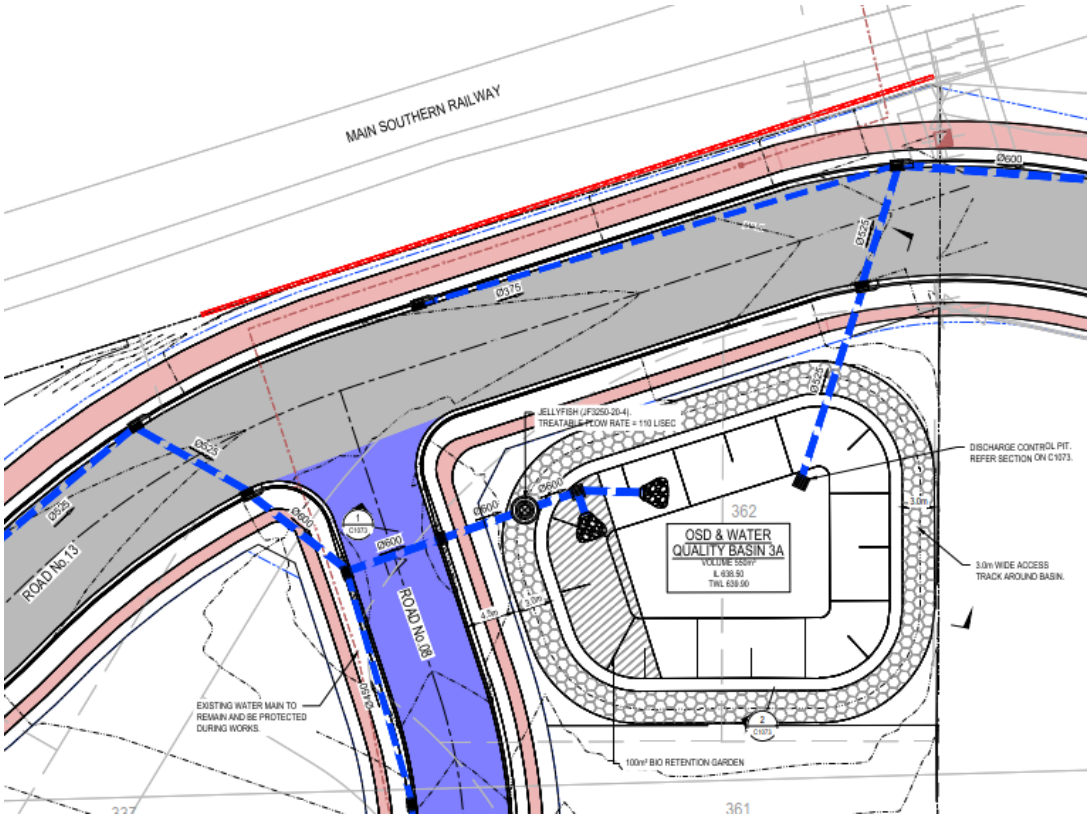

Figure 6: OSD Basin 3A plan

Figure 10 above shows the spatial requirements of the OSD basin including:

- 600 cu.m OSD storage volume.
- 300mm freeboard to top of basin embankment.
- 3.0m wide access track around top of basin.
- Inlet and outlet stormwater pipework and structures.
- On-line Gross Pollutant trap (further details in Section 6 regarding water quality).

The stormwater discharge control structure at the outlet of the basin consists of a low flow orifice and a high flow surcharge inlet grate at a level above the basin invert to control flow up to the 1% AEP storm event so that flows do not exceed the pre development rates. **Table 6** below presents a comparison between pre and post development flow rates as modelling in DRAINS.

Table 4: Pre vs post development flows – Basin 3A

Scenario	Peak Discharge Rates (L/sec)				
	20%	10%	5%	2%	1%
Pre-development	267	404	560	700	832
Post Development	262	306	351	623	830

3.4.2. Western Swale

Basin 3B (western swale) is located along the western edge of the site immediately adjacent to the Road No. 13 road reserve. Note that the swale is located wholly outside the road reserve in a dedicated drainage allotment.

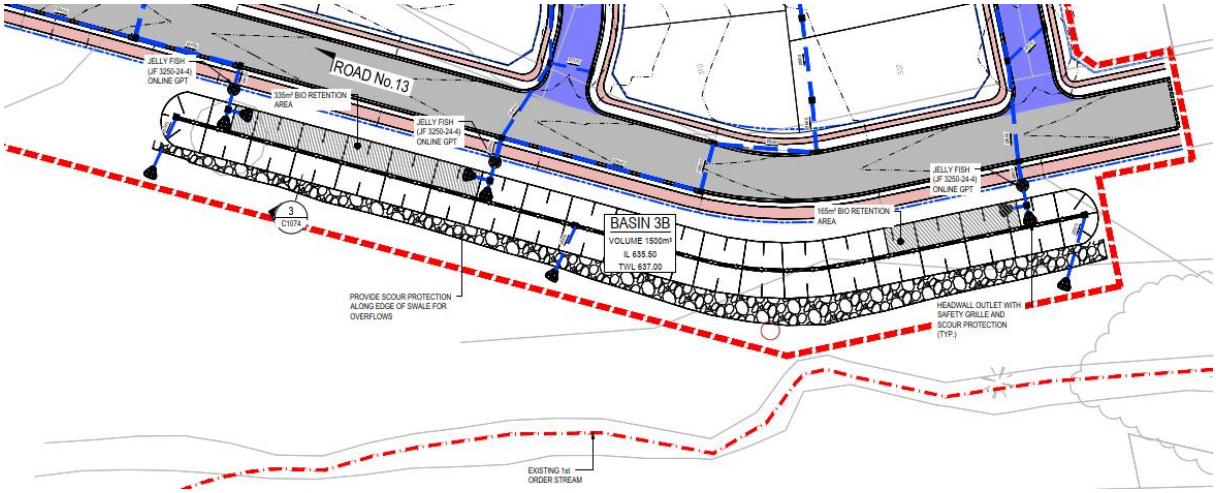

Figure 7: OSD Basin 3B (western swale) plan

Figure 11 above shows the spatial requirements of the OSD basin including:

- 1,500 cu.m OSD storage volume.
- 300mm freeboard to top of swale side slope fronting Road No. 13.
- 2.5m wide access track along roadside edge of swale which also doubles as a shared path / cycleway along the riparian corridor.
- Inlet and outlet stormwater pipework and structures.
- On-line Gross Pollutant traps (further details in Section 6 regarding water quality).

Multiple outlets are provided from the swale to the adjacent riparian corridor to spread the flow across the corridor similar to the predevelopment flow condition. The swale has been sized to store flows up to the 5%

AEP storm with larger storms overtopping the swale into the riparian corridor whilst ensuring that post development flows are maintained at pre development rates.

Table 7 below presents a comparison between pre and post development flow rates as modelling in DRAINS.

Table 5: Pre vs post development flows – Basin 3B (western swale)

Scenario	Peak Discharge Rates (L/sec)				
	20%	10%	5%	2%	1%
Pre-development	742	1,340	2,000	2,960	3,640
Post Development	735	889	1,150	2,250	3,090

3.4.3. Public safety

Goulburn Mulwaree Council - Standards for Engineering Works 2013 – Section D5.15 requires the design of OSD basins to consider public safety. This has been addressed in the following ways for the proposed OSD basins.

Basin 3A

- Will be enclosed in a pool-style fence to restrict access. This is due to the embankments being graded at 1 in 4 and the depth of water being 1.4m.
- A lockable 4.0m wide dual leaf gate will be provided for maintenance access.
- A depth indicator will be provided to visually identify the depth of water in the basin.
- The configuration of the discharge control pit provides the necessary safeguards to ensure blockages are minimised.
- Signage will be provided at emergency spillways (noting that these are only relied upon for flows > 1% AEP events).

Basin 3B – western swale

- Swale side slopes will be at 1 in 6 to allow egress for maintenance.
- Depth of water in the swale is limited to 1.2m at which point the swale discharges to the riparian corridor.
- Depth indicators will be provided at selected locations along the swale.
- Multiple discharges have been provided and will be configured to ensure the necessary safeguards are provided against blockages
- Signage will be provided at selected locations along the swale noting the flood risk of the riparian corridor and the use of the swale as a basin.
- No trees will be planted in the swale. Swales will be planted with smaller vegetation as described in the landscape architect's documentation.

4. Water Quality

The expected effect on water quality is required to be identified to satisfy State Environmental Planning Policy (Sydney Water Drinking Catchments) 2011. Since the proposed site sits within the Warragamba catchment this requires concurrence with Water NSW to ensure stormwater quality measures provide a Neutral or Beneficial Effect (NorBE). The stormwater quality assessment for this site has been undertaken in accordance with WaterNSW's *Neutral or Beneficial Effect on Water Quality Assessment Guideline 2022.*

The pre-development catchments and post development water quality treatment train has been modelling in MUSIC X to establish the pre-development annual pollutant loads and the benefit provided through implementation of the proposed water quality treatment train.

The pre-development catchments shown in **Figure 8** have been modelled using agricultural source nodes.

Post development catchments shown in **Figure 9** have been split into roof, sealed road and lot nodes reflecting the different types of surfaces and the specific water quality treatment measures relating to these surfaces.

Rainfall and evaporation data

WaterNSW Zone 1 climate data (rainfall and evapotranspiration) was adopted in the MUSIC X model. This meteorological climate data was downloaded from WaterNSW website and includes:

- Pluviometer data (six-minute rainfall intensity and evapotranspiration) from Zone 1 .mlb file for the period between 1995 and 1999 inclusive.
- Monthly potential evapotranspiration (PET) as per *the* Zone 1 .mlb file provided by WaterNSW.

Rainfall-runoff parameters

The rainfall-runoff parameters adopted in the MUSIC X model are consistent with the default parameters provided by MUSIC X, refer to **Table 6**.

Table 6: Rainfall-runoff parameters adopted in MUSIC X

Parameter	Unit	Value
Impervious area parameters		
Rainfall Threshold	mm/day	1.0
Pervious area parameter		
Soil Storage Capacity	mm	120
Initial Storage	% of Capacity	30
Field Capacity	mm	80
Infiltration Capacity Coefficient α	-	200
Infiltration Capacity Coefficient β	-	1.0
Groundwater properties		
Initial Depth (groundwater)	mm	10
Daily Recharge Rate	%	25
Daily Baseflow Rate	%	5
Daily Seepage Rate	%	0.0

Source nodes and pollutant generation

Consistent with the default standards in MUSIC X, pollutant events mean concentrations (EMCs) for base flow and storm flow scenarios have been adopted from Table 5-6 and 5-7 of *NSW MUSIC Modelling Guidelines*. The EMC values are applied to source nodes in the MUSIC X model to estimate annual pollutant loads exported

from various surfaces across the site. The adopted pollutant EMCs for various catchment types are summarised in **Table 7**.

Table 7: Stormwater quality parameters for MUSIC X source nodes

Land use category		log10 TSS (mg/l)		log10 TP (mg/l)		log10 TN (mg/l)	
		Base flow	Storm flow	Base flow	Storm flow	Base flow	Storm flow
Roof areas	Mean	1.10	1.30	-0.82	-0.89	0.32	0.30
	Std dev	0.17	0.32	0.19	0.25	0.12	0.19
Road areas	Mean	1.20	2.43	-0.85	-0.30	0.11	0.34
	Std dev	0.17	0.32	0.19	0.25	0.12	0.19
Pervious areas	Mean	1.20	2.15	-0.85	-0.60	0.11	0.34
	Std dev	0.17	0.32	0.19	0.25	0.12	0.19

4.1. Proposed water quality treatment train

The following treatment train is proposed to achieve compliance with WaterNSW NorBE requirements:

- 10kL rainwater reuse tanks for each lot (125 new lots, 29 existing lots)
- Gross Pollutant Traps installed upstream of OSD basins.
- 100m^2 bio retention garden within OSD Basin 3A.
- 200m long swale (OSD Basin 3B (western swale)).
- 500m^2 bio retention garden within OSD Basin 3B.

4.1.1. Rainwater Tanks

Rainwater tanks are proposed to be installed on each lot. Council's Stormwater Drainage Policy nominates a rainwater tank size of 10,000L for lots up to 700m^2 which has been adopted for the lots across this stage of the subdivision.

The following assumptions have been included in the MUSIC X model in relation to rainwater tanks:

- 100% of the dwelling roof area drains to each rainwater tank
- Roof areas have been approximated at 300m^2 for each lot.
- Estimated re-use is based on each dwelling being a 4-bedroom house on reticulated supply with toilet and laundry connection to rainwater reuse. This results in a daily reuse of 0.47kL/day and an external re-use of 55kL/year distributed across the year using PET statistical distribution.

4.1.2. Gross Pollutant Traps

Gross pollutant traps have been provided upstream of OSD basins / bio retention gardens to capture gross pollutants and coarse sediments. These systems are proposed to be on-line systems with internal high flows bypasses to accommodate the 1% AEP storm through the system without incurring any damage. Treatment flow rates are based on the 4 EY flow for each catchment draining to each basin resulting in the following selections:

- GPT upstream of Basin 3A – Jellyfish 3250-20-4 by Ocean Protect or equivalent with a treatable flow rate of 110 L/sec.
- GPTs upstream of Basin 3B (western swale) – 3 x Jellyfish 3250-24-4 by Ocean Protect or equivalent with a treatable flow rate of 3 x 130 L/sec.

4.1.3. Bio retention gardens

Bio retention gardens are proposed within the OSD Basins at the north-east and western parts of the site. Bio retention gardens are configured to treat low flows through a splitter pit located between the on-line GPT and the OSD basin outlet. **Table 10** below presents the bio retention parameters adopted in the MUSIC model.

Table 8: Bio retention garden parameters for MUSIC X

Bio retention area	Surface Area (m2)	Filter Area (m)	Extended Detention Depth (m)	Filter depth to under drain (m)	Weir length (m)
OSD Basin 3A	120	100	0.3	0.5	3
OSD Basin 3B	550	500	0.3	0.5	5

All bio-retention systems are to be constructed in accordance with the Adoption Guidelines for Stormwater Bio-Filtration Systems (FAWB, 2009) and Goulburn Mulwaree Council bio retention specification notes provided on drawing 23-1098-C1002.

A MUSIC X model was created to simulate post-development mean annual loads. The layout of the post-development scenario is presented in **Figure 12**.

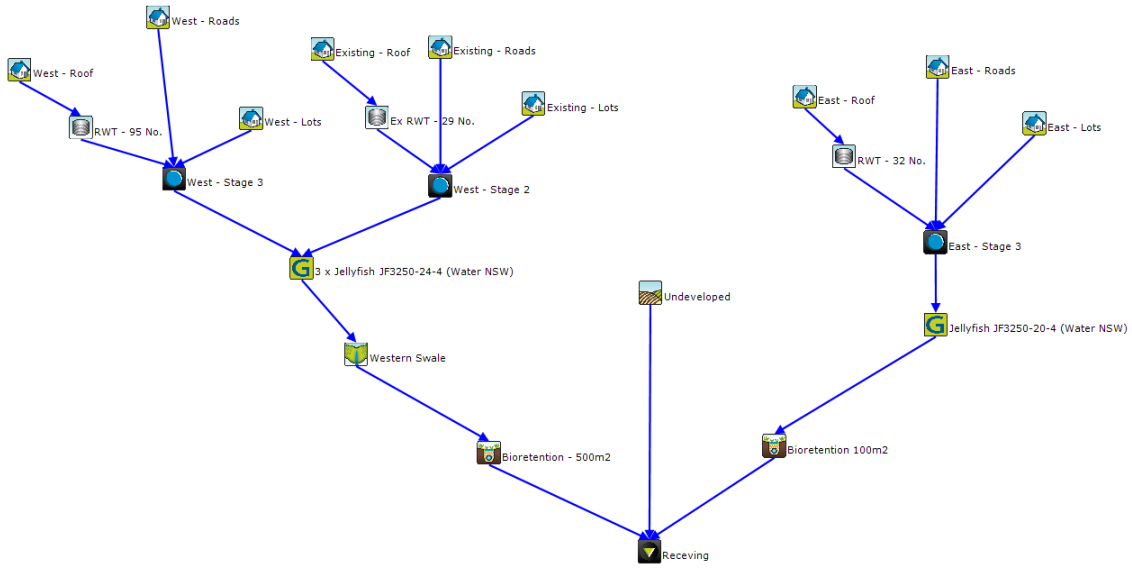

Figure 8: MUSIC X model layout – post development scenario

MUSIC X modelling results presented as mean annual loads at the receiving node indicate that NorBE is achieved, as shown in Error! Reference source not found.

Table 9: Summary of MUSIC X modelling achieving NorBE requirements.

Pollutant	Mean Annual Load (kg/yr)		
	Pre Dev	Post Dev	% reduction
Gross Pollutant	0	0	0
Total Suspended Soils	1,329	309.7	76.7%
Total Phosphorus	4.078	3.962	2.8%
Total Nitrogen	30.87	25.35	17.8%

5. Soil and Water Management

5.1. Construction Phase Erosion and Sediment Control

A Soil and Water Management Plan (SWMP) will be prepared in accordance with *Managing Urban Stormwater – Soils and Construction* (Landcom, 2004) prior to the issue of the Subdivision Works Certificate. The key objectives of the SWMP will be:

- Acknowledging the activities on a construction site that 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.
- Establishment of processes that effectively manage erosion, sedimentation and water quality practices during the life of the project.

5.2. 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.

5.3. Potential Impacts

The major potential impacts on waterway health 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 levels.
- Changed pH levels.
- Increased maintenance costs.
- Decrease in waterway capacity leading to increased flood levels and durations.

5.4. RUSLE Analysis

To inform the design of the SWMP, an analysis using the 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:

a) Assess the erosion risk at a site.
b) Identify suitable measures to overcome the erosion risk.
c) Estimate the required capacity of sediment retarding basins.
d) Compare the effectiveness of various erosion control measured.

Refer to **Table 10** below for estimates of soil loss on the site.

Table 10: RUSLE Analysis

Parameter	Value
Rainfall Erosivity Factor, R	960
Soil Erodibility Factor, K (Table C20, Blue Book)	0.05
Slope Length/Gradient Factor, LS	1.47
Erosion Control Practice Factor, P	1.20
Ground Cover and Management Factor, C	1
Computed Soil Loss (tonnes/ha/year), (A = R x K x LS x P x C)	**59.30**
Soil Loss Class	1 (Table 4.2 of the Blue Book)
Erosion Hazard	Very Low (Table 4.2 of the Blue Book)

It is noted the following parameters/assumptions were used for the analysis of this site:

- Rainfall Erosivity Factor (R) = 960 from (Equation 2, Appendix A2 Blue Book).
- Soil Erodibility Factor (K) = 0.05 (from Appendix C of Blue Book).
- Slope Length (LS): Is assumed to not exceed 100m immediately before forecast rainfall or during shutdown periods and a maximum grade of 4%.
- 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.

5.5. Design of Erosion and Sediment 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*
- Goulburn Mulwaree Council's guidelines and specifications

- *Managing Urban Stormwater: Soils and Construction*, Landcom, (4th Edition) (The "Blue Book") Volume 1 and Volume 2

With the proposed site being larger than 2,500m^2 in disturbed area, temporary sediment basins are required to be incorporated into the ESCP. Basins will be designed in accordance with 'Earth Basin Wet' SD6-4.

The proposed stormwater management basins and swales are proposed to be used temporarily as sitewide sediment basin during the bulk earthworks construction.

5.6. Construction Methodology

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.
- Rapid stabilisation of disturbed and exposed ground surfaces with hydro-seeding areas where future construction and building works are not currently proposed.
- All temporary sediment basins will be located clear of the 1% AEP flood extent from catchments upstream of the site.
- The proposed basins and swales can be utilised as the temporary sediment control basin.

Erosion and Sediment Control Plans will be prepared during the detailed design for all proposed control and protection measures across the site until completion of the subdivision works.

Suitable temporary erosion and sediment controls shall be designed by a suitably qualified engineer. Erosion and sediment controls shall be installed and maintained by the Contractor throughout all stages of works. Such controls shall be in accordance with the relevant requirements in the latest version of *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

5.7. 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 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.

5.8. Sediment Basin Maintenance

The site contains 'Type F' soils, or soils that contain a significant proportion of fine grained (33% or more of finer than 0.02mm) and require a much longer residence time to settle.

Stormwater within the settling zone should be drained or pumped out within 5 days (design time), if the nominated water quality targets can be met, to the satisfaction of the superintendent. Flocculation should be employed where extended settling is likely to fail to meet the objectives within the 5-day period.

Flocculation is when flocculating agents are applied to the sediment basins causing the colloidal particles to clump into larger units or 'floc' that can either settle in a reasonable time or be filtered.

Refer to Appendix E4 of the Blue Book for flocculation methodologies and manufacturer's instructions for application rates, regarding the proposed sediment basins.

5.9. Summary

The erosion and sediment control measures proposed for the site will comply with the requirements of Goulburn Mulwaree Council Engineering Guidelines and WaterNSW requirements.

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.

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