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CIVIL ENGINEERING REPORT FOR DEVELOPMENT APPLICATION

2115 CASTLEREAGH ROAD PENRITH NSW

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1 INTRODUCTION

1.1 Background

This civil engineering report has been prepared by Costin Roe Consulting Pty Ltd as part of a Development Application submission to the Penrith City Council for the development of an industrial warehouse/ distribution type facility.

The proposed development comprises warehouses, truck circulation and loading areas, dedicated container storage area, ancillary office space and parking areas.

1.2 Scope

Costin Roe Consulting Pty Ltd has been commissioned by Mr John Joannou c/- Aim Tenants to prepare this *Engineering Report* in support of the proposed application for development on the site.

This report provides a summary of the design principles and planning objectives for the following civil engineering components of the project:

- Earthworks & Retaining Walls;
- Stormwater Management including stormwater quantity and quality;
- Flooding; and
- Erosion & Sediment Control.

The engineering objectives for the development are to create a site which, based on the proposed architectural layout, responds to the topography and site constraints to provide an appropriate and economical stormwater management system which incorporates best practice in water sensitive urban design consistent with the requirements of council's water quality objectives.

A set of drawings have been prepared to show the proposed finished levels, retaining walls, stormwater drainage layout and water quantity and quality requirements for the development. These drawings are for development approval and subject to change through design progression in detail design and construction certificate, ensuring strategies and objectives set out in this document are maintained in the design.

1.3 Authority Jurisdiction

The consent authority is Penrith City Council and the engineering requirements of Penrith City Council (PCC) have been addressed.

1.4 Proposed Development

The proposed development is for the construction three industrial warehouse buildings on the eastern portion of the existing property. The proposal also includes two new multi-level carparking areas and associated offices on the western side of the property adjacent to Castlereagh Road, over existing parking areas. The indicative layout for the site has been included in **Figure 1.1**.

The proposed layout comprises three single level warehouse buildings with ancillary office spaces for each building. Truck loading access is made from a new site entry on Castlereagh Road (south) and the existing egress path along the southern boundary of the property. Fire brigade access for the full perimeter of the building. A second entry point is also proposed for truck and passenger from Castlereagh Road on the northern end of the site frontage. The existing central access driveway will be made redundant.

Civil works will include filling earthworks, construction of detention and flood mitigation systems, bio-retention water quality features and drainage structures. Works will also include in-ground stormwater drainage system, stormwater management system and pavements.

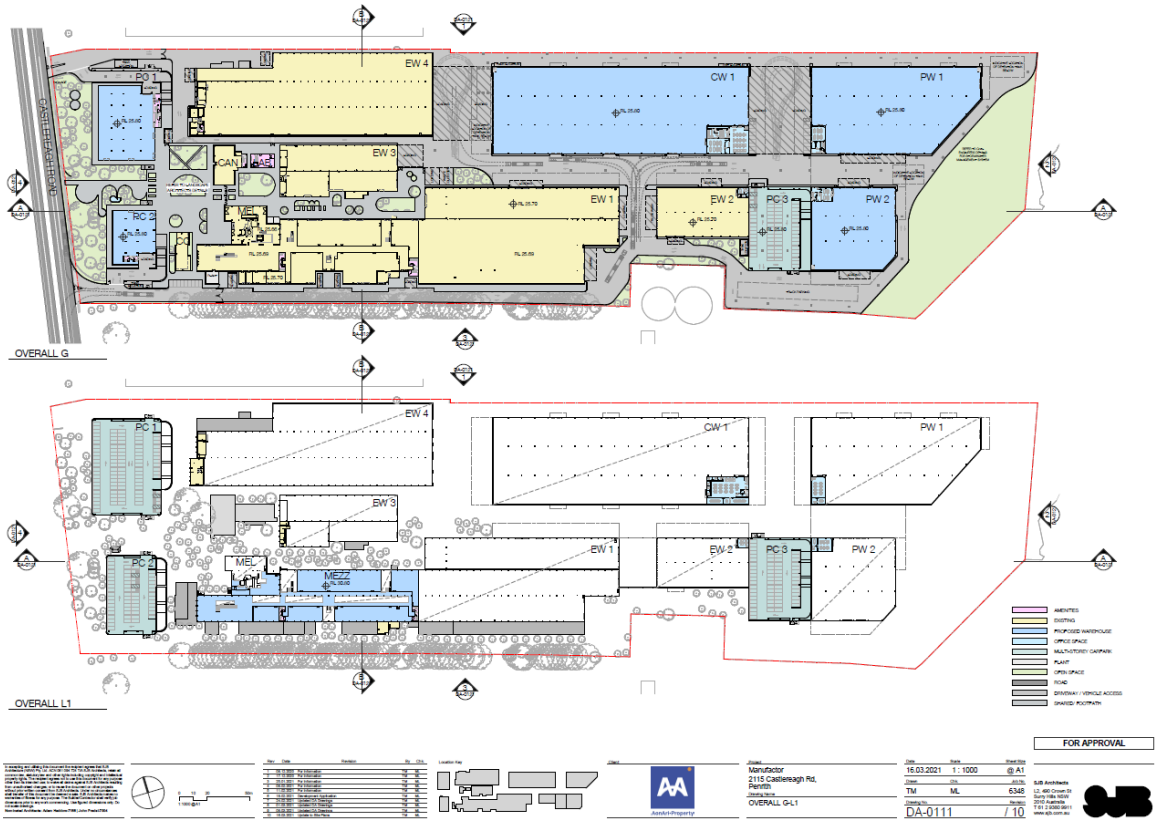


Figure 1.1. Proposed Development

2 SITE CHARACTERISTICS

2.1 Location & Description

The property, Lot 2 of DP 787827, is located within Penrith City Council (PCC) local government area (LGA), as shown in **Figure 1.1.**

The site is located on the eastern side of Castlereagh Road approximately 65m south of the intersection of Castlereagh Road and Lugard Street. The site comprises a roughly rectangular block with a total area of 12.06 Ha. The property is approximately 690m long and 180m wide (fronting Castlereagh Road).

The site is surrounded by the Meyer Timber facility and currently under construction O/I Glass warehouse facility to the north, wetland conservation zone to the east, undeveloped industrial land to the south and Castlereagh Road and industrial areas to the west. The nearest residential receptors are more than 750m north of the site.

The site comprises existing industrial steel framed buildings associated with current use on the site over much of the site. These existing buildings have finished floor levels between R.L. 25.6m and 25.7m A.H.D. Refer **Figure 1.1** and **1.2**.

There is minimal level change along the length of the property. Levels on Castlereagh Road frontage are noted to be RL 25.3m AHD, and levels on the eastern boundary are also at or around RL 25.3m AHD.

A wetland is located on the east of the site. A man made drainage swale and basin is located on the far east of the property. The eastern portion of the site currently drains to this flow path via a 300mm RCP. The drainage swale and basin ultimately discharges to the wetland east of the property via overland flow.

The majority of the site currently discharges stormwater to the north through the recently-construction 128 Andrews Road Facility via twin 600mm RCP and a formalised easement. The remainder of the site discharges east into the wetland area as described above. There is no council drainage located within Castlereagh Road.

The site is noted to be located within an area comprising existing industrial uses. The site is also noted to be located within the Nepean River Floodplain and flood planning considerations will be necessary for the development.

Figure 1.1. Locality Plan (Source: Sixmaps 2020)

Figure 1.2. Aerial Imagery (Source: Nearmap 8 June 2020)

Several existing public utilities (and associated easements) are present on the property adjacent to the south-eastern boundary. These include a 375mm CICL pressure sewer main and electrical lines. The pressure sewer main is noted to be a significant carrier and is a sensitive asset for Sydney Water. If any works are proposed around this asset, a Built Over Sewer approval (and associated assessments and reporting) will be necessary prior to any construction works.

2.2 Existing Stormwater Drainage

The site is currently developed as an industrial use. Existing drainage is present on site as inground pits and pipes. Discharge from the majority of the site is via 2x 600mm RCP pipes located on the northern boundary of the property. These pipes drain north through a detention basin in the currently under construction 128 Andrews Road Facility and easements/ RCBC construction to Lambridge Place constructed during the Myer Timber Facility construction period.

It is noted there is no inground drainage within Castlereagh Street. Castlereagh Street is noted to be subject to frequent ponding and inundation during rainfall due to the lack of public drainage and flat falls along the street gutter. It is noted that several large services are present in the vicinity of the gutter line which limit the ability for installation of public drainage in Castlereagh Street.

The eastern portion of the site (east) is drained via a 300mm RCP, and sheet flows, to an existing drainage swale and basin on the far east of the property. This basin/ swale then discharges directly into the wetland area east of the subject land.

Existing drainage is present on the two existing parking areas on the western/ Castlereagh Road frontage where the two new multi-level parking areas and offices are proposed. There is negligible difference in impervious areas on the Castlereagh Road site frontage development zone.

Management of stormwater over the site has been shown on drawings **Co14023.01-DA41 & DA42** and discussed in **Section 4.2**. Discharge from the existing developed portions of the property will be via existing pipes. The new construction will remain consistent with existing catchments with approximately 2Ha to drain through the existing pipes to the north and the remaining 2.7Ha to discharge to the wetland on the east.

It is noted the site is subject to flooding which is discussed in further sections of this report.

2.3 Proposed Stormwater Drainage System

The proposed stormwater drainage system for the development will comprise a minor and major system to safely and efficiently convey collected stormwater run-off from the development.

The minor system will consist of a piped drainage system designed to accommodate the 1 in 20-year ARI storm event (Q20). This results in the piped system being able to convey all stormwater runoff up to and including the Q20 event. The major system has been designed to cater for storms up to and including the 1 in 100-year ARI storm event (Q100). This major system employs overland flow paths to safely convey excess run-off from the site.

The design of the stormwater system for this site is based on the following:

- Runoff from the canopy will generally be designed in accordance with AS 3500.3 National Plumbing and Drainage Code Part 3 – Stormwater Drainage.

- Overall site runoff and stormwater management will generally be designed in accordance with the Institution of Engineers, Australia publication "Australian Rainfall and Runoff" (1988 Edition), Volumes 1 and 2 (AR&R).
- Design recurrence intervals for major and minor storms will be in accordance with Part C3 of PCC DCP2014.
- On-site detention, water quality measures and flooding requirements will be in accordance with Part C3 of PCC DCP2014.
- Stormwater harvesting is based on the requirement of PCC DCP2014 Part C3 and the NSW Department of Environment and Conservation Document *Managing Urban Stormwater: Harvesting and Reuse*.

Water quality has been considered in the design, throughout new paved areas, ensuring that any increase in the detrimental effects of pollution are mitigated and PCC Water Quality Objectives are met

Plans of the proposed stormwater drainage layout can be found on drawings **Co14203.01-DA41 & DA42** in **Appendix A**.

The objectives for the management of stormwater quantity and quality for the proposed application are consistent with PCC requirements. **Section 5** of this report discusses the proposed water quantity management and **Section 6** discusses the proposed water quality management. The means by which these objectives are achieved are as follows through a stormwater management basin consisting of an on-site detention basin combined with a bioretention basin.

- *Water Quantity* –
  Two on-site detention systems are proposed for the site for the areas of the site which require new impervious surfaces. The objective for water quantity is to attenuate the post development flows to less than or equal to the pre-development flows from the site through either tanked or open detention systems.
- *Water Quality* –
  Treatment of stormwater flows will be performed by a treatment train which comprises of pit inserts and proprietary filtration or bioretention.

There are two existing catchments on the site and the proposed legal points of discharge for the site will generally match existing catchment breakdown. Around half of the development footprint will be drained east (consistent with existing conditions) to the eastern drainage channel/basin, then the wetland, and the remainder of the new area will be drained north, through existing easements and twin 600mm RCP discharge locations with 128 Andrews Road property. This catchment ultimately drains to a culvert in Lambridge Place. The new parking areas on the Castlereagh Road frontage are noted to be constructed over existing impervious areas. As there is negligible change in impervious areas, no detention is proposed for this portion of the site.

Existing pre-developed flows will be maintained for the post-development conditions as noted above.

2.4 Eastern Service Zone

Dial Before You Dig (DBYD) information shows existing service corridor on the east of the property. The corridor comprises existing pressure sewer line and electrical transmission lines that runs through the eastern portion of the site within dedicated easements.

The sewer main is noted to be a 375mm CICL pressure sewer main and electrical lines. The pressure sewer main is noted to be a significant carrier and is a sensitive asset for Sydney Water. If any works are proposed around this asset, a Built Over Sewer approval (and associated assessments and reporting) will be necessary prior to any construction works.

The development is noted to be proposed to remain generally clear of the existing assets. Some minor works for drainage outlets will be necessary

3 SITE WORKS

3.1 Geotechnical Conditions

Based on our knowledge of the area, the site is expected to exhibit characteristics consistent with Cranebrook Formation.

Geotechnical investigations of surrounding sites reference the *Penrith 1:100,000 Geological Series Sheet 9030* and the site is shown to be underlain by Cranebrook Formation comprising Quaternary deposits of "gravel, sand, silt and clay".

The geotechnical profile is expected to comprise an alluvial profile with silty sands of around 1-2m depth over silty sandy gravels. The silty sands would exhibit CBR's of 10-14%, however it is noted that silts are difficult to work with and need a tight control of moisture content during the works. Noting that if the moisture content is slightly off optimum the material can become unworkable. The earthworks are recommended to be carried out by a earthworks contractor experienced with such soils.

In undeveloped eastern portions of the site, topsoil will vary in depth and could be expected to be generally averaging around 0.1m to 0.2m.

Geotechnical conditions will need to be confirm via detailed geotechnical investigation.

3.2 Earthworks

Bulk earthworks will be required to facilitate the development of the estate for industrial use. The earthworks will be undertaken to provide large flat building pads, facilitate site access from the existing site and to drain the site stormwater via gravity.

A high-level earthwork volume estimate assessment has been completed for the site. The earthworks volume estimates are high level based on a general layout in **Figure 1.1**. The earthworks analysis has been completed to a level of detail to enable general pad levels to be set and to obtain an order of magnitude cut and fill volume estimate. Given the preliminary nature of the assessment, an upper and lower bound of earthworks volumes has been included to allow for contingency in cost planning estimates.

The primary drivers for the proposed earthworks levels are achieving a cut to fill, to achieve flood planning requirements and to drain the site by gravity.

The earthworks volume estimates are as follows:

	Apparent Volume	**Upper Bound (+15%)**	**Lower Bound (-15%)**
Cut (m^3)	5700	6600	4900
Fill (m^3)	11700	13500	10000
Detail Excavation (@ 1500m^3/ Ha)	6400	7400	5500
Difference (m^3)	-400	-500	-400

Table 3.1. Earthwork Volume Estimates

The volume estimate is based on 4200m^3 of topsoil (100mm over the proposed 4.2 Ha development area) to be removed from the site (or placed elsewhere on site).

Allowances for service excavation during infrastructure and future building developments should also be made to avoid excessive exports during later stages of the project. Allowances in the range of 1,250-1,500m^3/Ha can be expected depending on the type of development and final site layouts. As noted, an upper and lower bound of earthworks volumes has been included to allow for some of these items.

3.3 Erosion and Sediment Control

Soil Erosion and Sediment Control measures will be provided for the development during the construction phase of the project. All Soil and Sediment Control measures will be performed in accordance with BCC requirements and recommendations set out in the Landcom document *Managing Urban Stormwater, Soils and Construction (1998) – The Blue Book*.

Measures, as set out in **Section 8** and **Appendix C & D**, will include sediment basins, construction entry/ truck shakers, sediment fences, diversion drains and drainage pit protection.

Refer **Section 8** and **Appendix C & D**

3.4 Retaining Walls

Retaining will be expected to be minimal given the relatively flat grading over the existing site. Final configuration will depend on the final levels proposed to meet flood planning and the masterplan site layout.

If necessary, the construction type for the walls will need to be masonry or other suitable durable retaining wall system. As per council policy timber structures are not permitted. Walls in could be formed of Keystone Reinforced Earth or similar construction, and walls in cut greater could comprise no-fines keystone.

4 STORMWATER HYDROLOGICAL MODELLING AND ANALYSIS

4.1 General Design Principles

The design of the stormwater system for this site will be based on relevant national design guidelines, Australian Standard Codes of Practice, Penrith City Council and accepted engineering practice as discussed in **Section 2.4** of this report.

Storm events for the 2 to 100 Year ARI events have been assessed.

4.2 Minor/ Major System Design

The piped stormwater drainage (minor) system has been designed to accommodate the 20-year ARI storm event (Q20). Overland flow paths (major) which will convey all stormwater runoff up to and including the Q100 event have also been provided which will limit major property damage and any risk to the public in the event of a piped system failure.

4.3 Rainfall Data

Rainfall Intensity Frequency Duration (IFD) data used as a basis for Drains modelling for the 2 to 100 Year ARI events was taken from *The Bureau of Meteorology Online IFD Tool*.

4.4 Runoff Models

Calculation of the runoff from storms of the design ARI have been calculated with the catchment modelling software DRAINS.

At this stage, the modelling performed is to calculate OSD requirements. Detailed hydraulic assessment of the internal drainage system will be calculated at detail/ construction certificate stage.

The design parameters for the Drains model are to be based on typical values and parameters for the area and are as follows:

Model	Model for Design and analysis run	Rational method	
	Rational Method Procedure	ARR87	
	Soil Type-Normal	3.0	
	Paved (Impervious) Area Depression Storage	1	mm
	Supplementary Area Depression Storage	1	mm
	Grassed (Pervious) Area Depression Storage	5	mm
AMC	Antecedent Moisture Condition (ARI=1-5 years)	2.5	
AMC	Antecedent Moisture Condition (ARI=10-20 years)	3.0	
AMC	Antecedent Moisture Condition (ARI=50-100 years)	3.5	
	Sag Pit Blocking Factor (Minor Systems)	0	
	On Grade Pit Blocking Factor (Minor Systems)	0	
	Sag Pit Blocking Factor (Major Systems)	0.5	
	On Grade Pit Blocking Factor (Major Systems)	0.2	
	Minor Storm Pit Freeboard	150	mm

Table 4.1. DRAINS ILSAX Parameters

4.5 Hydraulics

4.5.1 General Requirements

Hydraulic calculations will be carried out utilising DRAINS modelling software during the detail design stage to ensure that all surface and subsurface drainage systems meet or exceed the required standard.

4.5.2 Freeboard

The calculated water surface level in open junctions of the piped stormwater system will not exceed a freeboard level of 150mm below the finished ground level, for the peak runoff from the Minor System runoff. Where the pipes and junctions are sealed, this freeboard is not required.

4.5.3 Public Safety

For all areas subject to pedestrian traffic, the Depth-Velocity product (dV) of the depth of flow, d (in metres), and the velocity of flow, V (in metres per second), will be limited to 0.4, for all storms up to the 100-year ARI.

For other areas, the dV product will be limited to 0.6 for stability of vehicular traffic (whether parked or in motion) for all storms up to the 100-year ARI.

4.5.4 Inlet Pit Spacing

The spacing of inlets throughout the site will be such that the depth of flow, for the major system design storm runoff, will not exceed the top of the kerb (150mm above gutter invert).

4.5.5 Overland Flow

Dedicated flow paths have been designed to convey all storms up to and including the 100-year ARI. These flow paths will convey stormwater from the site to the detention systems prior to discharge.

4.6 Site Discharge

The site has two main catchments and subsequent discharge points.

Western Catchment

The western catchment drains twin 2x600mm RCP to the recently constructed detention system within 128 Andrews Road. Ultimate discharge to council infrastructure is made via a box culvert system to council drainage infrastructure in Lambridge Place.

Eastern Catchment

The eastern catchment drains to the rear channel and basin, prior to overflowing to the wetland area east of the property, designated as Wetland 158.

The design of the proposed outlet structure has been provided based on the NSW Office of Water document *Controlled Activities: Guidelines for Outlet Structures.*

The stormwater outlet consists of an outlet pipe and 'natural' energy dissipater in the location shown on **Co14203.01-DA40**. The outlet is aligned with the wetland to remove the potential for bank scour and shall include rip rap energy dissipaters constructed in accordance with the *Outlet Structures Guidelines* and "The Blue Book", ensuring that flows are distributed and velocity is reduced to a limit which will ensure no scour or limited potential for loss of habitat or ecological amenity (as confirmed by the Ecological Consultant). The arrangement of the outlet is shown figuratively below in **Figure 2.2** below. Further construction details regarding the configuration of dimensions, rock size and scour protection can be seen on drawing **Co14203.01.00-DA45**.

It is further noted that post-developed flows have been attenuated to pre-development, and that appropriate water quality and WSUD design has been employed to ensure acceptable water quality and flow rates to the Wetland 158. Further detail on water quantity and quality can be found in **Section 5** and **6** of this report.

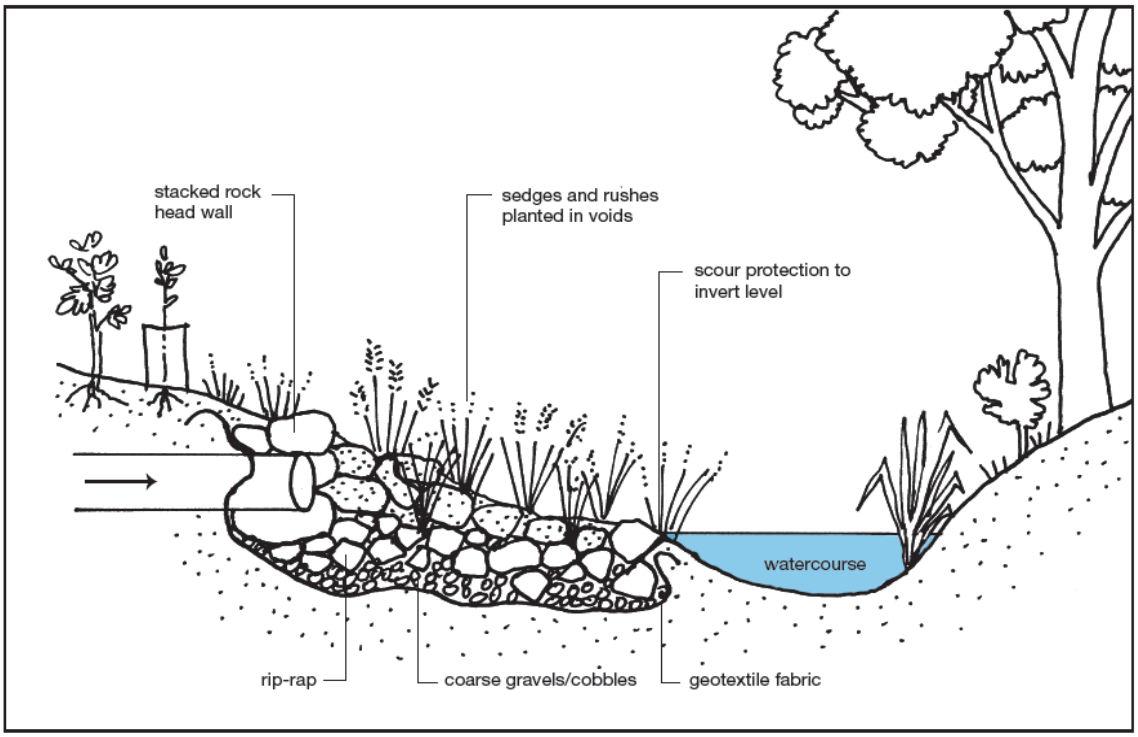


Figure 2.2. Outlet Structure Components

5 WATER QUANTITY MANAGEMENT

5.1 General Design Principles

Penrith City Council adopts the principles of water quantity management, also known as "On-site Detention (OSD)", to ensure the cumulative effect of development does not have a detrimental effect on the existing stormwater infrastructure and watercourses located within their LGA downstream from the particular site.

Section 3.3.3 of Councils draft stormwater management policy requires that "*it will be necessary to demonstrate that there will be no increase in runoff from the site as a result of the development for all storms up to and including the 100-year Average Recurrence Interval (ARI) event for all storm durations*".

5.2 Methodology

A hydrological analysis was undertaken to estimate the impact of the development of the site on peak flows at the downstream extent of the site. Modelling of stormwater runoff quantity was considered for the pre-existing case and for the operational phase of the development.

As the site is greater than 5000m^2, the simplified PSD/SSR method contained in Section 3.3 of the Penrith Council Document *Stormwater Drainage for Building Developments* has not been used in calculating the storage and discharge relationship for the site. Council's preferred modelling software, DRAINS has been used to assess the site detention discharge and storage relationship.

In order to assess the existing and operational phase peak discharges from the development site, a DRAINS hydrological model was used to estimate peak flows from catchments on the site for various storm durations for Q2 year ARI to Q100 year ARI events for the two adopted catchments.

5.3 Existing & Post Development Peak Flows

Tables 5.2 & **5.3** shows the existing and developed flows at the downstream boundaries for the western and eastern catchments respectively.

As noted in the council pre-development application minutes, peak flows are to match pre-development and flows are to be dissipated prior to entering the eastern channel and basin, then wetland on the eastern property catchment.

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Undeveloped	**Developed**	
		Site	Site (no atten.)	**Site (+ atten.)**
2	30	0.177	0.393	**0.158**
	60	0.227	0.329	**0.167**
	120	0.248	0.376	**0.167**
20	30	0.519	0.670	**0.220**
	60	0.456	0.553	**0.235**
	120	0.569	0.640	**0.239**
100	30	0.690	0.810	**0.257**
	60	0.583	0.676	**0.319**
	120	0.714	0.783	**0.357**

Table 5.2. Western Catchment - Q2, Q20 & Q100 ARI Peak Flows

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Undeveloped	Developed	
		Site	Site (no atten.)	**Site (+ atten.)**
2	30	0.260	0.577	**0.248**
	60	0.333	0.482	**0.282**
	120	0.364	0.551	**0.297**
20	30	0.761	0.982	**0.463**
	60	0.669	0.811	**0.490**
	120	0.835	0.939	**0.508**
100	30	1.01	1.19	**0.534**
	60	0.855	0.992	**0.567**
	120	1.05	1.15	**0.580**

Table 5.3. Eastern Catchment - Q2, Q20 & Q100 ARI Peak Flows

The post development (with site attenuation) flows can be seen to be lower than the pre-developed flows. The required detention storage for the development site is discussed in the following section.

5.4 Proposed Water Quantity Management

As previously discussed, detention storage on the development site is required to reduce local outflows for new impervious areas. The proposed site layout allows for provision of two OSD system which will be located within the site boundaries. An underground tank is proposed in the middle portion of the site to attenuate the western portion of site catchment. Catchments are shown on drawing **Co14203.01-DA40**.

A secondary basin is proposed to attenuate the eastern portion of the site. The discharge location from the eastern basin will be made via an outlet pipe to the adjacent wetlands. The proposed eastern OSD system is an above ground basin located in the south-east corner of the site, outside of the defined wetlands setback zone.

A number of combinations of storages and outlet arrangements have been modelled for the two catchments. The adopted arrangement models the open basin configuration

shown in **Tables 5.4 and 5.5** and the proposed layout can also be observed on drawings **Co14203.01-DA41 & DA42**, with details on **DA45** and **DA46**.

ARI	Duration (mins)	Peak Flow (m3/s)					Depth (mm)	Storage (m3)
		No Atten.	With attenuation					
			Low	High	Bypass	Total		
2	60	0.227	0.167	0	0	0.167	450	207
20	120	0.569	0.239	0	0	0.239	970	441
100	120	0.714	0.274	0.083	0	0.357	1260	571

Table 5.4. Western Catchment - OSD Characteristics (Post Developed)

ARI	Duration (mins)	Peak Flow (m3/s)					Depth (mm)	Storage (m3)
		No Atten.	With attenuation					
			Low	High	Bypass	Total		
2	60	0.482	0.282	0	0	0.282	530	358
20	120	0.939	0.508	0	0	0.508	790	590
100	120	1.150	0.580	0.044	0	0.624	930	739

Table 5.5. Eastern Catchment - OSD Characteristics (Post Developed)

The hydrologic analysis shows that, with the provision of the on-site detention system detailed above, the post development peak flows from the site will be attenuated to less than pre-development; hence the requirements of PCC have been met.

A positive covenant over the stormwater management system will need to be provided in accordance with Penrith City Council requirements.

6 STORMWATER QUALITY CONTROLS

6.1 Regional Parameters

There is a need to provide a design which incorporates the principles of Water Sensitive Urban Design (WSUD) and to target pollutants that are present in the stormwater so as to minimise the adverse impact these pollutants could have on receiving waters and to also meet the requirements specified by PCC.

PCC has nominated, in Section C3 of their *DCP2014*, the requirements for stormwater quality to be performed on a catchment wide basis. These are presented in terms of annual percentage pollutant reductions on a developed catchment and are as follows:

Gross Pollutants	90%
Total Suspended Solids	85%
Total Phosphorus	60%
Total Nitrogen	45%
Free Oil and Grease	90%

6.2 Proposed Stormwater Treatment System

Roof, hardstand and other extensive paved areas are required to be treated by the Stormwater Treatment Measures (STM). The STM shall be sized according to the whole catchment area of the Site. The STM's for the development are based on a treatment train approach as discussed in the NSW EPA document *Managing Urban Stormwater: Treatment Techniques* to ensure that all the objectives above are met.

Components of the treatment train for the development are as follows:

- Primary treatment to hardstand areas is via Enviropod pit inserts;
- Secondary treatment (overflow event only) is via trash screens and a sediment sump within the OSD system; and
- Tertiary treatment of site water will be via either a proprietary filtration system (within detention tank) or a bioretention system situated within the eastern on-site detention basin.

6.3 Stormwater Quality Modelling

6.3.1 Introduction

The MUSIC model was chosen to model water quality. This model, released by the Cooperative Research Centre for Catchment Hydrology (CRCCH), is a standard industry model for this purpose. MUSIC (the Model for Urban Stormwater Improvement Conceptualisation) is suitable for simulating catchment areas of up to 100 km^2 and utilises a continuous simulation approach to model water quality.

By simulating the performance of stormwater management systems, MUSIC can be used to predict if the proposed systems and changes to land use are appropriate for their catchments and capable of meeting specified water quality objectives (CRC 2002). The water quality constituents modelled in MUSIC, of relevance to this report, include Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN).

The pollutant retention criteria set out in Part C3 of PCC's DCP and nominated in Section 6.1 of this report were used as a basis for assessing the effectiveness of the selected treatment trains.

The MUSIC model "*14203.01_Castlereagh_Rd Rev 1.sqz*" was set up to examine the effectiveness of the water quality treatment train and to predict if PCC requirements have been achieved. The layout of the MUSIC model is presented in **Appendix B**.

6.3.2 Rainfall Data

Six-minute pluviographic data for the nearby Penrith Lakes AWS weather station was sourced from the Bureau of Meteorology (BOM) as nominated below. Evapo-transpiration data for the period was sourced from the Sydney Monthly Areal PET data set supplied with the MUSIC software.

Input	**Data Used**
Rainfall Station	67113 Penrith Lakes AWS
Rainfall Period	1999 – 2008 (10 years)
Mean Annual Rainfall (mm)	712
Evapo- transpiration	Sydney Monthly Areal PET
Model Time step	6 minutes

6.3.3 Rainfall Runoff Parameters

Parameter	**Value**
Rainfall Threshold	1.40
Soil Storage Capacity (mm)	105
Initial Storage (% capacity)	30
Field Capacity (mm)	70
Infiltration Capacity Coefficient a	150
Infiltration Capacity exponent b	3.5
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	10
Daily Seepage Rate (%)	0

6.3.4 Pollutant Concentrations & Source Nodes

Pollutant concentrations for source nodes are as per **Table 6.1**:

Flow Type	TSS (log_{10} values)		TP (log_{10} values)		TN (log_{10} values)	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Baseflow	1.20	0.17	-0.85	0.19	0.11	0.12
Stormflow	2.15	0.32	-0.60	0.25	0.30	0.19

Table 6.1. Pollutant Concentrations

The MUSIC model has been setup with a treatment train approach based on the pollutant concentrations in **Table 6.1** above.

6.3.5 Treatment Nodes

Bioretention and SW360 Enviropod nodes have been used in the modelling of the development.

There are two bioretention basins proposed which will be provided in accordance with industry best practice and the guidelines of the Monash University Facility for Advancing Water Biofiltration with the following parameters:

Bioretention 1

Parameter	**Value**	
Storage Properties		
Extended Detention Depth	300	mm
Storage Surface Area	170	m^2 (minimum)
Filter and Media Properties		
Filtration Area	170	m^2
Saturated Hydraulic Conductivity	100	mm/hr
Filter Depth	500	mm

Bioretention 2

Parameter	**Value**	
Storage Properties		
Extended Detention Depth	300	mm
Storage Surface Area	80	m^2 (minimum)
Filter and Media Properties		
Filtration Area	80	m^2
Saturated Hydraulic Conductivity	100	mm/hr
Filter Depth	500	mm

6.3.6 Results

Table 6.2 shows the results of the MUSIC analysis. The reduction rate is expressed as a percentage and compares the post-development pollutant loads without treatment versus post-development loads with treatment.

	Source	Residual Load	% Reduction
Flow (ML/yr)	26.6	26.1	1.8
Total Suspended Solids (kg/yr)	5160	416	91.9
Total Phosphorus (kg/yr)	10	3.18	68.3
Total Nitrogen (kg/yr)	61.1	33.2	45.6
Gross Pollutants (kg/yr)	747	0	100

Table 6.2. MUSIC analysis results

The model results indicate that, through the use of the STM in the treatment train, pollutant load reductions for Total Suspended Solids, Total Phosphorous, Total Nitrogen and Gross Pollutants will meet the requirements of C3 of PCC's DCP2014 on an overall catchment basis.

6.3.7 Modelling Discussion

MUSIC modelling has been performed to assess the effectiveness of the selected treatment trains and to ensure that the pollutant retention requirements of C3 of PCC's DCP2014 have been met.

The MUSIC modelling has shown that the proposed treatment train of STM will provide stormwater treatment which will meet PCC requirements in an effective and economical manner.

Hydrocarbon and oil & grease removal cannot be modelled with MUSIC software. As a warehouse and distribution centre, the facility is expected to have low source loadings of hydrocarbons. Potential sources of hydrocarbons and/or oil & grease which drain to the stormwater system would be limited to leaking engine sumps or for accidental fuel spills/leaks and leaching of bituminous pavements (car parking only). The potential for these pollutants is low and published data from the CSIRO indicates that average concentrations from industrial sites are in the order of 10mg/L and we would expect source loading from this site to be near to or below this concentration. Hydrocarbon pollution would also be limited to surface areas which will be treated via bioretention or filtration systems which are known to be effective in the treatment of hydrocarbons in stormwater.

Given the expected low source loadings of hydrocarbons and oil/grease and removal efficiencies of the treatment devices we consider the DGR's and PCC requirements have been met.

6.4 Stormwater Harvesting

Stormwater harvesting refers to the collection of stormwater from the developments internal stormwater drainage system for re-use in non-potable applications. Stormwater from the stormwater drainage system can be classified as either rainwater, where the flow is from roof areas only, or stormwater where the flow is from all areas of the development.

Rainwater harvesting will be required for the development site for re-use in non-potable applications. Internal uses include such applications as toilet flushing while external applications will be used for irrigation. The requirements as per Penrith Council C3 of DCP2014 is to reduce the water demand and provide a minimum 100kL rainwater tank.

In general terms, the rainwater harvesting system is expected to comprise and in-line tank for the collection and storage of rainwater. At times when the rainwater storage tank is full, rainwater can pass through the tank and continue to be discharged via gravity into the stormwater drainage system. Rainwater from the storage tank will be pumped for distribution throughout the development in a dedicated non- potable water reticulation system.

Rainwater tanks have been designed, using a water balance analysis to balance the supply and demand, based on the below base water demands, to provide a reduction in non-potable water demand.

6.5 Maintenance and Monitoring

It is important that each component of the water quality treatment train is properly operated and maintained. In order to achieve the design treatment objectives, an indicative maintenance schedule has been prepared (refer to **Table 6.5** below).

Note that inspection frequency may vary depending on site specific attributes and rainfall patterns in the area. In addition to the maintenance requirements below it is also recommended that inspections are made following heavy rainfall or major storm events. Event heavy rain inspections should be carried out as soon as practicable following an intense period of rainfall, (i.e. greater than 100mm over 48 hours), as measured at Prospect Dam Weather Station No. 67019.

Table 6.5. Indicative Maintenance Schedule

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
SWALES/ LANDSCAPED AREAS			
Check density of vegetation and ensure minimum height of 150mm is maintained. Check for any evidence of weed infestation	Six monthly	Maintenance Contractor	Replant and/or fertilise, weed and water in accordance with landscape consultant specifications
Inspect swale for excessive litter and sediment build up	Six monthly	Maintenance Contractor	Remove sediment and litter and dispose in accordance with local authorities' requirements.
Check for any evidence of channelisation and erosion	Six monthly/ After Major Storm	Maintenance Contractor	Reinstate eroded areas so that original, designed swale profile is maintained
Weed Infestation	Three Monthly	Maintenance Contractor	Remove any weed infestation ensuring all root ball of weed is removed. Replace with vegetation where required.
Inspect swale surface for erosion	Six Monthly	Maintenance Contractor	Replace top soil in eroded area and cover and secure with biodegradable fabric. Cut hole in fabric and revegetate.
BIO-RETENTION BASINS/ BIORETENTION SWALES			
Check all items nominated for SWALES/ LANDSCAPED AREAS above	Refer to SWALES/ LANDSCAPED AREAS section above	Refer to SWALES/ LANDSCAPED AREAS section above	Refer to SWALES/ LANDSCAPED AREAS section above
Check for sediment accumulation at inflow points	Six monthly/ After Major Storm	Maintenance Contractor	Remove sediment and dispose in accordance with local authorities' requirements.
Check for erosion at inlet or other key structures.	Six monthly/ After Major Storm	Maintenance Contractor	Reinstate eroded areas so that original, designed profile is maintained

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Check for evidence of dumping (litter, building waste or other).	Six monthly	Maintenance Contractor	Remove waste and litter and dispose in accordance with local authorities' requirements.
Check condition of vegetation is satisfactory (density, weeds, watering, replating, mowing/ slashing etc)	Six monthly	Maintenance Contractor	Replant and/or fertilise, weed and water in accordance with landscape consultant specifications
Check for evidence of prolonged ponding, surface clogging or clogging of drainage structures	Six monthly/ After Major Storm 5-10 years	Maintenance Contractor	Remove sediment and dispose in accordance with local authorities' requirements. Replace filter media & planting – refer to appropriately qualified engineer or stormwater specialist
Check stormwater pipes and pits	Six monthly/ After Major Storm	Maintenance Contractor	Refer to INLET/ JUNCTION PIT section below.
INLET & JUNCTION PITS			
Inside Pit	Six Monthly	Maintenance Contractor	Remove grate and inspect internal walls and base, repair where required. Remove any collected sediment, debris, litter.
Outside of Pit	Four Monthly/ After Major Storm	Maintenance Contractor	Clean grate of collected sediment, debris, litter and vegetation.
STORMWATER SYSTEM			

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
General Inspection of complete stormwater drainage system	Bi-annually	Maintenance Contractor	Inspect all drainage structures noting any dilapidation in structures and carry out required repairs.
OSD SYSTEM			
Inspect and remove any blockage from orifice	Six Monthly	Maintenance Contractor/ Owner	Remove grate and screen to inspect orifice.
Inspect trash screen and clean	Six Monthly	Maintenance Contractor/ Owner	Remove grate and screen if required to clean it.
Inspect pit sump for damage or blockage.	Six Monthly	Maintenance Contractor/ Owner	Remove grate & screen. Remove sediment/ sludge build up and check orifice and flap valve is clear.
Inspect storage areas and remove debris/ mulch/ litter etc. likely to block screens/ grates.	Six Monthly	Maintenance Contractor/ Owner	Remove debris and floatable materials.
Check attachment of orifice plate and screen to wall of pit	Annually	Maintenance Contractor	Remove grate and screen. Ensure plate or screen mounted securely, tighten fixings if required. Seal gaps if required.
Check orifice diameter is correct and retains sharp edge.	Five yearly	Maintenance Contractor	Compare diameter to design (see Work-as-Executed) and ensure edge is not pitted or damaged.
Check screen for corrosion	Annually	Maintenance Contractor	Remove grate and screen and examine for rust or corrosion, especially at corners or welds.
Inspect overflow weir and remove any blockage	Six monthly	Maintenance Contractor/ Owner	Ensure weir is free of blockage.
Inspect walls for cracks or spalling	Annually	Maintenance Contractor	Remove grate to inspect internal walls, repair as necessary.

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Check step irons	Annually	Maintenance Contractor	Ensure fixings are secure and irons are free from corrosion.
ENVIROPOD PIT INSERTS			
As per manufacturer's Operation and Maintenance Manual	Six Monthly & after major storm events As per manufacturer's Operation and Maintenance Manual	Maintenance Contractor	As per manufacturer's Operation and Maintenance Manual

7 FLOODING

The site has been identified by Penrith City Council as being flood affected during the 1% AEP and 0.5% AEP flood events. These events are associated with overbank flooding from the Nepean River which is approximately 1km west of the development site. Reference to the *Nepean River Flood Study* (2018) completed for Penrith City Council by Advisian, has been made and consultation with Councils flooding engineer Mr Myl Senthilvasan regarding the localised assessment relating to this project.

Our experience with Council is they require the following to be included in the development application documents:

- *Any development shall require the submission of a flood study to assess the impact of the proposed development upon flood flow conveyance through the site for the 1% AEP and 0.5% AEP Nepean River flood events. Assessment of local overland flows is also to be undertaken. The study shall include flood level difference mapping and an assessment of safe velocity / depth ratios through the site and along the access handle.*
- *Flood safe evacuation access for the 1% AEP flood is to be provided from the development site.*
- *The development shall not have any adverse flood impacts upon adjoining properties.*
- *The application must demonstrate that the proposal is compatible with the State Government Floodplain Development Manual and Council's Local Environmental*
- *Plan and Development Control Plan for Flood Liable Lands.*
- *All habitable floor levels shall be a minimum of 0.5m above the 1% AEP flood event.*

An analysis of the impact of the development on existing flooding has been completed to confirm no affectation on upstream, downstream and adjoining properties in both the 1% AEP and 0.5% AEP events and to confirm the proposed building will meet flood immunity and flood planning requirements as noted above.

Reference to **Appendix F** should be made for the assessment in full. **Appendix F** contains detailed technical information including hydrological and hydraulic assessment, and results of the assessments. Also included in **Appendix F** is a concise description of how the items included in *Clause 7.2 of Penrith City Council LEP 2010* can also be found.

Modelling has been completed using council preferred TUFLOW modelling engine. The model output shows that the 1% AEP level is RL25.28m AHD and the 0.5% AEP flood level is 25.94m AHD. Refer to **Figure 7.1** and **7.2** for the post development flood extents and levels.

The assessment shows that sufficient a flood-way is available during the 0.5% AEP event. Further that flood afflux is negligible during the 1% AEP event, and within council recommendations during the 0.5% AEP event. The modelling output also shows a minor afflux in flood levels of 250mm during the 0.5% AEP post developed flooding events locally within the site boundaries. This would be considered acceptable in terms of the requirements of Councils Part C3 DCP.

Refer to **Figures F5 to F12** for the flood model output and results, and **Appendix F** for the site egress strategy.

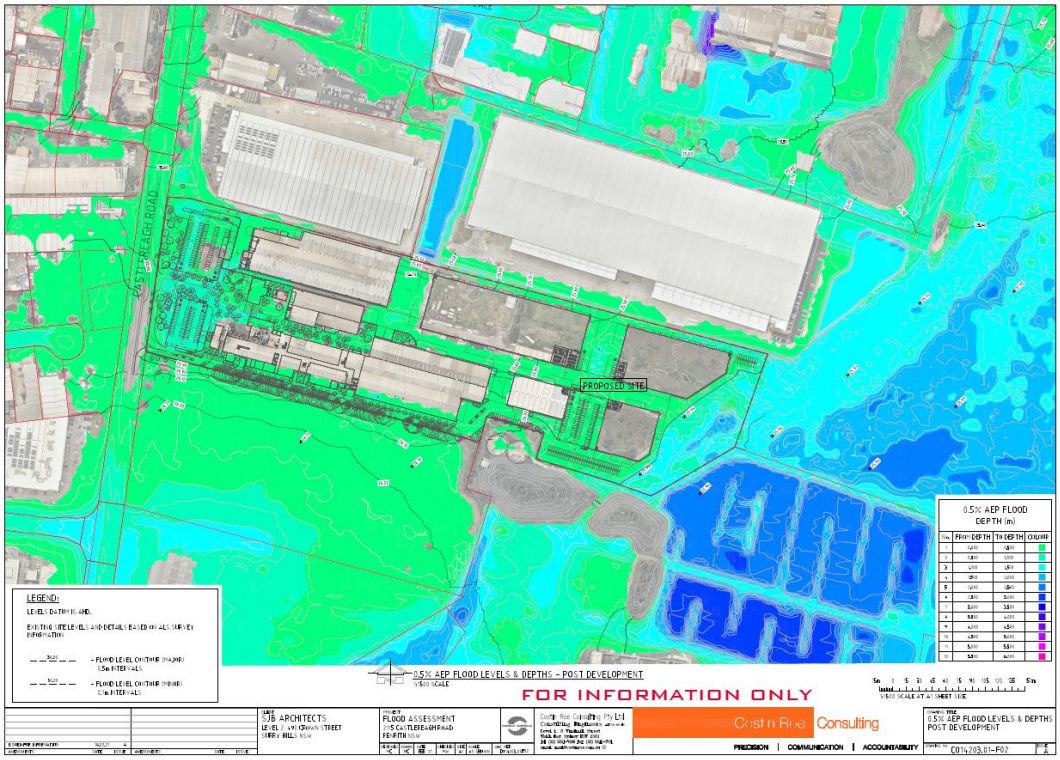


Figure 7.1. 0.5% AEP Post Development Flood Extent and Levels

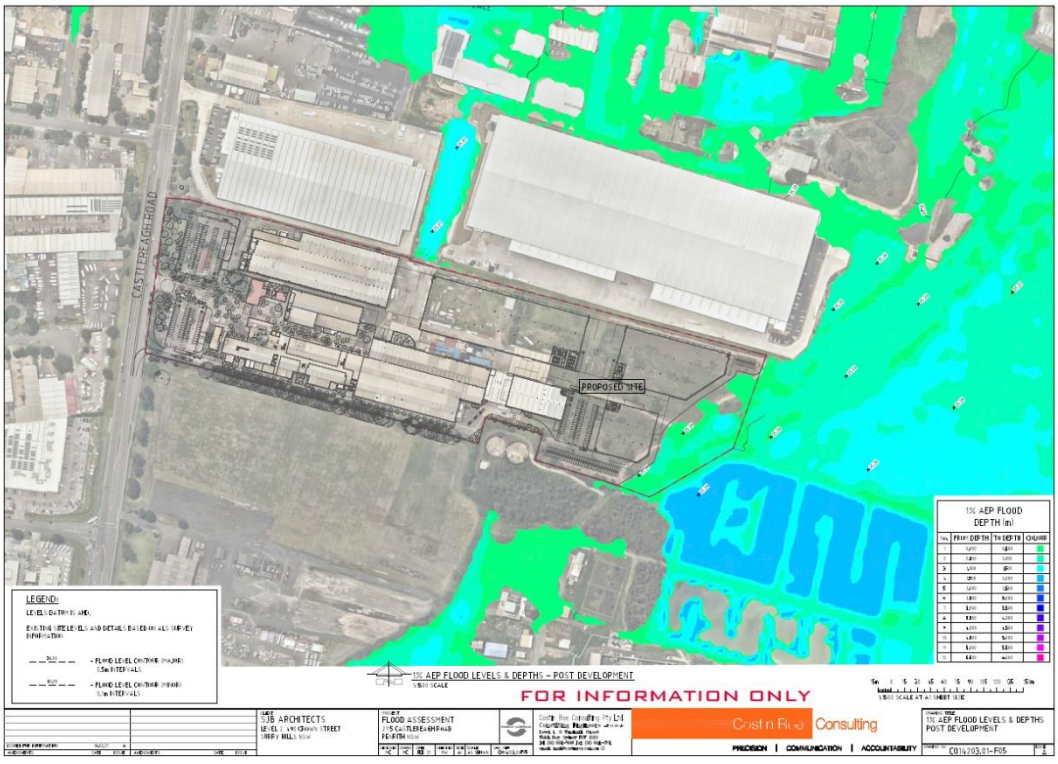


Figure 7.2. 1% AEP Post Development Flood Extent and Levels

8 SOIL AND WATER MANAGEMENT

8.1 Soil and Water Management General

Section 1 provides a summary of the construction works for the Proposal. While all construction activities have the potential to impact on water quality, the key activities are:

- Erosion and sediment control installation.
- Grading of existing earthworks to suit building layout, drainage layout and pavements.
- Stormwater and drainage works.
- Service installation works.
- Building construction works.

Without any mitigation measures and during typical construction activities, site runoff would be expected to convey a significant sediment load. A *Soil and Water Management Plan* (SWMP) and *Erosion and Sediment Control Plan* (ESCP), or equivalent, would be implemented for the construction of the Proposal. The SWMP and ESCPs would be developed in accordance with the principles and requirements of *Managing Urban Stormwater – Soils & Construction Volume 1 ('Blue Book')(Landcom, 2004)*.

In accordance with the principles included in the Blue Book, a number of controls have been incorporated into a preliminary ESCP (refer to accompanying Drawings in **Appendix A**) and draft SWMP in **Appendix C**.

The sections below outline the proposed controls for management of erosion and sedimentation during construction of the Proposal.

8.2 Typical Management Measures

Sediment Basins

Sediment basins have been sized (based on 5 day 85th percentile rainfall) and located to ensure sediment concentrations in site runoff are within acceptable limits. Preliminary basin sizes have been calculated in accordance with the Blue Book and are based on 'Type F' soils. These soils are fine grained and require a relatively long residence time to allow settling.

Sediment basins for 'Type F' soils are typically wet basins which are pumped out following a rainfall event when suspended solids concentrations of less than 50 mg/L have been achieved.

Sediment Fences

Sediment fences are located around the perimeter of the site to ensure no untreated runoff leaves the site. They have also been located around the existing drainage channels to minimise sediment migration into waterways and sediment basins.

Stabilised Site Access

For the proposal, stabilised site access is proposed at one location at the entry to the works area. This will limit the risk of sediment being transported onto Muir Road and other public roads.

8.3 Other Management Measures

Other management measures that will be employed are expected to include:

- Minimising the extent of disturbed areas across the site at any one time.
- Progressive stabilisation of disturbed areas or previously completed earthworks to suit the proposal once trimming works are complete.
- Regular monitoring and implementation of remedial works to maintain the efficiency of all controls.

It is noted that the controls included in the preliminary ESCP are expected to be reviewed and updated as the design, staging and construction methodology is further developed for the Proposal.

9 CONCLUSION

This Civil Engineering Report has been prepared to support a development application for a proposed industrial facility at Castlereagh Road, Penrith.

A civil engineering strategy for the site has been developed which provides a best practice solution within the constraints of the existing landform and proposed development layout. Within this strategy a stormwater quantity and quality management strategy has been developed to reduce both peak flows and pollutant loads in stormwater leaving this site. The stormwater management for the development has been designed in accordance with Penrith City Council's Section C3 of DCP2014.

The hydrological assessment proves local post development flows from the site will be less than pre-development flows and demonstrates that the site discharge will not adversely affect any land, drainage system or watercourse as a result of the development.

Further flooding assessment, completed using TUFLOW modelling, confirms the building can be sited above the 1% AEP with appropriate freeboard and maintaining floodways during the 0.5% AEP event as required by council.

During the construction phase, a Sediment and Erosion Control Plan will be in place to ensure the downstream drainage system and receiving waters are protected from sediment laden runoff.

During the operational phase of the development, a treatment train incorporating the use of a bioretention system is proposed to mitigate any increase in stormwater pollutant load generated by the development. MUSIC modelling results indicate that the proposed STM are effective in reducing pollutant loads in stormwater discharging from the site and meet the requirements of Council's pollution reduction targets. Best management practices have been applied to the development to ensure that the quality of stormwater runoff is not detrimental to the receiving environment.

Further, as included in **Appendix F**, a framework for flood awareness and confirmation of how safe site egress from the site can be made with sufficient warning times and triggers for flood actions.

It is recommended the management strategies in this report be approved and incorporated into the future detailed design.

10 REFERENCES

- Managing Urban Stormwater: Harvesting and Reuse – 2006 (NSW DEC);
- Managing Urban Stormwater: Source Control – 1998 (NSW EPA);
- Managing Urban Stormwater: Treatment Techniques – 1997 (NSW EPA);
- Managing Urban Stormwater: Soils & Construction – 2004 (LANDCOM);
- Penrith City Council – DCP 2014 (Part C3); and
- Water Sensitive Urban Design – "Technical Guidelines for Western Sydney" by URS Australia Pty Ltd, May 2004

Appendix A

DRAWINGS BY COSTIN ROE CONSULTING

INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH, NSW

DRAWING LIST:

DRAWING NO.	DRAWING TITLE
C014203.01-DA 10	DRAWING LIST & GENERAL NOTES
C014203.01-DA 20	EROSION & SEDIMENT CONTROL PLAN
C014203.01-DA 25	EROSION & SEDIMENT CONTROL DETAILS
C014203.01-DA 41	CONCEPT STORMWATER DRAINAGE PLAN - SHEET 1
C014203.01-DA 42	CONCEPT STORMWATER DRAINAGE PLAN - SHEET 2
C014203.01-DA 45	STORMWATER DRAINAGE DETAILS - SHEET 1
C014203.01-DA 46	STORMWATER DRAINAGE DETAILS - SHEET 2
C014203.01-DA 47	STORMWATER DRAINAGE DETAILS - SHEET 3
C014203.01-DA 48	STORMWATER DRAINAGE DETAILS - SHEET 4
C014203.01-DA 51	FINISHED LEVELS PLAN - SHEET 1
C014203.01-DA 52	FINISHED LEVELS PLAN - SHEET 2

GENERAL NOTES:

1. THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL ARCHITECTURAL AND OTHER CONSULTANTS' DRAWINGS AND SPECIFICATIONS AND WITH SUCH OTHER WRITTEN INSTRUCTIONS AS MAY BE ISSUED DURING THE COURSE OF THE CONTRACT. ANY DISCREPANCY SHALL BE REFERRED TO THE ENGINEER BEFORE PROCEEDING WITH THE WORK.
2. ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE RELEVANT AND CURRENT STANDARDS AUSTRALIA CODES AND WITH THE BY-LAWS AND ORDINANCES OF THE RELEVANT BUILDING AUTHORITIES EXCEPT WHERE VARIED BY THE PROJECT SPECIFICATION.
3. ALL DIMENSIONS SHOWN SHALL BE VERIFIED BY THE BUILDER ON SITE.
   ENGINEER'S DRAWINGS SHALL NOT BE SCALED FOR DIMENSIONS.
   ENGINEER'S DRAWINGS ISSUED IN ANY ELECTRONIC FORMAT MUST NOT BE USED FOR DIMENSIONAL SETOUT.
   REFER TO THE ARCHITECT'S DRAWINGS FOR ALL DIMENSIONAL SETOUT INFORMATION.
4. DURING CONSTRUCTION THE STRUCTURE SHALL BE MAINTAINED IN A STABLE CONDITION AND NO PART SHALL BE OVERSTRESSED. TEMPORARY BRACING SHALL BE PROVIDED BY THE BUILDER TO KEEP THE WORKS AND EXCAVATIONS STABLE AT ALL TIMES.
5. UNLESS NOTED OTHERWISE ALL LEVELS ARE IN METRES AND ALL DIMENSIONS ARE IN MILLIMETRES.
6. ALL WORKS SHALL BE UNDERTAKEN IN ACCORDANCE WITH ACCEPTABLE SAFETY STANDARDS & APPROPRIATE SAFETY SIGNS SHALL BE INSTALLED AT ALL TIMES DURING THE PROGRESS OF THE JOB.

ELECTRONIC INFORMATION NOTES:

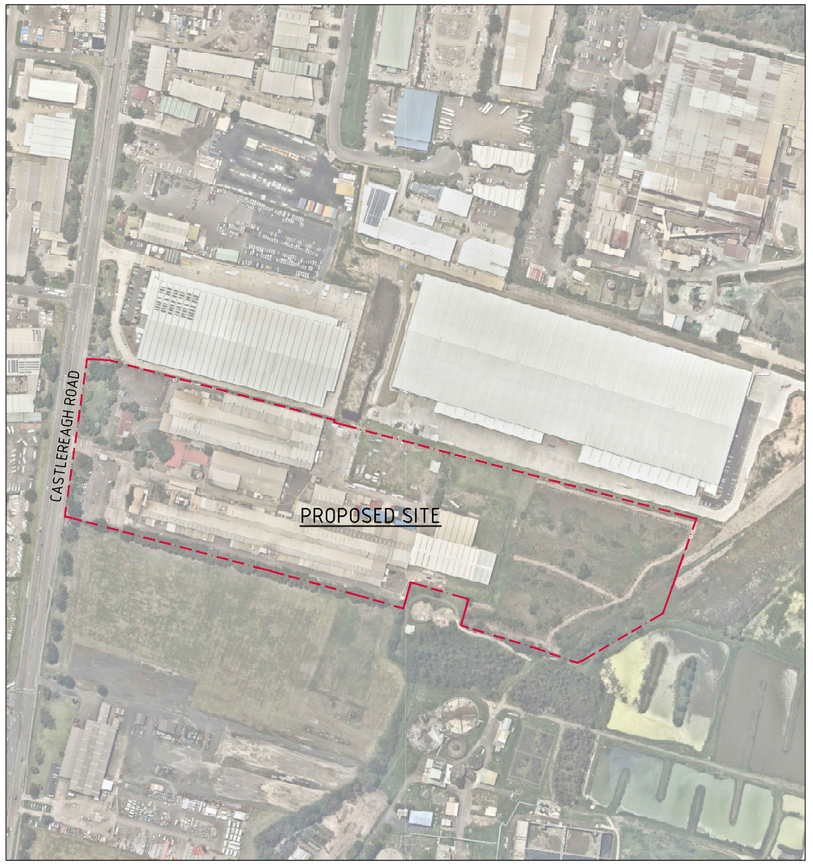
1. THE ISSUED DRAWINGS IN HARD COPY OR PDF FORMAT TAKE PRECEDENCE OVER ANY ELECTRONICALLY ISSUED INFORMATION, LAYOUTS OR DESIGN MODELS.
2. THE CONTRACTOR'S DIRECT AMENDMENT OR MANIPULATION OF THE DATA OR INFORMATION THAT MIGHT BE CONTAINED WITHIN AN ENGINEER-SUPPLIED DIGITAL TERRAIN MODEL AND ITS SUBSEQUENT USE TO UNDERTAKE THE WORKS WILL BE SOLELY AT THE DISCRETION OF AND THE RISK OF THE CONTRACTOR.
3. THE CONTRACTOR IS REQUIRED TO HIGHLIGHT ANY DISCREPANCIES BETWEEN THE DIGITAL TERRAIN MODEL AND INFORMATION PROVIDED IN THE CONTRACT AND/OR DRAWINGS AND IS REQUIRED TO SEEK CLARIFICATION FROM THE SUPERINTENDENT.
4. THE ENGINEER WILL NOT BE LIABLE OR RESPONSIBLE FOR THE POSSIBLE ON-GOING NEED TO UPDATE THE DIGITAL TERRAIN MODEL, SHOULD THERE BE ANY AMENDMENTS OR CHANGES TO THE DRAWINGS OR CONTRACT INITIATED BY THE CONTRACTOR.

SURVEY NOTE:

EXISTING LEVELS ARE BASED ON INFORMATION PROVIDED BY LTS SURVEYORS DATED 04/03/21.

SITE PREPARATION NOTES:

1. ALL EARTHWORKS SHALL BE COMPLETED GENERALLY IN ACCORDANCE WITH THE GUIDELINES SPECIFIED BY THE GEOTECHNICAL ENGINEER..
2. EXISTING LEVELS ARE BASED ON INFORMATION PROVIDED BY LTS SURVEYORS DATED 04/03.21.
3. STRIP ANY TOP SOIL OR DELETERIOUS MATERIAL AND DISPOSE OF FROM SITE OR STORE AS DIRECTED.
4. COMPLETE CUT TO FILL EARTHWORKS TO ACHIEVE THE REQUIRED LEVELS AS INDICATED ON THE DRAWINGS WITHIN A TOLERANCE OF +0mm/-10mm THROUGH BUILDING PADS/PAVEMENTS AND +0mm/-20mm ELSEWHERE.
5. PREPARE STEEP BATTERS TO RECEIVE FILL BY CONSTRUCTING BENCHING TO FACILITATE FILL PLACEMENT AND COMPACTION.
6. AREAS TO RECEIVE FILL (THAT ARE NOT ON BENCHED BATTERS) AND AREAS IN CUT SHALL BE PROOF ROLLED TO IDENTIFY ANY SOFT HEAVING MATERIAL. SOFT MATERIAL SHALL BE BOXED OUT AND REMOVED PRIOR TO FILL PLACEMENT. PROOF ROLLING TO BE INSPECTED BY A GEOTECHNICAL ENGINEER OR THE EARTHWORKS DESIGNER.
7. SITE WON FILL SHALL BE COMPACTED IN MAXIMUM 300mm LAYERS AND TO DRY OR HILF DENSITY RATIOS (STANDARD COMPACTION) OF BETWEEN 98% AND 103%. THE PLACEMENT MOISTURE VARIATION OR HILF MOISTURE VARIATION SHALL BE CONTROLLED TO BE BETWEEN 2% DRY AND 2% WET.
8. IMPORTED FILL SHALL BE COMPACTED IN MAXIMUM 300mm LAYERS AND TO DRY OR HILF DENSITY RATIOS (STANDARD COMPACTION) OF BETWEEN 98% AND 103%. THE PLACEMENT MOISTURE VARIATION OR HILF MOISTURE VARIATION SHALL BE CONTROLLED TO BE BETWEEN 2% DRY AND 2% WET.
9. ALL ENGINEERED FILL PARTICLES SHALL BE ABLE TO BE INCORPORATED WITHIN A SINGLE LAYER. FURTHER, LESS THAN 30% OF PARTICLES SHALL BE RETAINED ON THE 37.5 mm SIEVE. ENGINEERED FILL SHALL BE ABLE TO BE TESTED IN ACCORDANCE WITH THE STANDARD COMPACTION METHOD (AS1289.5.4.1) OR HILF TEST METHOD (AS1289.5.7.1). THESE METHODS REQUIRE LESS THAN 20% RETAINED ON THE 37.5 mm SIEVE. WHERE BETWEEN 20% AND 30% OF PARTICLES ARE RETAINED ON THE 37.5 mm SIEVE THE ABOVE TEST METHODS SHALL STILL BE ADOPTED AND TEST REPORTS ANNOTATED APPROPRIATELY. THESE REQUIREMENTS SHOULD BE MET BY THE MATERIAL AFTER PLACEMENT AND COMPACTION
10. ALL THE EARTHWORKS UNDERTAKEN AND THE SUBGRADE CONDITION IN THE CUT AREAS (IN THE STATED PERIOD) ARE DOCUMENTED IN THE REPORTS AND HAVE BEEN UNDERTAKEN IN ACCORDANCE WITH THE SPECIFICATION (EG. COSTIN ROE SITE PREPARATION NOTES IN DWG C013003.01-EWC10).
11. PRIOR TO ANY EARTHWORKS, EROSION CONTROL AS OUTLINED IN THE EROSION AND SEDIMENTATION CONTROL PLAN SHALL BE COMPLETED.
12. EXISTING ROCK, IF ANY, SHALL BE REMOVED BY HEAVY ROCK BREAKING OR RIPPING.
13. MATCH EXISTING LEVELS AT BATTER INTERFACE.
14. CONTRACTOR TO MATCH EXISTING LEVELS AT THE INTERFACE OF EARTHWORKS AND EXISTING SURFACE AT BATTER LOCATIONS OR WHERE NO RETAINING WALLS ARE PRESENT. ANY DISCREPANCY BETWEEN DESIGN AND EXISTING LEVELS TO BE REFERRED TO THE ENGINEER FOR DIRECTION OR ADJUSTMENTS TO DESIGN LEVELS.
15. DURING EARTHWORKS THE CONTRACTOR IS TO ENSURE ALL AREAS ARE FREE DRAINING & WILL NOT RETAIN WATER DURING RAINFALL. PROVIDE TEMPORARY MEASURES AS REQUIRED TO ENSURE FREE FLOWING RUNOFF THROUGH MANAGED DRAINAGE PATHS, DIVERSION DRAINS OR OTHER SUITABLE DISPOSAL METHOD AS AGREED DURING THE WORKS. REFER ANY CONCERNS TO THE ENGINEER. REFER TO EROSION AND SEDIMENT CONTROL DRAWINGS AND NOTES.



LOCALITY PLAN
NOT TO SCALE

FOR DEVELOPMENT APPLICATION

ISSUE	DESCRIPTION	DATE
A	ISSUED FOR DEVELOPMENT APPLICATION	04.02.21
B	ISSUED FOR DEVELOPMENT APPLICATION	26.03.21

AMENDMENTS	DATE	ISSUE
AMENDMENTS	DATE	ISSUE

CLIENT

PROJECT: INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA10

Costin Roe Consulting Pty Ltd.
Consulting Engineers
Level 1, 8 Windmill Street
Walsh Bay, Sydney NSW 2000
Tel: (02) 9251-7699 Fax: (02) 9241-5721
email: mail@costinroe.com.au

Costin Roe Consulting
PRECISION | COMMUNICATION | ACCOUNTABILITY

DRAWING TITLE: DRAWING LIST AND GENERAL NOTES
DRAWING No: C014203.01- DA10
ISSUE: B

SEDIMENTATION BASIN NOTE:

FOR SEDIMENT & EROSION CONTROL DETAILS REFER TO DRAWING C014203.01-DA25.

SEDIMENTATION BASIN SIZING BASED ON RECOMMENDATIONS OF 'SOILS AND CONSTRUCTION; MANAGING URBAN STORMWATER-THE BLUE BOOK'. CAPACITY BASED UPON 5 DAY RAINFALL DEPTH AT 85th PERCENTILE INTENSITY (32.2mm).

APPROXIMATE AREA OF DISTURBED SITE = 2.10ha

SEDIMENT BASIN 1:

CATCHMENT AREA	= 2.10ha
REQUIRED BASIN VOLUME	= 507m³
BASE DIMENSIONS (L X W)	= 10.0m x 20.0m
TOP DIMENSIONS (L X W)	= 19.0m x 29.0m
MAX SIDE SLOPE	= 1V:3H
DEPTH	= 1.50m
PROVIDED BASIN VOLUME	= 541m³

SEDIMENTATION BASINS TO COLLECT RUN-OFF IN EXTREME RAINFALL EVENTS. COLLECTED RUN-OFF TO BE ASSESSED BY A QUALIFIED LABORATORY FOR DOUSING RATES OF ALUM OR GYPSUM TO ENSURE COAGULATION OF SEDIMENTS PRIOR TO WATER BEING DISCHARGED TO COUNCIL STORMWATER SYSTEM.

EACH BASIN IS TO HAVE A MARKER PLACED AS PER THE DETAIL TO INDICATE WHEN SEDIMENT IS TO BE REMOVED. REMOVED SEDIMENT IS TO BE CLASSED AND DEWATERED PRIOR TO REMOVAL FROM SITE.

ALLOWANCE TO BE MADE DURING BENCHING OF SITE TO ENSURE RUN-OFF IS DIRECTED TO SEDIMENTATION BASINS.

NOTES:
1. ASSUME TYPE D SOIL (CLAY/SILTY CLAY)
2. ASSUME GROUP D SOIL (HIGH PLASTICITY AND SHRINK/SWELL PROPERTIES)

EROSION CONTROL NOTES:

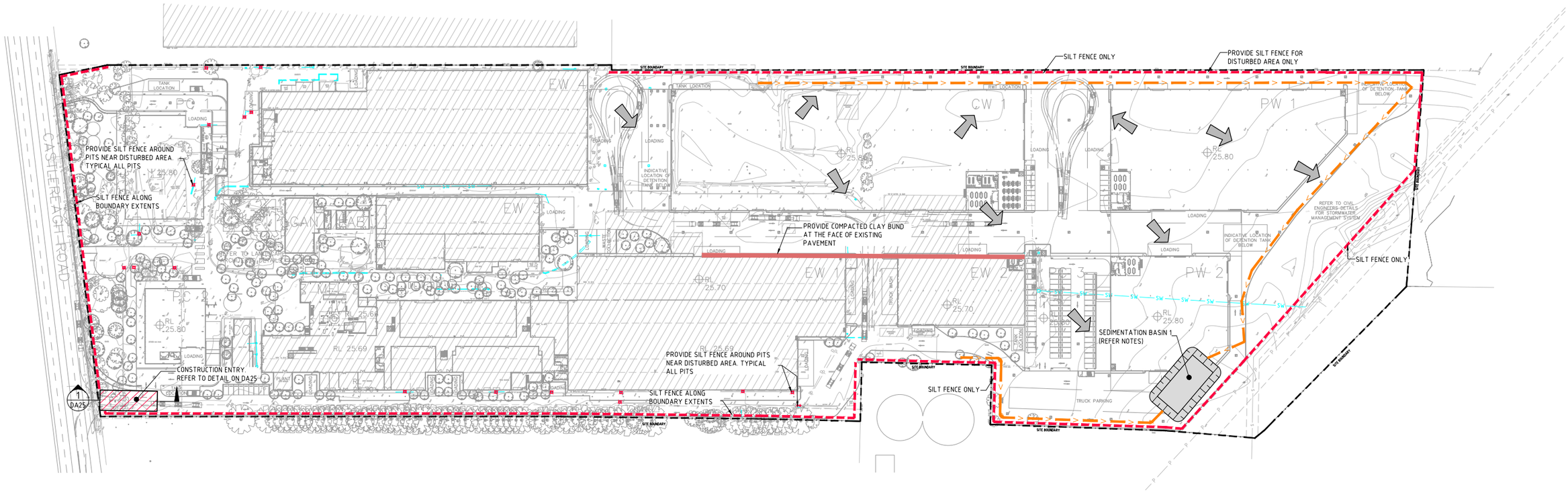
ALL CONTROL WORK INCLUDING DIVERSION BANKS AND CATCH DRAINS, V-DRAINS AND SILT FENCES SHALL BE COMPLETED DIRECTLY FOLLOWING THE COMPLETION OF THE EARTHWORKS.

1. SILT FENCES AND SILT FENCE RETURNS SHALL BE ERECTED CONVEX TO THE CONTOUR TO POND WATER.
2. HAY BALE BARRIERS AND GEOFABRIC FENCES ARE TO BE CONSTRUCTED TO TOE OF BATTER, PRIOR TO COMMENCEMENT OF EARTHWORKS, IMMEDIATELY AFTER CLEARING OF VEGETATION AND BEFORE REMOVAL OF TOP SOIL.
3. ALL TEMPORARY EARTH BERMS, DIVERSION AND SILT DAM EMBANKMENTS ARE TO BE MACHINE COMPACTED, SEEDED AND MULCHED FOR TEMPORARY VEGETATION COVER AS SOON AS THEY HAVE BEEN FORMED.
4. CLEAR WATER IS TO BE DIVERTED AWAY FROM DISTURBED GROUND AND INTO THE DRAINAGE SYSTEM.
5. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING AND PROVIDING ON GOING ADJUSTMENT TO EROSION CONTROL MEASURES AS REQUIRED DURING CONSTRUCTION.
6. ALL SEDIMENT TRAPPING STRUCTURES AND DEVICES ARE TO BE INSPECTED AFTER STORMS FOR STRUCTURAL DAMAGE OR CLOGGING, TRAPPED MATERIAL IS TO BE REMOVED TO A SAFE, APPROVED LOCATION.
7. ALL FINAL EROSION PREVENTION MEASURES INCLUDING THE ESTABLISHMENT OF GRASSING ARE TO BE MAINTAINED UNTIL THE END OF THE DEFECTS LIABILITY PERIOD.
8. ALL EARTHWORKS AREAS SHALL BE ROLLED ON A REGULAR BASIS TO SEAL THE EARTHWORKS.
9. ALL FILL AREAS ARE TO BE LEFT WITH A BUND AT THE TOP OF THE SLOPE AT THE END OF EACH DAYS EARTHWORKS. THE HEIGHT OF THE BUND SHALL BE A MINIMUM OF 200mm.
10. ALL CUT AND FILL SLOPES ARE TO BE SEEDED AND HYDROMULCHED WITHIN 10 DAYS OF COMPLETION OF FORMATION.
11. AFTER REVEGETATION OF THE SITE IS COMPLETE AND THE SITE IS STABLE IN THE OPINION OF A SUITABLY QUALIFIED PERSON ALL TEMPORARY WORK SUCH AS SILT FENCE, DIVERSION DRAINS ETC SHALL BE REMOVED.
12. ALL TOPSOIL STOCKPILES ARE TO BE SUITABLY COVERED TO THE SATISFACTION OF THE SITE MANAGER TO PREVENT WIND AND WATER EROSION.
13. ANY AREA THAT IS NOT APPROVED BY THE CONTRACT ADMINISTRATOR FOR CLEARING OR DISTURBANCE BY THE CONTRACTOR'S ACTIVITIES SHALL BE CLEARLY MARKED AND SIGN POSTED, FENCED OFF OR OTHERWISE APPROPRIATELY PROTECTED AGAINST ANY SUCH DISTURBANCE.
14. ALL STOCKPILE SITES SHALL BE SITUATED IN AREAS APPROVED FOR SUCH USE BY THE SITE MANAGER. A 6m BUFFER ZONE SHALL EXIST BETWEEN STOCKPILE SITES AND ANY STREAM OR FLOW PATH. ALL STOCKPILES SHALL BE ADEQUATELY PROTECTED FROM EROSION AND CONTAMINATION OF THE SURROUNDING AREA BY USE OF THE MEASURES APPROVED IN THE EROSION AND SEDIMENTATION CONTROL PLAN.
15. ACCESS AND EXIT AREAS SHALL INCLUDE SHAKE-DOWN OR OTHER METHODS APPROVED BY THE SITE MANAGER FOR THE REMOVAL OF SOIL MATERIALS FORM MOTOR VEHICLES.
16. THE CONTRACTOR IS TO ENSURE RUNOFF FROM ALL AREAS WHERE THE NATURAL SURFACE IS DISTURBED BY CONSTRUCTION, INCLUDING ACCESS ROADS, DEPOT AND STOCKPILE SITES, SHALL BE FREE OF POLLUTANTS BEFORE IT IS EITHER DISPERSED TO STABLE AREAS OR DIRECTED TO NATURAL WATERCOURSES.
17. THE CONTRACTOR SHALL PROVIDE AND MAINTAIN SLOPES, CROWNS AND DRAINS ON ALL EXCAVATIONS AND EMBANKMENTS TO ENSURE SATISFACTORY DRAINAGE AT ALL TIMES WATER SHALL NOT BE ALLOWED TO POND ON THE WORKS UNLESS SUCH PONDING IS PART OF AN APPROVED ESCP / SWMP.
18.

LEGEND:

PROVIDE 1m RETURNS TO SILT FENCE AT 30m MAX. INTERVALS. TYPICAL (N.S.O.P.)

- DENOTES DIVERSION DRAIN
- DENOTES SILT FENCE WITH CATCH DRAIN
- DENOTES SILT FENCE ONLY
- DENOTES COMPACTED CLAY BERM
- DENOTES CONSTRUCTION ENTRY



EROSION AND SEDIMENT CONTROL PLAN
SCALE 1:750

6m 0 15 30 45 60 75m
SCALE 1:750 AT A0 SIZE PLOT

FOR DEVELOPMENT APPLICATION

AMENDMENTS	DATE	ISSUE
ISSUED FOR DEVELOPMENT APPLICATION	26.03.21	B
ISSUED FOR INFORMATION	04.02.21	A

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA20

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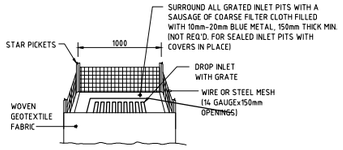
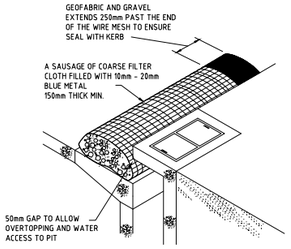
DRAWING TITLE
EROSION & SEDIMENT CONTROL PLAN

DRAWING No C014203.01- DA20 ISSUE B

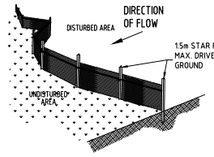


GRATED INLET PIT FILTER DETAIL
N.T.S



KERB INLET PIT CONTROL
N.T.S

NOTE : ADOPT ABOVE DETAILS AROUND ALL PITS WITHIN AREA ENCOMPASSED BY SILT FENCE & TO PITS ON THE ROAD ADJACENT TO SITE BOUNDARY.



TYPICAL SILT FENCE DETAIL
N.T.S.
PROVIDE 1m RETURNS AT 30m INTERVALS.
TYPICAL

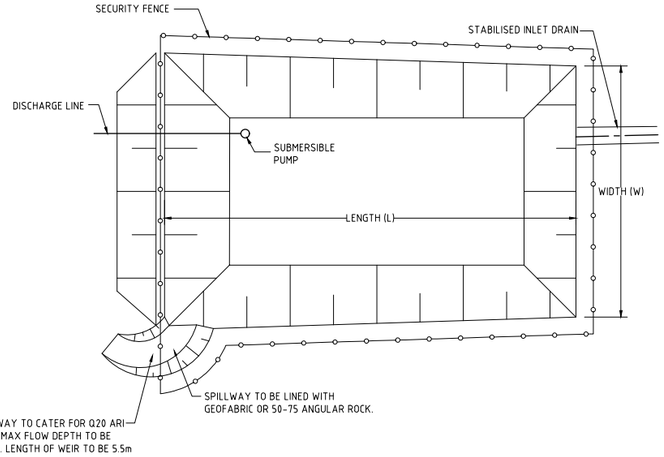
NOTES:
ALL EROSION & SEDIMENT CONTROL MEASURES TO BE INSPECTED & MAINTAINED DAILY BY SITE MANAGER.

MINIMISE DISTURBED AREAS.

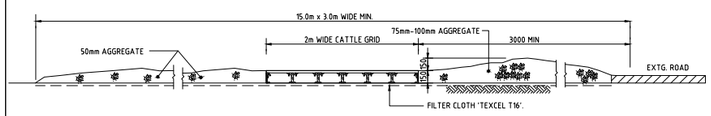
ROADS & FOOTPATHS TO BE SWEPT DAILY.

1.2m TURF TO BE PLACED BEHIND KERBS.

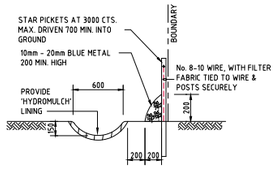
DUST MINIMISATION CONTROL BY WATERING TO BE IMPLEMENTED BY SITE MANAGER AS REQUIRED OR AS DIRECTED BY THE EPA.



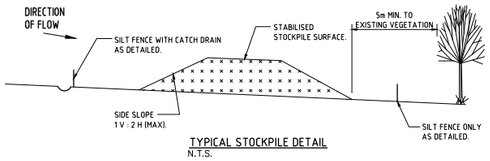
TYPICAL SEDIMENT CONTROL POND PLAN
SCALE 1:250



SECTION 1:20 (1 / DA20) : STABILISED CONSTRUCTION ENTRANCE 'TRUCK SHAKER'

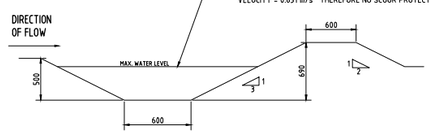


TYPICAL OPEN DRAIN & SILT FENCE
SCALE 1:20

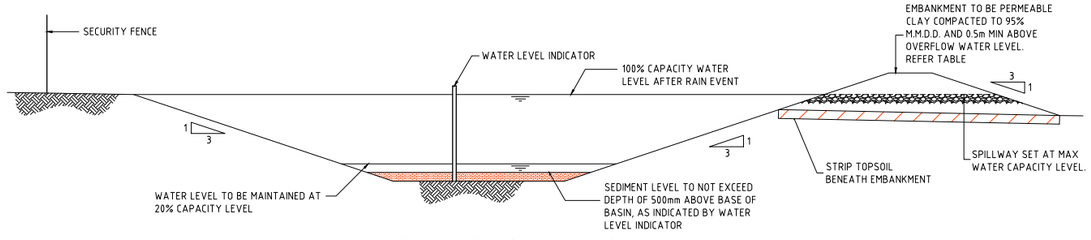


TYPICAL STOCKPILE DETAIL
N.T.S.

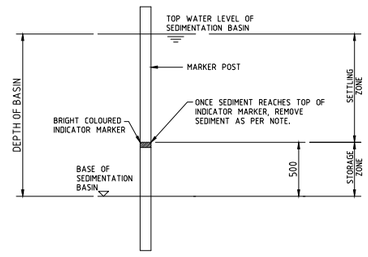
STOCKPILE NOTES
1. PLACE ALL STOCKPILES IN LOCATIONS MORE THAN 5m FROM EXISTING VEGETATION, ROADS & HAZARD AREAS.
2. CONSTRUCT ON THE CONTOUR AS LOW, FLAT ELONGATED MOUNDS. SIDE SLOPE TO BE 1 V: 2 H MAX.
3. WHERE THERE IS SUFFICIENT AREA, TOPSOIL STOCKPILES SHALL BE LESS THAN 2m IN HEIGHT.
4. WHERE STOCKPILES ARE TO BE IN PLACE FOR MORE THAN 10 DAYS, STABILISE USING WOOD CHIP MULCH - 16 TONNE/Ha.
5. CONSTRUCT SILT FENCE WITH CATCH DRAIN ON UPSLOPE SIDE TO DIVERT WATER AROUND STOCKPILES & SILT FENCE ONLY 1 TO 2m DOWNSLOPE AS SHOWN.



DIVERSION DRAIN SECTION
SCALE 1:20



TYPICAL SEDIMENT CONTROL BASIN SECTION
SCALE 1:50



SEDIMENT STORAGE MARKER
SCALE 1:20

FOR DEVELOPMENT APPLICATION

ISSUE	DATE	AMENDMENTS
B	26.03.21	ISSUED FOR DEVELOPMENT APPLICATION
A	04.02.21	ISSUED FOR INFORMATION

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA25

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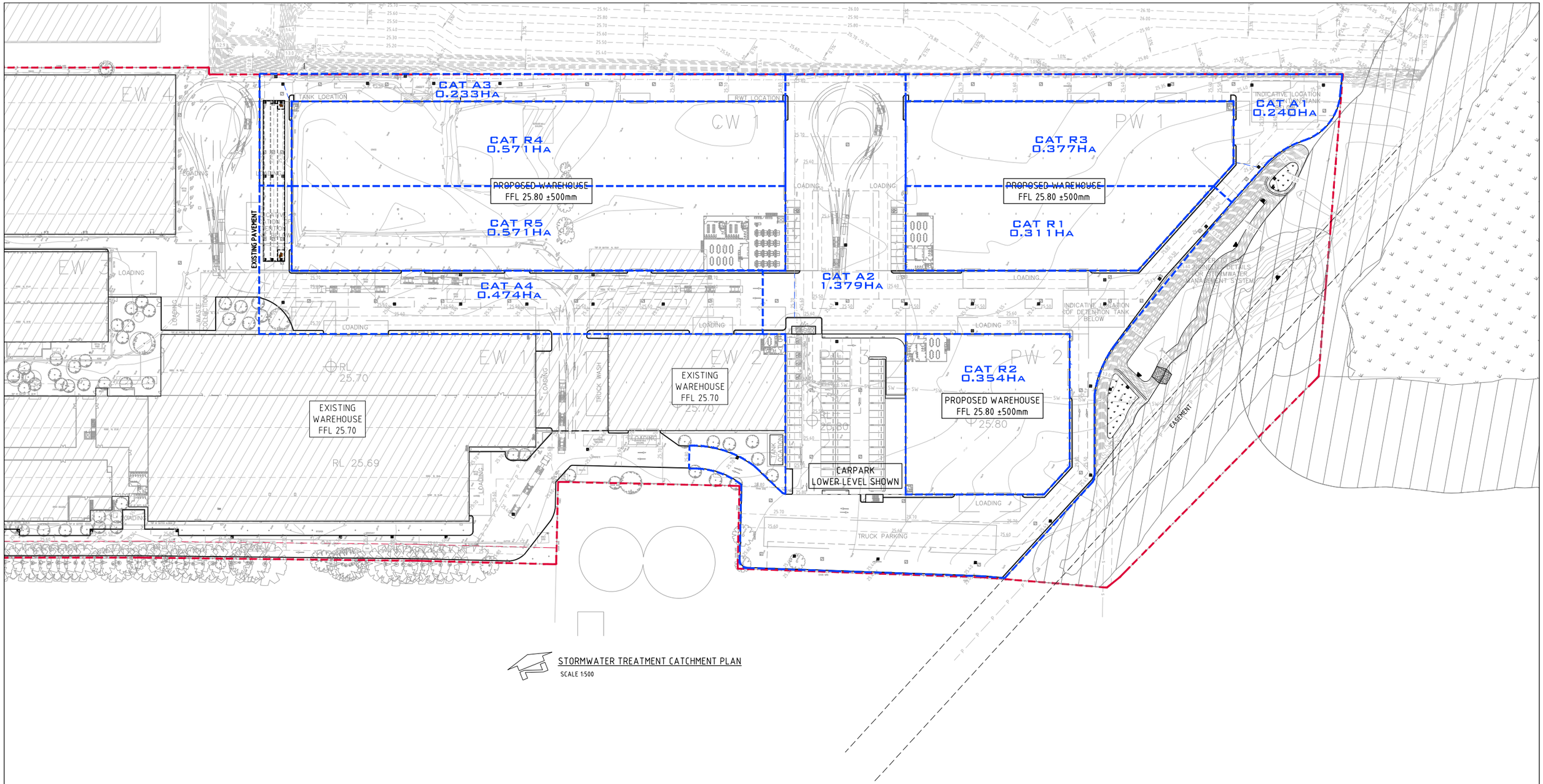
DRAWING TITLE
EROSION & SEDIMENT CONTROL DETAILS

DRAWING No C014203.01- DA25 ISSUE B



STORMWATER TREATMENT CATCHMENT PLAN
SCALE 1:500

5m 0 10 20 30 40 50m
1:500 SCALE AT A0 SHEET SIZE

FOR DEVELOPMENT APPLICATION

ISSUE	DATE
ISSUED FOR DEVELOPMENT APPLICATION	25.03.21 B
ISSUED FOR INFORMATION	04.02.21 A

AMENDMENTS | DATE | ISSUE

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
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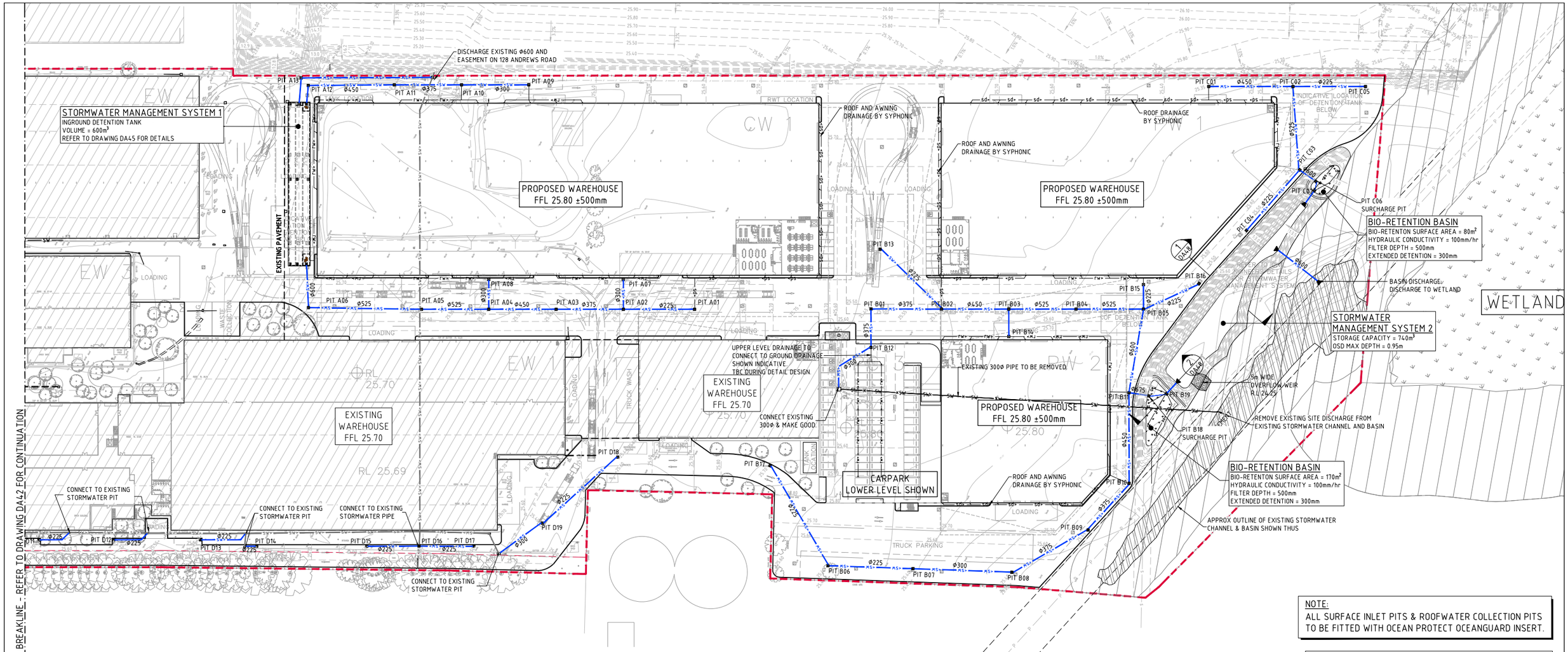
DRAWING TITLE
STORMWATER TREATMENT CATCHMENT PLAN

DRAWING No C014203.01- DA40 ISSUE B



CONCEPT STORMWATER DRAINAGE PLAN - SHEET 1

SCALE 1:500

PIT SCHEDULE - STORMWATER NETWORK 'A'

PIT No.	GRATE RL	TYPE	CHAMBER SIZE	COMMENT
PIT A01	25.45	S.G.G.P	900x900	◕
PIT A02	25.45	S.G.G.P	900x900	◕
PIT A03	25.45	S.G.G.P	900x900	◕
PIT A04	25.45	S.G.G.P	900x900	◕
PIT A05	25.45	S.G.G.P	900x900	◕
PIT A06	25.45	S.G.G.P	900x900	◕
PIT A07	25.65	S.J.P	900x900	
PIT A08	25.65	S.J.P	900x900	◕
PIT A09	25.40	S.G.G.P	900x900	◕
PIT A10	25.40	S.G.G.P	900x900	◕
PIT A11	25.40	S.G.G.P	900x900	◕
PIT A12	25.40	S.G.G.P	900x900	◕
PIT A13	25.50	S.J.P	900x900	

◕ DENOTES PIT TO BE FITTED WITH OCEAN PROTECT OCEANGUARD INSERT

PIT SCHEDULE - STORMWATER NETWORK 'B'

PIT No.	GRATE RL	TYPE	CHAMBER SIZE	COMMENT
PIT B01	25.45	S.G.G.P	900x900	◕
PIT B02	25.45	S.G.G.P	900x900	◕
PIT B03	25.45	S.G.G.P	900x900	◕
PIT B04	25.45	S.G.G.P	900x900	◕
PIT B05	25.45	S.G.G.P	900x900	◕
PIT B06	25.40	S.G.G.P	900x900	◕
PIT B07	25.40	S.G.G.P	900x900	◕
PIT B08	25.40	S.G.G.P	900x900	◕
PIT B09	25.45	S.G.G.P	900x900	◕
PIT B10	25.55	S.G.G.P	900x900	◕
PIT B11	25.55	S.G.G.P	900x900	◕
PIT B12	25.30	S.G.G.P	900x900	◕
PIT B13	25.30	S.G.G.P	900x900	◕
PIT B14	25.65	S.J.P	900x900	
PIT B15	25.65	S.J.P	900x900	
PIT B16	25.45	S.G.G.P	900x900	◕
PIT B17	25.70	S.G.G.P	900x900	◕
PIT B18	24.05	S.G.G.P	900x900	◕
PIT B19	24.35	S.G.G.P	900x900	◕

◕ DENOTES PIT TO BE FITTED WITH OCEAN PROTECT OCEANGUARD INSERT

PIT SCHEDULE - STORMWATER NETWORK 'C'

PIT No.	GRATE RL	TYPE	CHAMBER SIZE	COMMENT
PIT C01	25.35	S.G.G.P	900x900	◕
PIT C02	25.30	S.G.G.P	900x900	◕
PIT C03	25.45	S.G.G.P	900x900	◕
PIT C04	25.45	S.G.G.P	900x900	◕
PIT C05	25.30	S.G.G.P	900x900	◕
PIT C06	24.05	S.G.G.P	900x900	
PIT C07	24.35	S.G.G.P	900x900	◕

◕ DENOTES PIT TO BE FITTED WITH OCEAN PROTECT OCEANGUARD INSERT

STORMWATER DRAINAGE NOTES:

1. ALL STORMWATER WORKS TO BE COMPLETED IN ACCORDANCE WITH AUSTRALIAN STANDARD AS3500.3:2003 PLUMBING AND DRAINAGE, PART 3: STORMWATER DRAINAGE.
2. THE MINOR (PIPED) SYSTEM HAS BEEN DESIGNED FOR THE 1 IN 20 YEAR ARI STORM EVENT AND THE MAJOR (OVERLAND) SYSTEM HAS BEEN DESIGNED FOR THE 1 IN 100 YEAR ARI STORM EVENT.
3. ALL FINISHED PAVEMENT LEVELS SHALL BE AS INDICATED ON FINISHED LEVELS PLANS C014203.01-DA50.
4. PIT SIZES SHALL BE AS INDICATED IN THE SCHEDULE WHILE PIPE SIZES AND DETAILS ARE PROVIDED ON PLAN.
5. EXISTING STORMWATER PIT LOCATIONS AND INVERT LEVELS TO BE CONFIRMED BY SURVEY PRIOR TO COMMENCING WORKS ON SITE.
6. ALL STORMWATER PIPES Φ375 OR GREATER SHALL BE CLASS 2 (WITH HS2 SUPPORT) REINFORCED CONCRETE WITH RUBBER RING JOINTS UNLESS NOTED OTHERWISE.
7. ALL PIPES UP TO AND INCLUDING Φ300 TO BE uPVC GRADE SN8 UNO.
8. PIPE CLASS NOMINATED ARE FOR IN-SERVICE LOADING CONDITIONS ONLY. CONTRACTOR IS TO MAKE ANY NECESSARY ADJUSTMENTS REQUIRED FOR CONSTRUCTION CONDITIONS.
9. ALL CONCRETE PITS GREATER THAN 1000mm DEEP SHALL BE REINFORCED USING N12-200 EACH WAY CENTERED IN WALL AND BASE. LAP MINIMUM 300mm WHERE REQUIRED. ALL CONCRETE FOR PITS SHALL BE F'c=25 MPa. PRECAST PITS MAY BE USED WITH THE APPROVAL OF THE ENGINEER.
10. IN ADDITION TO ITEM 6 ABOVE, ALL CONCRETE PITS GREATER THAN 3000mm DEEP SHALL HAVE WALLS AND BASE THICKNESS INCREASED TO 200mm.
11. PIPES SHALL BE LAID AS PER PIPE LAYING DETAILS. PARTICULAR CARE SHALL BE TAKEN TO ENSURE THAT THE PIPE IS FULLY AND EVENLY SUPPORTED. RAM AND PACK FILLING AROUND AND UNDER BACK OF PIPES AND PIPE FAUCETS, WITH NARROW EDGED RAMMERS OR OTHER SUITABLE TAMPING DETAILS.
12. CONCRETE PIPES UNDER, OR WITHIN THE ZONE OF INFLUENCE OF PAVED AREAS SHALL BE LAID USING HS2 TYPE SUPPORT, AS A MINIMUM, IN ACCORDANCE WITH AS 3725. AGGREGATE BACKFILL SHALL NOT BE USED FOR PIPE BEDDING AND OR HAUNCH/SIDE SUPPORT.
13. WHERE PIPE LINES ENTER PITS, PROVIDE 2m LENGTH OF STOCKING WRAPPED SLOTTED Φ100 uPVC TO EACH SIDE OF PIPE.
14. ALL SUBSOIL DRAINAGE LINES SHALL BE Φ100 SLOTTED uPVC WITH APPROVED FILTER WRAP LAID IN 300mm WIDE GRANULAR FILTER UNLESS NOTED OTHERWISE. LAY SUBSOIL LINES TO MATCH FALLS OF LAND AND/OR 1 IN 200 MINIMUM. PROVIDE CAPPED CLEANING EYE (RODDING POINT) AT UPSTREAM END OF LINE AND AT 30m MAX. CTS. PROVIDE SUBSOIL LINES TO ALL PAVEMENT/ LANDSCAPED INTERFACES, TO REAR OF RETAINING WALLS (AS NOMINATED BY STRUCTURAL ENGINEER) AND AS SHOWN ON PLAN.
15. ALL PIPE GRADES 1 IN 200 MINIMUM UNO.
16. PROVIDE STEP IRONS IN PITS DEEPER THAN 1000mm.
17. MIN. 600 COVER TO PIPE OBVERT BENEATH ROADS & MIN. 400 COVER BENEATH LANDSCAPED AND PEDESTRIAN AREAS.
18. PIT COVERS IN TRAFFICABLE PAVEMENT SHALL BE CLASS D 'HEAVY DUTY', THOSE LOCATED IN NON-TRAFFICABLE AREAS SHALL BE CLASS B 'MEDIUM DUTY' U.N.O.
19. PROVIDE CLEANING EYES (RODDING POINTS) TO PIPES AT ALL CORNERS AND T-JUNCTIONS WHERE NO PITS ARE PRESENT.
20. DOWN PIPES (DP) TO BE AS PER HYDRAULIC ENGINEERS DETAILS WITH CONNECTOR TO MATCH DP SIZE U.N.O. ON PLAN. PROVIDE CLEANING EYE AT GROUND LEVEL.
21. PIPE LENGTHS NOMINATED ON PLAN OR LONGSECTIONS ARE MEASURED FROM CENTER OF PITS TO THE NEAREST 0.5m AND DO NOT REPRESENT ACTUAL LENGTH. THE CONTRACTOR IS TO ALLOW FOR THIS.

NOTE:

ALL SURFACE INLET PITS & ROOFWATER COLLECTION PITS TO BE FITTED WITH OCEAN PROTECT OCEANGUARD INSERT.

LEVELS NOTE:

LEVELS SHOWN TO BE ±500mm FROM THOSE SHOWN.
FINAL LEVELS SUBJECT TO FINAL GEOTECHNICAL INVESTIGATIONS, ARCHITECTURAL LAYOUT AND ACHIEVING A CUT TO FILL EARTHWORKS BALANCE OVER THE PROPERTY

LEGEND:

LEVELS DATUM IS AHD.

EXISTING SITE LEVELS AND DETAILS BASED ON SURVEY INFORMATION PROVIDED BY LTS SURVEYORS DATED 04/03.21.

- SGGP, SINGLE GRATED GULLY PIT
- SJP, SEALED JUNCTION PIT
- KIP, KERB INLET PIT
- GD, GRATED DRAIN (300W x 225D UNO)
- PROPOSED DRAINAGE LINE
- EXISTING DRAINAGE LINE
- ROOFWATER DOWNPIPE (INDICATIVE)
- ROOFWATER LINE
- SUBSOIL LINE
- OVERLAND FLOW DIRECTION
- FINISHED PAVEMENT CONTOUR (MAJOR) 0.5m INTERVALS
- FINISHED PAVEMENT CONTOUR (MINOR) 0.1m INTERVALS

5m 0 10 20 30 40 50m
1:500 SCALE AT A0 SHEET SIZE

FOR DEVELOPMENT APPLICATION

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2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
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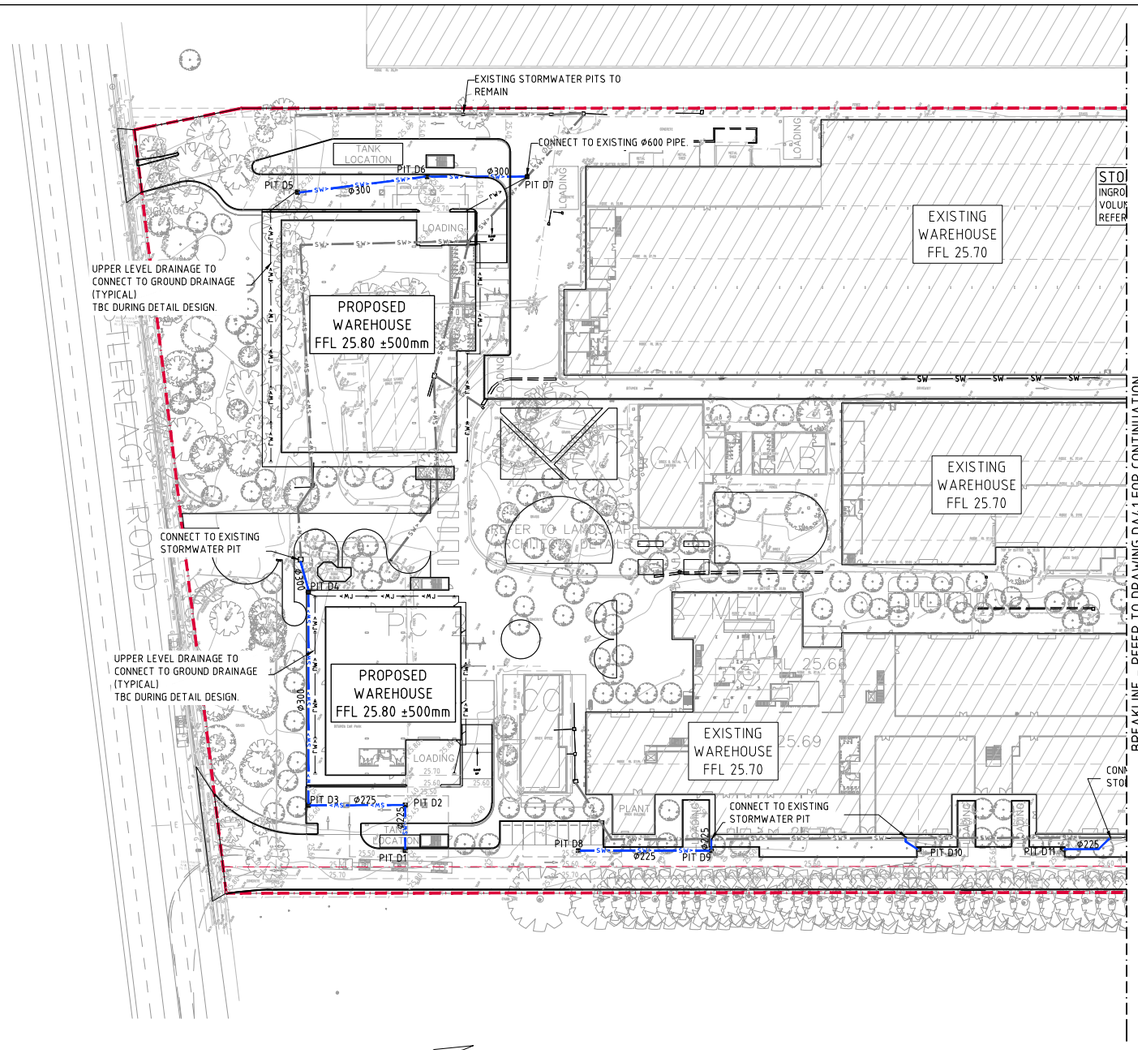
DRAWING TITLE
CONCEPT STORMWATER DRAINAGE PLAN
SHEET 1

DRAWING No C014203.01- DA41 ISSUE B



CONCEPT STORMWATER DRAINAGE PLAN - SHEET 2
SCALE 1:500

PIT SCHEDULE - STORMWATER NETWORK 'D'

PIT No.	GRATE RL	TYPE	CHAMBER SIZE	COMMENT
PIT D1	25.40	S.G.G.P	600x600	◔
PIT D2	25.40	S.G.G.P	600x600	◔
PIT D3	25.60	S.G.G.P	600x600	◔
PIT D4	25.60	S.G.G.P	600x600	◔
PIT D5	25.20	S.G.G.P	600x600	◔
PIT D6	25.30	S.G.G.P	600x600	◔
PIT D7	25.30	S.G.G.P	900x900	◔
PIT D8	25.40	S.G.G.P	600x600	◔
PIT D9	25.40	S.G.G.P	600x600	◔
PIT D10	25.40	S.G.G.P	600x600	◔
PIT D11	25.40	S.G.G.P	600x600	◔
PIT D12	25.40	S.G.G.P	600x600	◔
PIT D13	25.40	S.G.G.P	600x600	◔
PIT D14	25.50	S.G.G.P	600x600	◔
PIT D15	25.50	S.G.G.P	600x600	◔
PIT D16	25.70	S.G.G.P	600x600	◔
PIT D17	25.50	S.G.G.P	600x600	◔
PIT D18	25.40	S.G.G.P	600x600	◔
PIT D19	25.40	S.G.G.P	600x600	◔

◔ DENOTES PIT TO BE FITTED WITH OCEAN PROTECT OCEANGUARD INSERT

NOTE:
ALL SURFACE INLET PITS & ROOFWATER COLLECTION PITS TO BE FITTED WITH OCEAN PROTECT OCEANGUARD INSERT.

LEVELS NOTE:
LEVELS SHOWN TO BE ±500mm FROM THOSE SHOWN.
FINAL LEVELS SUBJECT TO FINAL GEOTECHNICAL INVESTIGATIONS, ARCHITECTURAL LAYOUT AND ACHIEVING A CUT TO FILL EARTHWORKS BALANCE OVER THE PROPERTY

NOTES:
REFER TO DRAWING DA41 FOR STORMWATER DRAINAGE NOTES.

LEGEND:
LEVELS DATUM IS AHD.

EXISTING SITE LEVELS AND DETAILS BASED ON SURVEY INFORMATION PROVIDED BY LTS SURVEYS DATED 04/03/21.

- SGGP, SINGLE GRATED GULLY PIT
- SJP, SEALED JUNCTION PIT
- KIP, KERB INLET PIT
- GD, GRATED DRAIN (300W x 225D UNO)
- PROPOSED DRAINAGE LINE
- EXISTING DRAINAGE LINE
- ROOFWATER DOWNPIPE (INDICATIVE)
- ROOFWATER LINE
- SUBSOIL LINE
- OVERLAND FLOW DIRECTION
- FINISHED PAVEMENT CONTOUR (MAJOR) 0.5m INTERVALS
- FINISHED PAVEMENT CONTOUR (MINOR) 0.1m INTERVALS

5m 0 10 20 30 40 50m
1:500 SCALE AT A0 SHEET SIZE

FOR DEVELOPMENT APPLICATION

AMENDMENTS	DATE	ISSUE
ISSUED FOR DEVELOPMENT APPLICATION	25.03.21	B
ISSUED FOR INFORMATION	23.03.21	A

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA42

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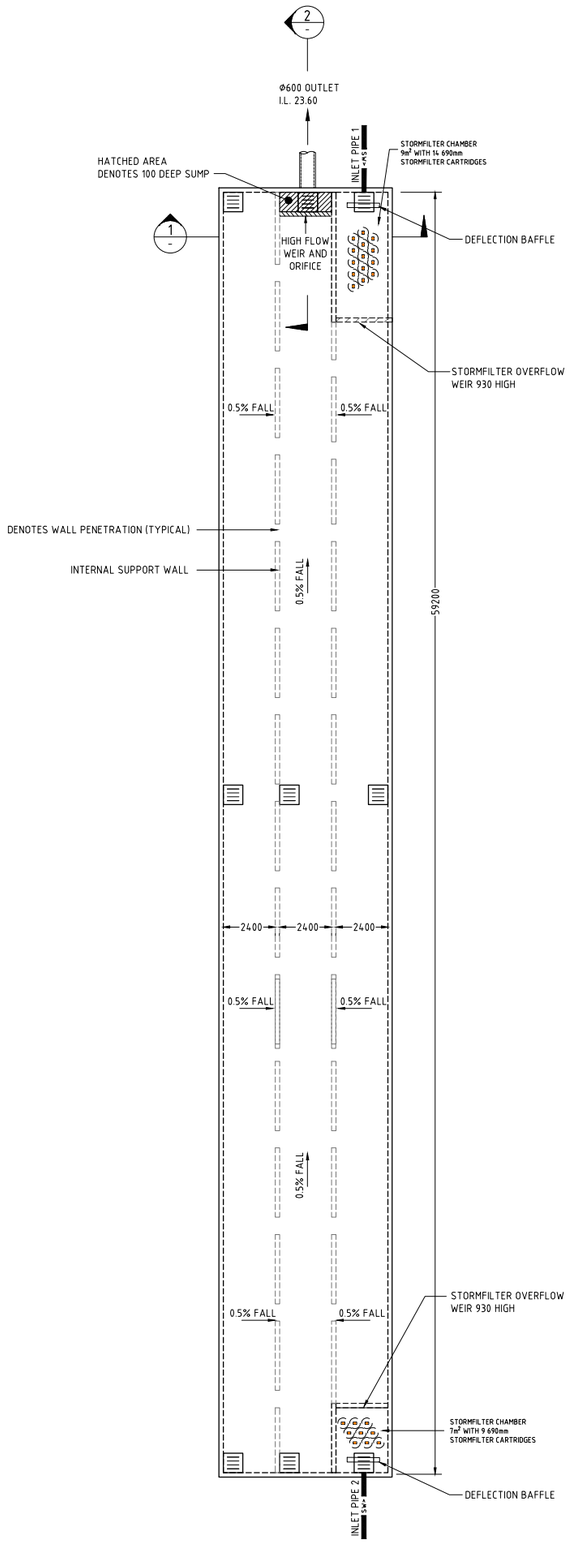
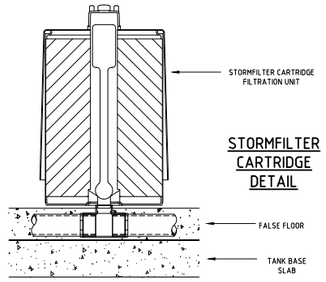
DRAWING TITLE
CONCEPT STORMWATER DRAINAGE PLAN
SHEET 2

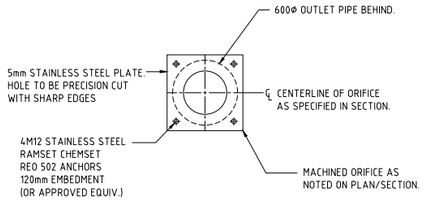
DRAWING No C014203.01- DA42 ISSUE B



OSD TANK PLAN
SCALE 1:100



STORMFILTER CARTRIDGE DETAIL



ORIFICE PLATE DETAIL
SCALE 1:20

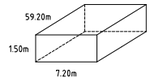
OSD TANK DETAILS

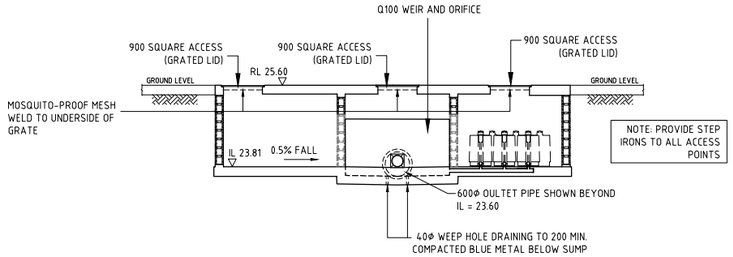
SITE AREA	
TOTAL SITE AREA	1847$0m^2$
TOTAL SITE AREA DRAINING TO STORAGE (95% IMPERVIOUS)	1847$0m^2$

STORAGE

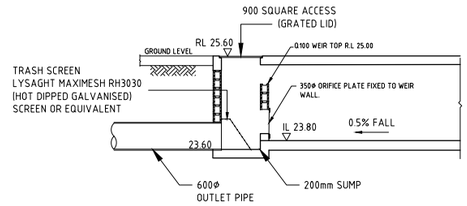
REQUIRED STORAGE	570m^3
OUTLET ORIFICE ø	350 mm
ORIFICE CENTRELINE RL	RL 23.80
VOLUME PROVIDED	600m^3

INTERNAL TANK DIMENSIONS
(INC. HIGH FLOW CHAMBERS)





SECTION 1:50 (1) : TYPICAL THRU' TANK



SECTION 1:50 (2) : TYPICAL THRU' TANK

200mm 0 500 1000 1500 2000mm
SCALE 1:20 AT A0 SIZE SHEET

500mm 0 1 2 3 4 5m
SCALE 1:50 AT A0 SIZE SHEET

1m 0 1 2 3 4 5 6 7 8 9 10m
SCALE 1:100 AT A0 SIZE SHEET

FOR DEVELOPMENT APPLICATION

ISSUE	DATE	AMENDMENTS
B	26.03.21	ISSUED FOR DEVELOPMENT APPLICATION
A	04.02.21	ISSUED FOR INFORMATION

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA45

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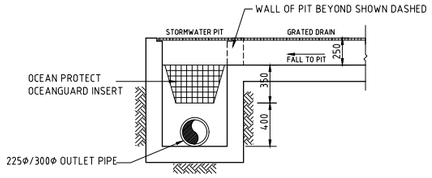
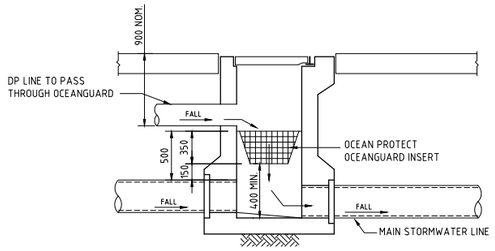
DRAWING TITLE
STORMWATER DRAINAGE DETAILS
SHEET 1

DRAWING No C014203.01- DA45
ISSUE B



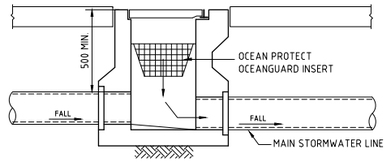
GRATED DRAIN/STORMWATER PIT WITH OCEANGUARD CONFIGURATION

SCALE 1:20



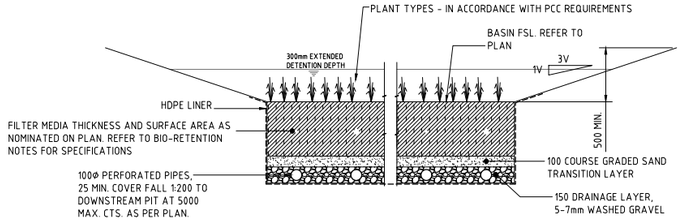
ROOFWATER/STORMWATER PIT WITH OCEANGUARD CONFIGURATION

SCALE 1:20



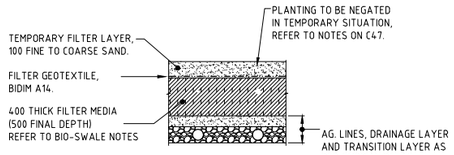
STORMWATER PIT WITH OCEANGUARD CONFIGURATION

SCALE 1:20



TYPICAL BIO-RETENTION DETAIL

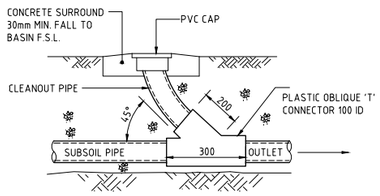
1:20



BIO-RETENTION CONSTRUCTION DETAIL

SCALE 1:20

TEMPORARY DETAIL FOR USE DURING CONSTRUCTION & SITE STABILISATION PERIOD - REFER TO NOTES FOR IMPLIMENTATION PERIODS.



CLEANOUT EYE ELEVATION

SCALE 1:20

DENOTED C.E. ON PLAN

BIO-RETENTION NOTES:

FILTER MEDIA TO BE LOAMY SAND WITH A PERMEABILITY NOT LESS THAN 200mm/hr. FILTER MEDIA TO BE FREE OF RUBBISH, DELETERIOUS MATERIAL, TOXICANTS, DECLARED PLANTS AND LOCAL WEEDS, AND IS TO NOT BE HYDROPHOBIC.

FILTER MEDIA TO HAVE THE FOLLOWING COMPOSITION RANGE:

CLAY & SILT (<0.05mm)	<3%
VERY FINE SAND (0.05-0.15mm)	5-30%
FINE SAND (0.15-0.25mm)	10-30%
MEDIUM TO COARSE SAND (0.25-1.00mm)	40-60%
COARSE SAND (1.0-2.0mm)	7-10%
FINE GRAVEL (2.0-3.4mm)	<3%

FILTER MEDIA THAT DOES NOT MEET THE FOLLOWING CRITERIA SHALL BE REJECTED:

a. ORGANIC MATTER CONTENT TO BE IDEALLY WITHIN 1% TO 3% (W/W) AND TO BE NO GREATER THAN 5%(W/W).
b. PH TO BE BETWEEN 5.5 AND 7.5
c. PHOSPHOROUS CONTENT TO BE NO GREATER THAN 35mg/kg

FILTER MEDIA TO BE ASSESSED BY QUALIFIED HORTICULTURALIST TO ENSURE CAPABILITY OF SUPPORTING PLANT LIFE.

DRAINAGE LAYER TO BE CLEAN GRAVEL 5-7mm.

PROVIDE 100mm TOPSOIL AND TEMPORARY EROSION PROTECTION (JUTEMASTER OR EQUIV) TO SWALE BATTER SLOPES AND ADJACENT LANDSCAPED AREAS. NOTE THAT NO TOPSOIL IS TO BE PLACED OVER FILTRATION MEDIA. PROVIDE SILT FENCE TO TOP OF BANK UNTIL SUCH TIME AS THIS STABILISING AND VEGETATION HAS BEEN COMPLETED.

BIO-RETENTION TO BE PARTIALLY INSTALLED, FOLLOWING COMPLETION OF THE ROAD, WITH THE TOP 75-100mm OF FILTER MEDIA REPLACED WITH A FINE TO COARSE SAND UNDERLAIN WITH A GEOTEXTILE LAYER (REFER TO DETAIL). FOLLOWING COMPLETION OF THE UPSTREAM DEVELOPMENT AND SITE STABILISATION, THE SAND IS TO BE REMOVED, REPLACED WITH FILTER MATERIAL AND PLANTED OUT. REFER TO TEMPORARY BIO-BASIN DETAIL

PRIOR TO PLANTING, THE TOP 100mm OF THE BIORETENTION FILTER MEDIA IS TO BE AMELIORATED WITH APPROPRIATE ORGANIC MATTER, FERTILISER AND TRACE ELEMENTS TO AID PLANT ESTABLISHMENT AS PER THE TABLE BELOW:

TABLE: RECIPE FOR AMELIORATING TOP 100mm OF BIORETENTION FILTER MEDIA

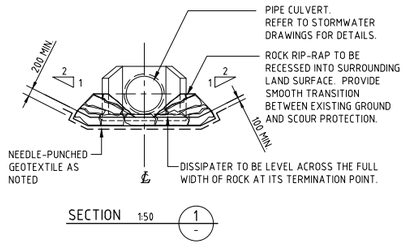
CONSTITUENT	QUANTITY (kg/m2 OF FILTER AREA)
GRANULATED POULTRY MANURE FINES	50
SUPERPHOSPHATE	2
MAGNESIUM SULPHATE	3
POTASSIUM SULPHATE	2
TRACE ELEMENT MIX	1
FERTILISER NPK (16.4.14)	4
LIME	20

DISSIPATER NOTES :

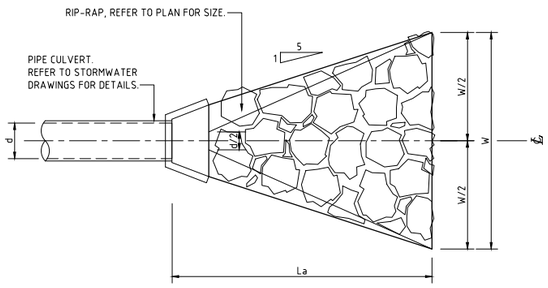
1. ALIGN STRUCTURE EVENLY WITH BANK.
2. LOCATE STRUCTURE AT INVERT LEVEL OF STREAM AND POINT IN A DOWNSTREAM DIRECTION.
3. PIPE TO REST ON, AND BE PACKED IN, BY RIP-RAP (SIZE AS NOTED).
4. DISCHARGE INTO STREAM WHERE BEDROCK IS PRESENT, OTHERWISE SCOUR PROTECT AS REQUIRED.
5. SCOUR PROTECT THE OPPOSITE BANK AS REQUIRED. SCOUR PROTECTION TO BE PROVIDED WHERE OPPOSITE BANK IS WITHIN 12-14 TIMES THE PIPE DIAMETER.
6. RIP-RAP TO CONSIST OF ANGULAR RUN-OF-QUARRY ROCK (d50= 150mm MINIMUM) AS NOTED ON THE PLAN. RIP-RAP TO BE MINIMUM THICKNESS OF RIP-RAP LAYER TO BE 1.6x AVERAGE ROCK SIZE (d50).
7. RIP-RAP IS TO BE PLACED OVER A 200mm LAYER OF 140mm COBBLES OVER NEEDLE-PUNCHED GEOFAB A44.
8. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS. THE FINISHED RIP-RAP SURFACE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS.
9. GAPS IN RIP-RAP TO BE HAND PACKED WITH TOPSOIL & PLANTED WITH NATIVE SEDGES & RUSHES TO PROVIDE. THE INTENT IS FOR THERE TO BE NO VOIDS BETWEEN RIP-RAP BOULDERS.
10. ENSURE THE FINISHED ROCK SURFACE BLENDS WITH THE SURROUNDING GROUND LEVELS. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.
11. ENSURE THAT STORMWATER FROM SURROUNDING GROUND IS FREE TO ENTER THE STRUCTURE WITHOUT CAUSING UNDESIRABLE PONDING OR SCOUR.

DISSIPATER SCHEDULE

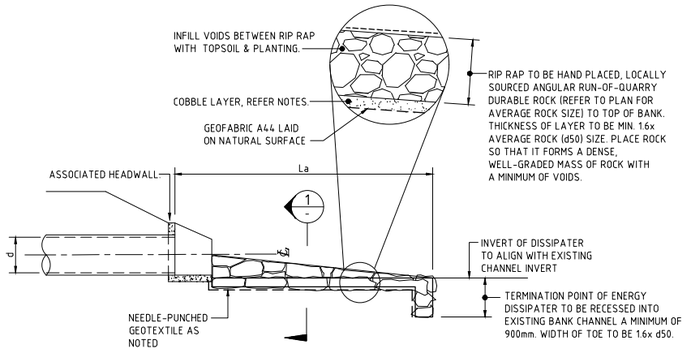
DISCHARGE POINT	d	La	W	RIP-RAP (d50)
OUTLET				



SECTION 1:50 1



PLAN



SECTIONAL ELEVATION

STORMWATER OUTLET DISSIPATER WITH HEADWALL

SCALE 1:50

200mm 0 500 1000 1500 2000mm

SCALE 1:20 AT A0 SIZE SHEET

500mm 0 1 2 3 4 5m

SCALE 1:50 AT A0 SIZE SHEET

FOR DEVELOPMENT APPLICATION

ISSUE	DATE	AMENDMENTS
B	26.03.21	ISSUED FOR DEVELOPMENT APPLICATION
A	04.02.21	ISSUED FOR INFORMATION

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA46

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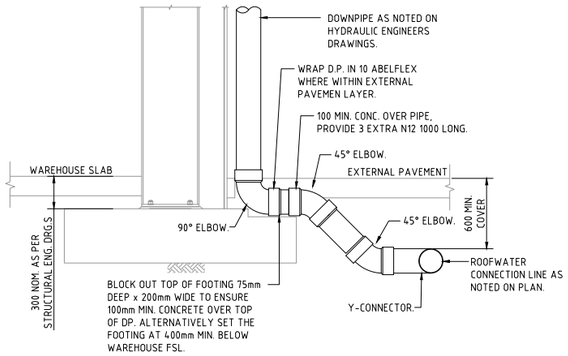
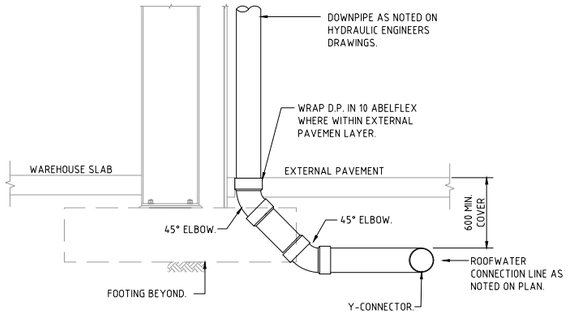
DRAWING TITLE
STORMWATER DRAINAGE DETAILS SHEET 2

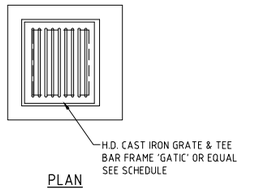
DRAWING No C014203.01-DA46 ISSUE B



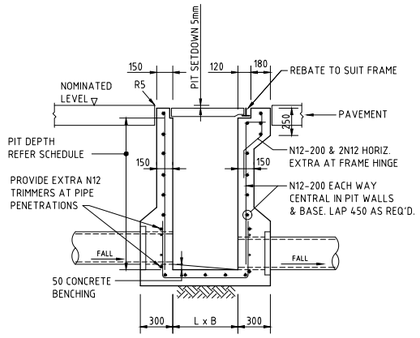
DOWNPIPE TURN-UP DETAIL A
(AT FOOTING LOCATION)
SCALE 1:20



DOWNPIPE TURN-UP DETAIL B
(CLEAR OF FOOTING)
SCALE 1:20



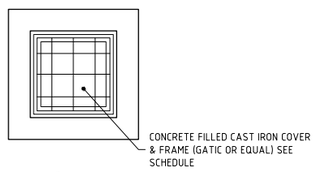
PLAN
SCALE 1:20



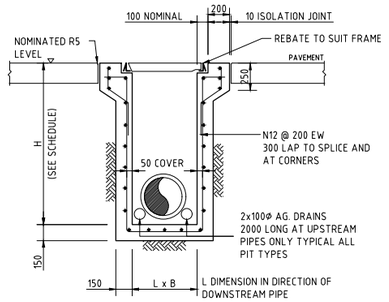
SEE SCHEDULE
L DIMENSION IN DIRECTION OF DOWNSTREAM PIPE

SECTION
SCALE 1:20

SINGLE GRATED GULLY PIT - SGGP

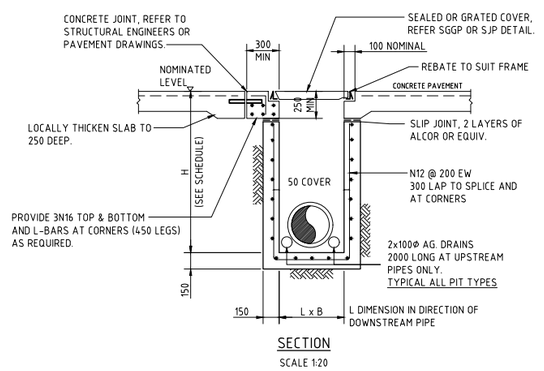


PLAN
1:20



SECTION
SCALE 1:20

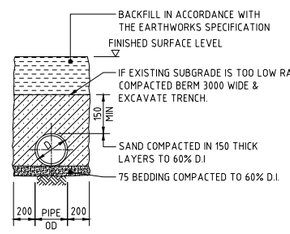
SEALED PIT - SP



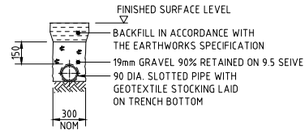
SECTION
SCALE 1:20

SJP/CIS & SGGP/CIS (CAST IN SLAB) PIT DETAIL GRATE/COVER SUPPORT CAST-INTO PAVEMENT SLAB

(ADOPT IN CONCRETE PAVEMENT FOR SGGP's & SJP's, WHERE PITS ARE LOCATED IN THE CORNER OF SLAB PANELS OR ADJACENT TO SLAB PANEL JOINTS)

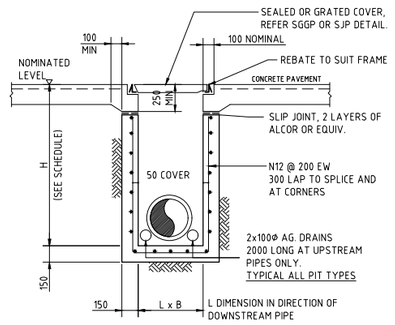


SUPPORT TO uPVC PIPES
SCALE 1:20



SUPPORT TO AGRICULTURAL DRAIN
SCALE 1:20

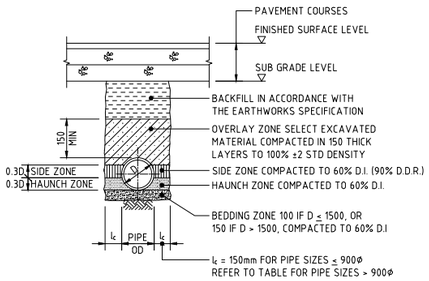
SIDE ZONE MATERIAL GRADING	
SIEVE SIZE (mm)	WEIGHT PASSING (%)
19.0	100
9.5	100 TO 50
2.6	100 TO 30
0.60	50 TO 15
0.075	25 TO 0



SECTION
SCALE 1:20

SJP/CIS & SGGP/CIS (CAST IN SLAB) PIT DETAIL GRATE/COVER SUPPORT CAST-INTO PAVEMENT SLAB

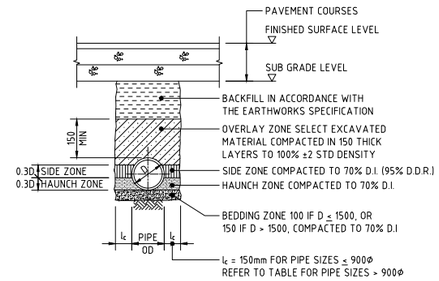
(ADOPT IN CONCRETE PAVEMENTS FOR SGGP's & SJP's, WHERE JOINTS ARE NOT LOCATED WITHIN PROXIMITY OF THE GRATE)



TYPE HS2 SUPPORT TO CONCRETE PIPES UNDER PAVEMENT
SCALE 1:20
D ≤ 1350, MAX FILL = 4.0m
D > 1350, MAX FILL = 3.0m

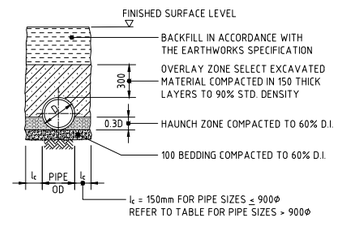
BEDDING & HAUNCH MATERIAL GRADING	
SIEVE SIZE (mm)	WEIGHT PASSING (%)
19.0	100
2.36	100 TO 50
0.60	90 TO 50
0.30	60 TO 10
0.15	25 TO 0
0.075	10 TO 0

SIDE ZONE WIDTH	
PIPE SIZE (mm)	lc (mm)
≤ 900Φ	150
1050Φ	175
1200Φ	200
1350Φ	225
1500Φ	250
1650Φ	275
1800Φ	300
ENGINEER TO SPECIFY TRENCH WIDTHS FOR PIPE SIZES GREATER THAN 1800Φ	



TYPE HS3 SUPPORT TO CONCRETE PIPES UNDER PAVEMENT
SCALE 1:20
D ≤ 1050, MAX FILL = 6.0m
D > 1050, MAX FILL = 4.8m

SIDE ZONE MATERIAL GRADING	
SIEVE SIZE (mm)	WEIGHT PASSING (%)
19.0	100
9.5	100 TO 50
2.6	100 TO 30
0.60	50 TO 15
0.075	25 TO 0
SELECT FILL MATERIAL IN ACCORDANCE WITH TABLE 1 AS 3725	



TYPE H1 SUPPORT TO CONCRETE PIPES AT LANDSCAPED AREAS
SCALE 1:20

BEDDING & HAUNCH MATERIAL GRADING	
SIEVE SIZE (mm)	WEIGHT PASSING (%)
19.0	100
2.36	100 TO 50
0.60	90 TO 50
0.30	60 TO 10
0.15	20 TO 0

SIDE ZONE WIDTH	
PIPE SIZE (mm)	lc (mm)
≤ 900Φ	150
1050Φ	175
1200Φ	200
1350Φ	225
1500Φ	250
1650Φ	275
1800Φ	300
ENGINEER TO SPECIFY TRENCH WIDTHS FOR PIPE SIZES GREATER THAN 1800Φ	

CONCRETE QUALITY					
ELEMENT	SLUMP	AGGREGATE (MAX. SIZE)	CEMENT TYPE	ADMIXTURE	F'c (MPa)
PIT	80	20	GP	NIL	25

NOTES:

1. WHERE GULLY PIT IS LOCATED ON KERB RETURNS OR BULB OF CUL-DE-SACS PROVIDE CURVED PRECAST CONCRETE LINTELS.
2. SAG PITS SHALL HAVE LINTEL PLACED CENTRALLY ABOUT THE GRATE.
3. ALL REINFORCING TO HAVE 30 MIN. CLAER CONCRETE COVER.
4. FOR PITS DEEPER THAN 1200mm CLIMB RAILS SHALL BE PROVIDED.

200mm 0 500 1000 1500 2000mm
SCALE 1:20 AT A0 SIZE SHEET

FOR DEVELOPMENT APPLICATION

ISSUE	DATE	AMENDMENTS	DATE	ISSUE	AMENDMENTS	DATE	ISSUE
ISSUED FOR DEVELOPMENT APPLICATION	26.03.21	B					
REVISED SCHEME	04.02.21	A					

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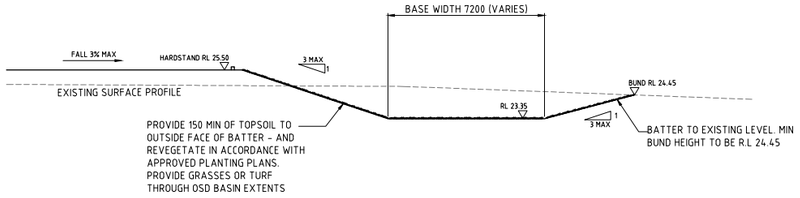
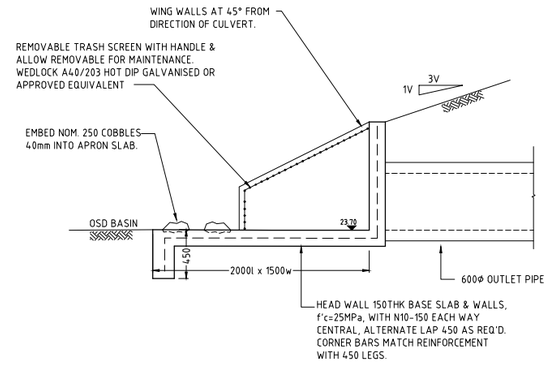
DRAWING TITLE
STORMWATER DRAINAGE DETAILS SHEET 3

DRAWING No C014203.01-DA47 ISSUE B

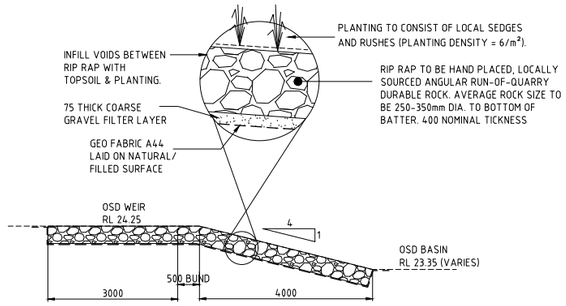


SECTION 1:100 (1 / DA41) TYPICAL THROUGH OSD BASIN



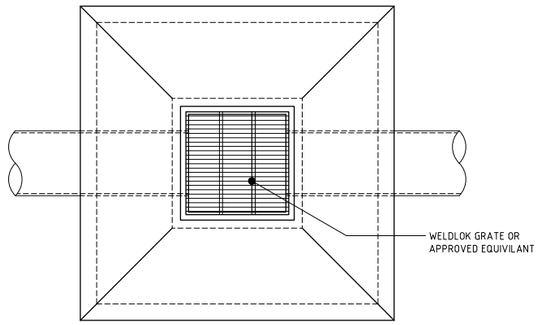
OSD BASIN OUTLET DETAIL

1:20



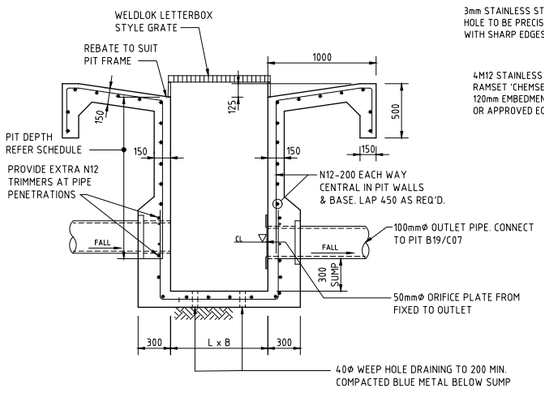
TYPICAL THROUGH BASIN 1 WEIR

SCALE 1:50



PLAN

SCALE 1:20

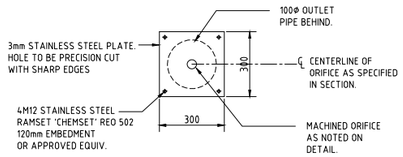


SECTION

SCALE 1:20

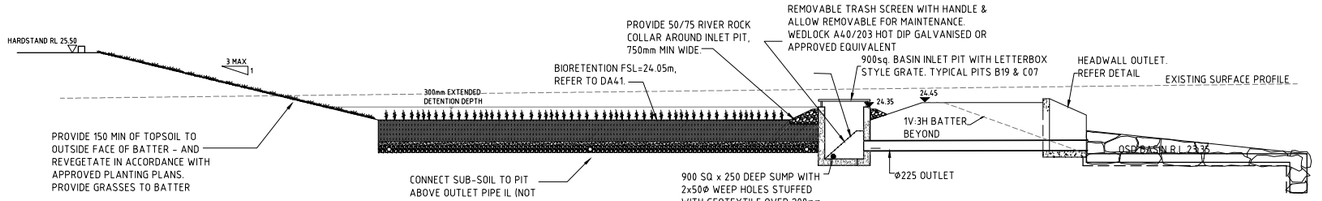
PIT B18 & C06

SURCHARGE PIT



ORIFICE PLATE DETAIL-PIT B18/C06

1:20



SECTION 1:50 (2 / DA41) TYPICAL THROUGH BIO-RETENTION BASIN

1m 0 1 2 3 4 5 6 7 8 9 10m

SCALE 1:100 AT A0 SIZE SHEET

200mm 0 500 1000 1500 2000mm

SCALE 1:20 AT A0 SIZE SHEET

500mm 0 1 2 3 4 5m

SCALE 1:50 AT A0 SIZE SHEET

FOR DEVELOPMENT APPLICATION

ISSUED FOR DEVELOPMENT APPLICATION	26.03.21	A
AMENDMENTS	DATE	ISSUE

AMENDMENTS	DATE	ISSUE

AMENDMENTS	DATE	ISSUE

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA48

Costin Roe Consulting Pty Ltd.
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Tel: (02) 9251-7699 Fax: (02) 9241-5721
email: mail@costinroe.com.au

Costin Roe Consulting

PRECISION | COMMUNICATION | ACCOUNTABILITY

DRAWING TITLE
STORMWATER DRAINAGE DETAILS SHEET 4

DRAWING No C014203.01-DA48 ISSUE A

STORMWATER MANAGEMENT SYSTEM #1
REFER TO DRAWING DA41

PROPOSED WAREHOUSE
FFL 25.80 ±500mm

PROPOSED WAREHOUSE
FFL 25.80 ±500mm

EXISTING WAREHOUSE
FFL 25.70

EXISTING WAREHOUSE
FFL 25.70

PROPOSED WAREHOUSE
FFL 25.80 ±500mm

CARPARK
LOWER LEVEL SHOWN

STORMWATER MANAGEMENT SYSTEM #2
REFER TO DRAWING DA41

BREAKLINE - REFER TO DRAWING DA52 FOR CONTINUATION

FINISHED LEVELS PLAN - SHEET 1
SCALE 1:500

LEVELS NOTE:

LEVELS SHOWN TO BE ±500mm FROM THOSE SHOWN.
FINAL LEVELS SUBJECT TO FINAL GEOTECHNICAL INVESTIGATIONS, ARCHITECTURAL LAYOUT AND ACHIEVING A CUT TO FILL EARTHWORKS BALANCE OVER THE PROPERTY

FINISHED LEVELS PLAN NOTES:

1. LEVELS DATUM IS A.H.D.
2. ALL CONTOUR LINES & SPOT LEVELS INDICATE FINISHED PAVEMENT LEVELS U.N.O. ON PLAN.
3. THE MAJOR CONTOUR INTERVAL IS 0.5m
4. THE MINOR CONTOUR INTERVAL IS 0.1m.
5. MINIMUM PAVEMENT GRADE IS TO BE 1:100 (1%).
6. MAXIMUM PAVEMENT GRADE IS TO BE 1:20 (5%) IN CARPARKING AREAS AND 1:25 (4%) ELSEWHERE.
7. MAXIMUM RAMP GRADES ARE TO BE 1:12 (8.3%) U.N.O. ON PLAN
8. PROVIDE MINIMUM 3.0m LONG TRANSITION WHERE CHANGES GRADE EXCEDE 1:20 (5%).
9. PERMANENT BATTER SLOPES ARE TO HAVE A MAXIMUM GRADE OF 1V:3H.
10. ALL BATTER SLOPES WITH GRADES AT OR EXCEDING 1V:6H ARE TO BE TURFED IMMEDIATELY, OR APPROPRIATE EROSION CONTROL IS TO BE PROVIDED TO THE SATISFACTION OF THE ENGINEER.
11. THE ACCESS ROAD TO THE HARDSTAND AREA IS TO HAVE A CROSSFALL OF 2% AS INDICATED ON PLAN.
12. ALL FOOTPATHS ARE TO FALL AWAY FROM THE BUILDING AT 2.5% NOMINAL GRADE.
13. ALL PAVEMENTS ARE TO BE SET AT 50mm BELOW THE FINISHED FLOOR LEVEL OF THE WAREHOUSE AND OFFICE AREAS.

LEGEND:

LEVELS DATUM IS AHD.

- SGGP, SINGLE GRATED GULLY PIT
- SJP, SEALED JUNCTION PIT
- KIP, KERB INLET PIT
- GD, GRATED DRAIN (300W x 225D UNO)
- 50.00 - FINISHED PAVEMENT CONTOUR (MAJOR) 0.5m INTERVALS
- 50.10 - FINISHED PAVEMENT CONTOUR (MINOR) 0.1m INTERVALS

5m 0 10 20 30 40 50m
1:500 SCALE AT A0 SHEET SIZE

FOR DEVELOPMENT APPLICATION

ISSUE	DATE	AMENDMENTS	ISSUE	DATE	AMENDMENTS	ISSUE	DATE
B	25.03.21	ISSUED FOR DEVELOPMENT APPLICATION					
A	23.03.21	ISSUED FOR REVIEW TO CLIENT					

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA51

Costin Roe Consulting Pty Ltd.
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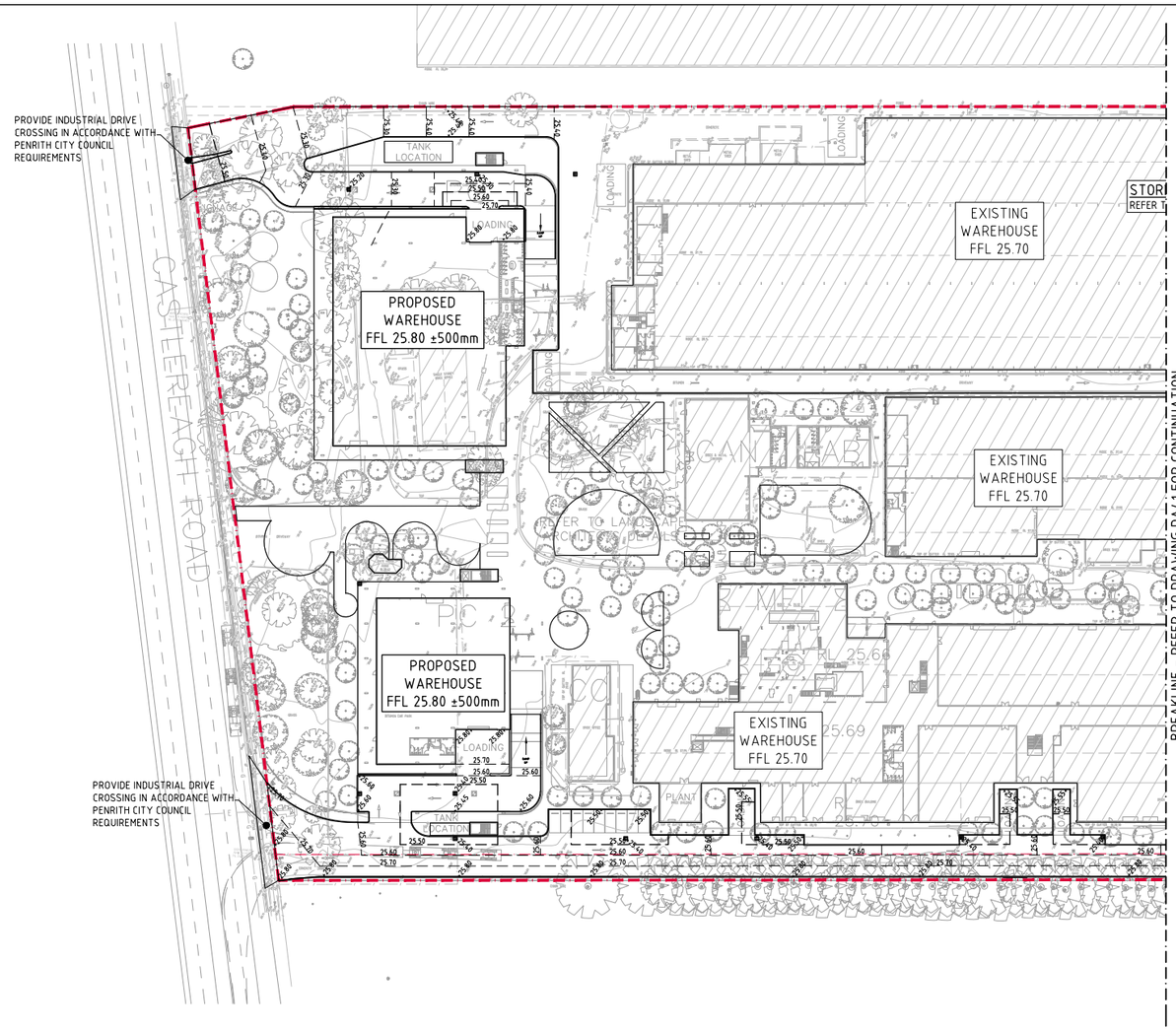
Costin Roe Consulting
PRECISION | COMMUNICATION | ACCOUNTABILITY

DRAWING TITLE
FINISHED LEVELS PLAN
SHEET 1

DRAWING No C014203.01- DA51
ISSUE A



FINISHED LEVELS PLAN - SHEET 2
SCALE 1:500

LEVELS NOTE:
LEVELS SHOWN TO BE ±500mm FROM THOSE SHOWN.
FINAL LEVELS SUBJECT TO FINAL GEOTECHNICAL INVESTIGATIONS, ARCHITECTURAL LAYOUT AND ACHIEVING A CUT TO FILL EARTHWORKS BALANCE OVER THE PROPERTY

LEGEND:
LEVELS DATUM IS AHD.

- SGGP, SINGLE GRATED GULLY PIT
- SJP, SEALED JUNCTION PIT
- KIP, KERB INLET PIT
- GD, GRATED DRAIN (300W x 225D UNO)
- 50.00 - FINISHED PAVEMENT CONTOUR (MAJOR) 0.5m INTERVALS
- 50.10 - FINISHED PAVEMENT CONTOUR (MINOR) 0.1m INTERVALS

NOTES:
REFER TO DRAWING DA51 FOR FINISHED LEVELS NOTES.

5m 0 10 20 30 40 50m
1:500 SCALE AT A0 SHEET SIZE

FOR DEVELOPMENT APPLICATION

ISSUE	DATE	AMENDMENTS	ISSUE	DATE	AMENDMENTS	ISSUE	DATE
ISSUED FOR DEVELOPMENT APPLICATION	25.03.21	B					
ISSUED FOR SCOPING	23.03.21	A					

CLIENT

PROJECT
INDUSTRIAL DEVELOPMENT
2115 CASTLEREAGH ROAD
PENRITH NSW

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	DM	FEB '21	MW	A0	AS SHOWN	C014203.00-DA52

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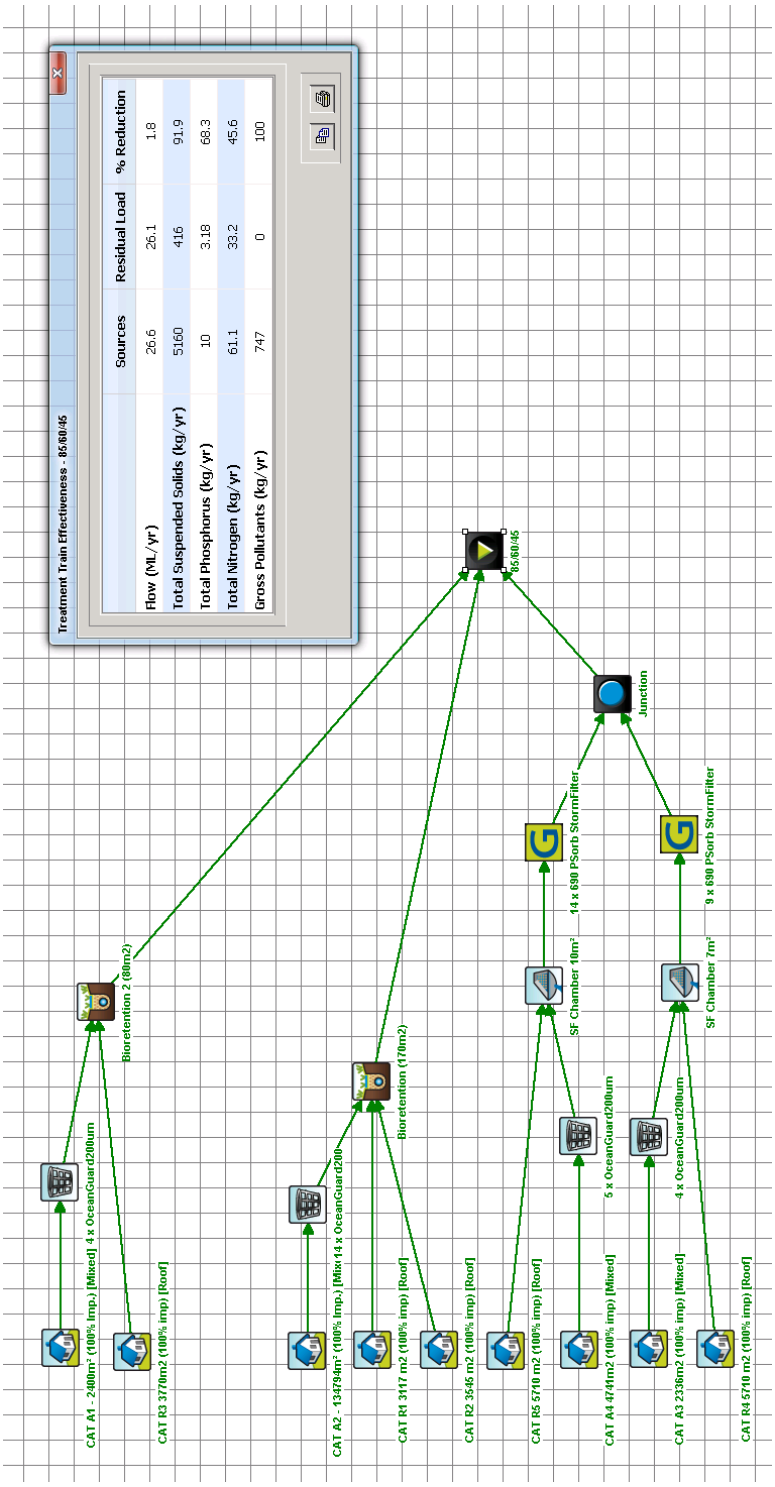
Costin Roe Consulting
PRECISION | COMMUNICATION | ACCOUNTABILITY

DRAWING TITLE
FINISHED LEVELS PLAN
SHEET 2

DRAWING No C014203.01- DA52 ISSUE A

Appendix B

MUSIC MODEL CONFIGURATION



Appendix C

EROSION & SEDIMENT CONTROL PLAN

C.1 Introduction

An erosion and sediment control plan (ESCP) is shown on drawing **Co14203.01-DA20** with details on **DA25**. These are conceptual plans only providing sufficient detail to clearly show that the works can proceed without undue pollution to receiving waters. A detailed plan will be prepared once consent is given and before works start.

C.2 General Conditions

1. The ESCP will be read in conjunction with the engineering plans, and any other plans or written instructions that may be issued in relation to development at the subject site.
2. Contractors will ensure that all soil and water management works are undertaken as instructed in this specification and constructed following the guidelines stated in Landcoms *Managing Urban Stormwater, Soils and Construction (1998) "The Blue Book"* and Penrith City Council specifications.
3. All subcontractors will be informed of their responsibilities in minimising the potential for soil erosion and pollution to down slope areas.

C.3 Land Disturbance

1. Where practicable, the soil erosion hazard on the site will be kept as low as possible and as recommended in Table C.1.

Land Use	Limitation	Comments
Construction areas	Limited to 5 (preferably 2) metres from the edge of any essential construction activity as shown on the engineering plans.	All site workers will clearly recognise these areas that, where appropriate, are identified with barrier fencing (upslope) and sediment fencing (downslope), or similar materials.
Access areas	Limited to a maximum width of 5 metres	The site manager will determine and mark the location of these zones onsite. They can vary in position so as to best conserve existing vegetation and protect downstream areas while being considerate of the needs of efficient works activities. All site workers will clearly recognise these boundaries.
Remaining lands	Entry prohibited except for essential management works	

Table C.1 Limitations to access

C.4 Erosion Control Conditions

1. Clearly visible barrier fencing shall be installed as shown on the plan and elsewhere at the discretion of the site superintendent to ensure traffic control and prohibit unnecessary site disturbance. Vehicular access to the site shall be limited to only those essential for construction work and they shall enter the site only through the stabilised access points.
2. Soil materials will be replaced in the same order they are removed from the ground. It is particularly important that all subsoils are buried and topsoils remain on the surface at the completion of works.
3. Where practicable, schedule the construction program so that the time from starting land disturbance to stabilisation has a duration of less than six months.
4. Notwithstanding this, schedule works so that the duration from the conclusion of land shaping to completion of final stabilisation is less than 20 working days.
5. Land recently established with grass species will be watered regularly until an effective cover has properly established and plants are growing vigorously. Further application of seed might be necessary later in areas of inadequate vegetation establishment.
6. Where practical, foot and vehicular traffic will be kept away from all recently established areas
7. Earth batters shall be constructed in accordance with the Geotechnical Engineers Report or with as law a gradient as practical but not steeper than:
    - 2H:1V where slope length is less than 7 metres
    - 2.5H:1V where slope length is between 7 and 10 metres
    - 3H:1V where slope length is between 10 and 12 metres
    - 4H:1V where slope length is between 12 and 18 metres
    - 5H:1V where slope length is between 18 and 27 metres
    - 6H:1V where slope length is greater than 27 metres
8. All earthworks, including waterways/drains/spillways and their outlets, will be constructed to be stable in at least the design storm event.
9. During windy weather, large, unprotected areas will be kept moist (not wet) by sprinkling with water to keep dust under control. In the event water is not available in sufficient quantities, soil binders and/or dust retardants will be used or the surface will be left in a cloddy state that resists removal by wind.

C.5 Pollution Control Conditions

1. Stockpiles will not be located within 5 metres of hazard areas, including likely areas of high velocity flows such as waterways, paved areas and driveways. Silt/ sediment fences and appropriate stabilisation of stockpiles are to be provided as detailed on the drawings.
2. Sediment fences will:
    a) Be installed where shown on the drawings, and elsewhere at the discretion of the site superintendent to contain the coarser sediment fraction (including aggregated fines) as near as possible to their source.
    b) Have a catchment area not exceeding 720 square meters, a storage depth (including both settling and settled zones) of at least 0.6 meters, and internal dimensions that provide maximum surface area for settling, and
    c) Provide a return of 1 metre upslope at intervals along the fence where catchment area exceeds 720 square meters, to limit discharge reaching each section to 10 litres/second in a maximum 20-year t_c discharge.
3. Sediment removed from any trapping device will be disposed in locations where further erosion and consequent pollution to down slope lands and waterways will not occur.
4. Water will be prevented from directly entering the permanent drainage system unless it is relatively sediment free (i.e. the catchment area has been permanently landscaped and/or likely sediment has been treated in an approved device). Nevertheless, stormwater inlets will be protected.
5. Temporary soil and water management structures will be removed only after the lands they are protecting are stabilised.

C.6 Waste Management Conditions

Acceptable bind will be provided for any concrete and mortar slurries, paints, acid washings, lightweight waste materials and litter. Clearance service will be provided at least weekly.

C.7 Site Inspection and Maintenance

1. A self-auditing program will be established based on a Check Sheet. A site inspection using the Check Sheet will be made by the site manager:
    - At least weekly.
    - Immediately before site closure.
    - Immediately following rainfall events in excess of 5mm in any 24-hour period.

    The self-audit will include:
    - Recording the condition of every sediment control device
    - Recording maintenance requirements (if any) for each sediment control device

- Recording the volumes of sediment removed from sediment retention systems, where applicable
- Recording the site where sediment is disposed
- Forwarding a signed duplicate of the completed Check Sheet to the project manager/developer for their information

2. In addition, a suitably qualified person will be required to oversee the installation and maintenance of all soil and water management works on the site. The person shall be required to provide a short monthly written report. The responsible person will ensure that:
   - The plan is being implemented correctly
   - Repairs are undertaken as required
   - Essential modifications are made to the plan if and when necessary

The report shall carry a certificate that works have been carried out in accordance with the plan.

3. Waste bins will be emptied as necessary. Disposal of waste will be in a manner approved by the Site Superintendent.
4. Proper drainage will be maintained. To this end drains (including inlet and outlet works) will be checked to ensure that they are operating as intended, especially that,
   - No low points exist that can overtop in a large storm event
   - Areas of erosion are repaired (e.g. lined with a suitable material) and/or velocity of flow is reduced appropriately through construction of small check dams of installing additional diversion upslope.
   - Blockages are cleared (these might occur because of sediment pollution, sand/soil/spoil being deposited in or too close to them, breached by vehicle wheels, etc.).
5. Sand/soil/spoil materials placed closer than 2 meters from hazard areas will be removed. Such hazard areas include and areas of high velocity water flows (e.g. waterways and gutters), paved areas and driveways.
6. Recently stabilised lands will be checked to ensure that erosion hazard has been effectively reduced. Any repairs will be initiated as appropriate.
7. Excessive vegetation growth will be controlled through mowing or slashing.
8. All sediment detention systems will be kept in good, working condition. In particular, attention will be given to:
   a) Recent works to ensure they have not resulted in diversion of sediment laden water away from them
   b) Degradable products to ensure they are replaced as required, and
   c) Sediment removal, to ensure the design capacity or less remains in the settling zone.
9. Any pollutants removed from sediment basins or litter traps will be disposed of in areas where further pollution to down slope lands and waterways should not occur.

10. Additional erosion and/or sediment control works will be constructed as necessary to ensure the desired protection is given to down slope lands and waterways, i.e. make ongoing changes to the plan where it proves inadequate in practice or is subjected to changes in conditions at the work site or elsewhere in the catchment.
11. Erosion and sediment control measures will be maintained in a functioning condition until all earthwork activities are completed and the site stabilised
12. Litter, debris and sediment will be removed from the gross pollutant traps and trash racks as required.

Appendix D

EROSION CONTROL CHECK SHEET

EROSION AND SEDIMENT CONTROL

WEEKLY SITE INSPECTION SHEET

LOCATION .....

INSPECTION OFFICER ..... **DATE** .....

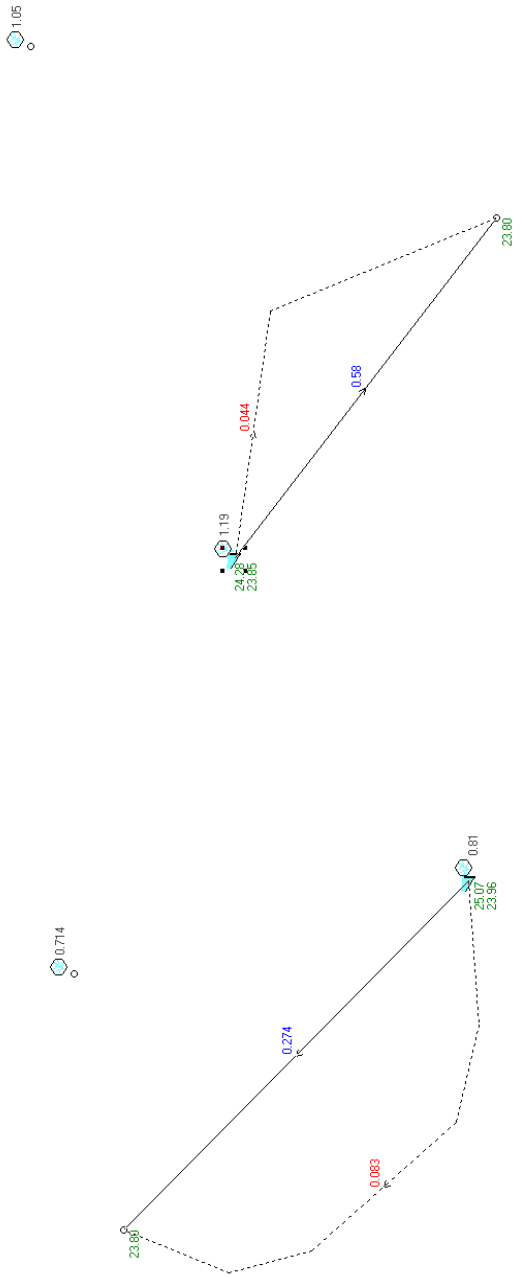
SIGNATURE .....

Legend: □ OK □ Not OK N/A Not applicable

Item	Consideration	Assessment
1	Public roadways clear of sediment.	.....
2	Entry/exit pads clear of excessive sediment deposition.	.....
3	Entry/exit pads have adequate void spacing to trap sediment.	.....
4	The construction site is clear of litter and unconfined rubbish.	.....
5	Adequate stockpiles of emergency ESC materials exist on site.	.....
6	Site dust is being adequately controlled.	.....
7	Appropriate drainage and sediment controls have been installed prior to new areas being cleared or disturbed.	.....
8	Up-slope "clean" water is being appropriately diverted around/through the site.	.....
9	Drainage lines are free of soil scour and sediment deposition.	.....
10	No areas of exposed soil are in need of erosion control.	.....
11	Earth batters are free of "rill" erosion.	.....
12	Erosion control mulch is not being displaced by wind or water.	.....
13	Long-term soil stockpiles are protected from wind, rain and stormwater flow with appropriate drainage and erosion controls.	.....
14	Sediment fences are free from damage.	.....
15	Sediment-laden stormwater is not simply flowing "around" the sediment fences or other sediment traps.	.....
16	Sediment controls placed up-slope/around stormwater inlets are appropriate for the type of inlet structure.	.....
17	All sediment traps are free of excessive sediment deposition.	.....
18	The settled sediment layer within a sediment basin is clearly visible through the supernatant prior to discharge such water.	.....
19	All reasonable and practicable measures are being taken to control sediment runoff from the site.	.....
20	All soil surfaces are being appropriately prepared (i.e. pH, nutrients, roughness and density) prior to revegetation.	.....
21	Stabilised surfaces have a minimum 70% soil coverage.	.....
22	The site is adequately prepared for imminent storms.	.....
23	All ESC measures are in proper working order.	.....

Appendix E

DRAINS MODEL CONFIGURATION



Appendix F
FLOOD ASSESSMENT

F.1 INTRODUCTION

F.1.1 Introduction

The site has been identified by Penrith City Council as being flood affected during the 1% AEP and 0.5% AEP flood events. These events are associated with overbank flooding from the Nepean River which is approximately 1km west of the development site. Reference to the *Nepean River Flood Study*, *Report* (2018) completed for Penrith City Council by Advisian.

Council requires the following to be included in the development application documents:

- *Any development shall require the submission of a flood study to assess the impact of the proposed development upon flood flow conveyance through the site for the 1% AEP and 0.5% AEP Nepean River flood events. Assessment of local overland flows is also to be undertaken. The study shall include flood level difference mapping and an assessment of safe velocity / depth ratios through the site and along the access handle.*
- *Flood safe evacuation access for the 1% AEP flood is to be provided from the development site.*
- *The development shall not have any adverse flood impacts upon adjoining properties.*
- *The application must demonstrate that the proposal is compatible with the State Government Floodplain Development Manual and Council's Local Environmental*
- *Plan and Development Control Plan for Flood Liable Lands.*
- *All habitable floor levels shall be a minimum of 0.5m above the 1% AEP flood event.*

Appendix F presents the analysis of the impact of the development on existing flooding has been completed to confirm no affectation on upstream, downstream and adjoining properties in both the 1% AEP and 0.5% AEP events and to confirm the proposed building will meet flood immunity and flood planning requirements as noted above.

Further, additional information pertaining to safe egress from the site has been included in the report to confirm rate of rise, flood action triggers and warning time available.

Data has been obtained from a number of sources and includes information required for input to the numerical models, together with information required for validation of model results and the adequate representation and presentation of those results.

F.1.2 Survey/ DTM

Survey is required to define the physical attributes of the floodplain topography including the creek cross sections and the associated floodplain levels.

The pre-development scenario survey has been compiled based on information obtained through government sources in the form of ALS survey information. The on-ground survey information was completed in and around the study area to properly define the existing overland flow path cross section and features.

The proposed development levels were then added to the pre-developed survey surface to create a post developed surface to use in the TUFLOW model and scenario modelling. This DTM was inputted into the TUFLOW model to simulate land filling and proposed compensation areas in and around the flood affected land.

The surveys and design surfaces were used as the basis for the digital terrain model (DTM) used in the hydraulic modelling of the pre and post development scenario respectively.

F.1.3 Previous Studies

A previous study of Reference to the *Nepean River Flood Study, Exhibition Draft Report* completed for Penrith City Council by Advisian (formerly Worley Parsons). Consultation was made with Councils flooding engineer Mr Myl Senthilvasan during previous development approval and modelling exercises on surrounding properties in 2017 and 2018 regarding the localised assessment relating to this project. Downstream boundary levels, flows and flood levels from the Nepean River study were utilised to calibrate and validate the model completed by Costin Roe Consulting. The modelling utilised in this application is noted to be an extension of previously agreed modelling used in approved developments on 128 Andrews Road.

It is also noted that a previous development application upon the 128 Andrews Road site by Iplex Pipelines approved under DA13/1174 included a flood study for the site prepared by Worley Parsons (reference 301015-02973-IPLEX FIA, dated 18 September 2014). The 2017 Nepean River study, completed by the same consultants, precedes the 2014 study and although the 2014 study provides good background information has not been utilised in our assessment.

The 2018 *Nepean River Flood Study* was utilised to validate hydrological and flood surface results produced in our assessment for the pre-developed condition. It can be seen when comparing the flood depth results of the Costin Roe Consulting model with the output from the 2018 Flood Study that the results are generally consistent and that the Costin Roe Consulting model is suitable for use in modelling post development scenarios.

F.2 CATCHMENT INVESTIGATION & HYDROLOGY

F.2.1 Contributing Catchment Definition

The Nepean River is located approximately 800 metres west of the proposed site. The river flows south to north through Penrith until it reaches the Penrith Lakes Scheme and International Regatta Centre, at which point it veers sharply west. This change in direction of the river is located directly west of the development site.

Due to the location of the site in close proximity to the Nepean River there is potential during large floods for floodwaters to overtop the banks of the river and inundate the adjoining floodplain and parts of the site. Detailed two-dimensional modelling completed as part of the *Nepean River Flood Study* indicated that extensive flooding will occur across areas east of Castlereagh Road where the site is located.

The contributing catchment associated with the site flooding is associated with the overtopping with the Nepean River banks and has been extrapolated from the Table 7 of the *Nepean River Flood Study* as a percentage of the total flow within the Nepean River floodwaters.

F.2.2 Hydrological Assessment of Existing Catchment

Flood hydrographs for the different flood events were required to be confirmed. Utilising the flood hydrograph defined in *The Nepean River Flood Study* in Table 7, a percentage of the total flow is shown overtopping the river banks at Castlereagh Road. This percentage was applied to the overall Nepean River flood hydrograph to model flows affecting the proposed site. Inflow hydrographs were extrapolated for the 1% AEP and 0.5% AEP events as shown in **Figure F1** and **Figure F2**. Local rainfall was not considered in this assessment and the inflow hydrograph only allows for flooding from the Nepean River.

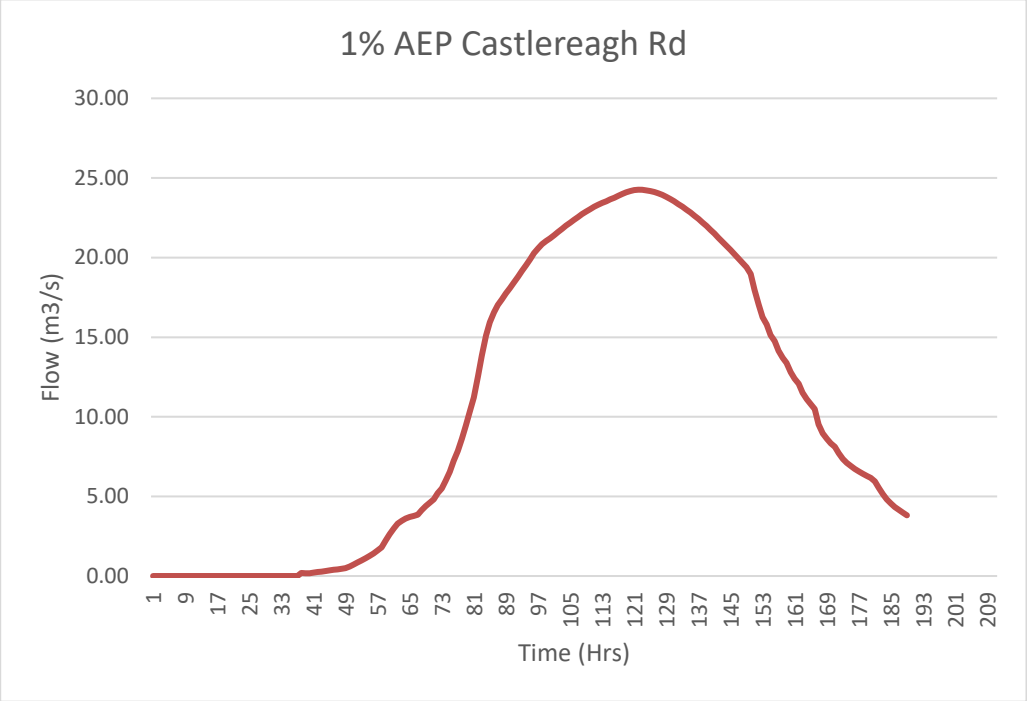


Figure F1 1% AEP Inflow Hydrograph

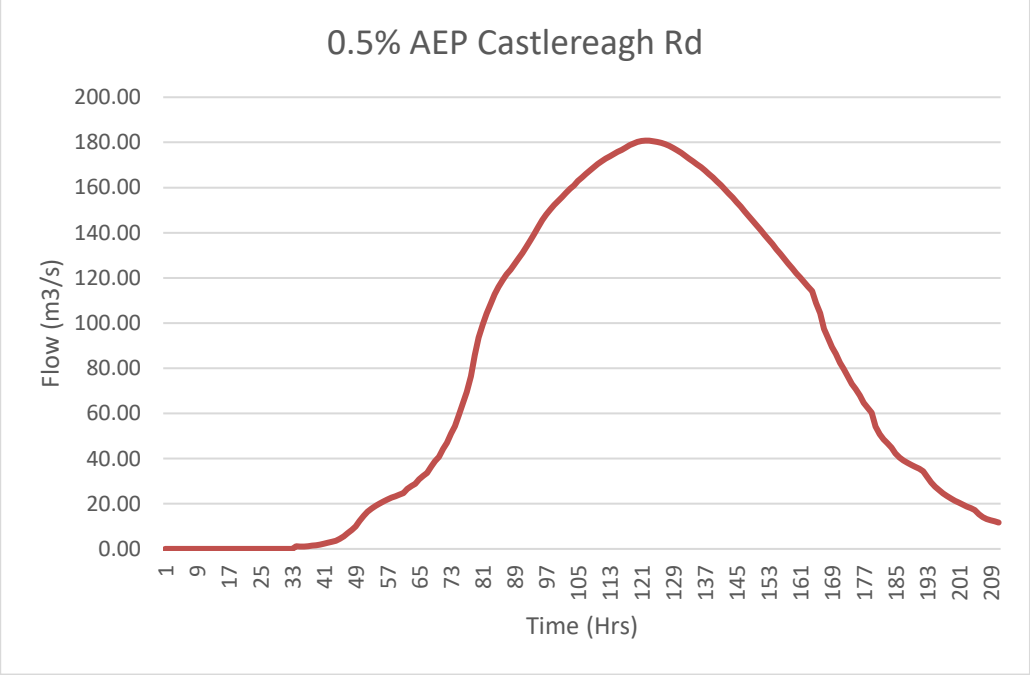


Figure F2 0.5% AEP Inflow Hydrograph

F.3 HYDRODYNAMIC MODEL DEVELOPMENT

F 3.1 Flood Behaviour

The proposed development site is affected by overbank flooding from the Nepean River within an area described in the *Nepean River Flood Study* as the "*Andrews Road Corridor"*. The flood behaviour of the site and surrounding industrial area is described in *Section 9.1.4* of the *Nepean River Flood Study*. A summary of the flood behaviour as described by Advisian is included for information as follows.

> *The Andrews Road corridor follows a relict flowpath along the eastern edge of the valley running northwards from Boundary Creek. It currently emanates as a backwater breakout from the creek at the rear of the Penrith Sewerage Treatment Plant (STP) and traverses across Andrews Road, through the Waterside lakes, under Castlereagh Road just south of Cranebrook, then through the North Pond and Duralia Lake, and eventually draining into Penrith Lakes Main Lake A, Figure 47.*
>
> *Under the normal operating levels of the eastern lakes within the Penrith Lakes Scheme, there is insufficient volume of overflow along the Andrews Road corridor for the 100yr ARI flood to completely fill Duralia Lake, and thus the peak 100yr ARI level in Cranebrook village and Waterside is sensitive to both the volume and the initial level of the lakes. The 200yr ARI and higher floods experience a fully connected flowpath between Boundary Creek and Main Lake A, Figure 46.*
>
> *The Boundary Creek breakout occurs at a Penrith gauge level of RL 25.5m and subsequent behaviour is detailed as follows,* ***Table 14****.*

In regard to the proposed site it is noted that the site is not affected during the 1 in 50 year ARI storm event and that lead times, based on the maximum rate of rise of 0.7m/hour between 19, 12 and 5hours will be available for egress following SES/ BOM minor, moderate and major flood warnings. Further discussion on egress from the site is discussed in **Section F5**.

Table 14 - Andrews Road flow corridor, flood behaviour

Time Relative to Breakout	Flood Behaviour
0 hours (breakout level RL 24.7m)	Some industrial properties along the creek are affected
+ 2.8 hrs (25.01m)	Flow has expanded across the flowpath, connected through to Lambridge Place, overtopped Andrews Road and extended up Castlereagh Road while the Waterside lakes have been filling
+ 3.5 hrs (25.15m)	The Waterside lakes have filled and flow has crossed Nepean Street.
+ 5.8 hrs (25.58m)	Flow has connected through the Bebo arch culvert under Castlereagh Road into the North Pond within Penrith Lakes. Peachtree Creek, and the river north of Boundary Creek Have overtopped, inundating more of the industrial properties
+ 6.3 hrs (25.71m)	The North Pond has overflowed into Duralia Lake and Cranebrook Village has become affected
+ 7.0 hrs (25.89m)	Main Lake A overtops into Duralia Lake
+ 8.3 hrs (26.17m)	Access to Andrews Road from Waterside has been cut along Laycock Street.
+ 8.5 hrs (26.22m)	Main Lake A and Duralia Lake levels equalise, after which Duralia Lake remains slightly higher.

Note: Thea above times and levels at the breakout are based on the PMF design flood which has the fastest rate of rise.

F 3.2 Extent and Topography

The model extent is shown in **Figure F.9** of this appendix. The model begins approximately 920m upstream of the development and extending approximately 520m to the north.

F.3.3 Boundary Conditions

Inflow Boundaries

Design inflow hydrographs for the model have been included at a location approximately 920m upstream of the development site with the flows based on hydrology as discussed in **Section F.2** of this Appendix.

The upstream boundary was located sufficiently upstream of the development to ensure the extent of predicted impacts from the development would be covered and any modelling iterations would be resolved clear of the development affectation zone.

Downstream Water Level Boundaries

Downstream boundary location has been included at a distance of approximately 520m downstream of the study area. The downstream water levels have been based on flood levels included in the *Nepean River Flood Study* as follows:

AEP	Boundary Level (m)
1%	24.0
0.5%	25.0

Table F2. Downstream Boundary Water Levels.

Refer **Figure F.3** on following page.

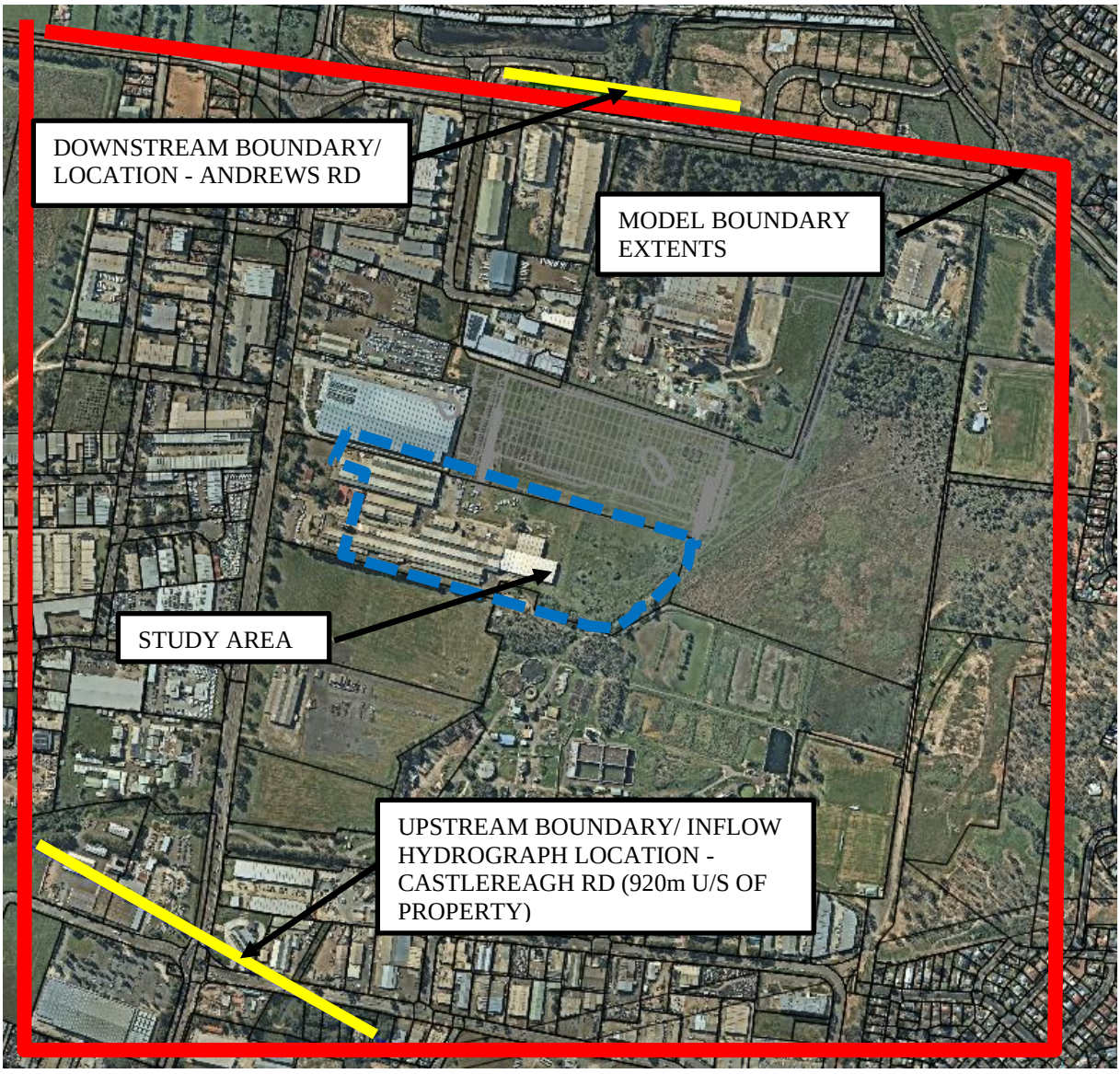


Figure F3. Model Extent and Model Boundary Locations

F.3.4 Channel and Floodplain Roughness

Roughness values adopted in the model are contained in **Table F3** below. These are generally consistent with those included in the *Table 2* of the *Nepean River Flood Study*, except where adjusted to ensure validation of model results and achieving consistency with the results of the *Nepean River Flood Study*.

Table F3. Adopted TUFLOW Element Roughness Values

Model Element	Description	Roughness Parameter Value (Nepean River Flood Study	Roughness Parameter Value (TUFLOW Study)
1	Grassland	0.04	**0.04**
2	Bushland	0.05	**0.05**
3	Roads	0.03	**0.03**
4	Buildings	Block Out	**10.0**
5	Industrial Area	0.07	**0.07**

A figurative representation of where the above roughness values have been applied can be found in **Figure F4.**

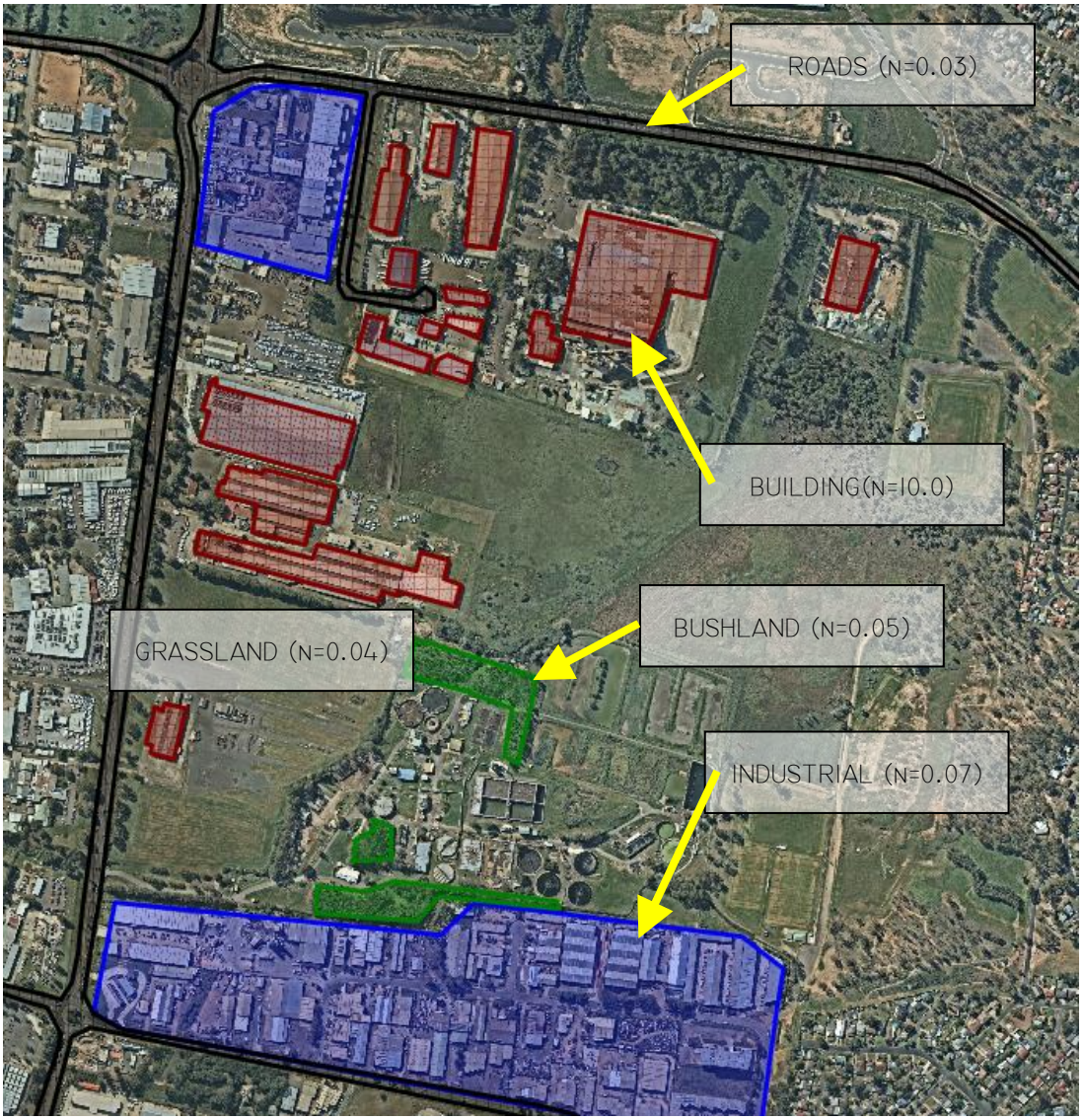


Figure F4 Manning's Roughness Surface Areas

F.3.5 Model Validation

Model validation has been completed by comparing results of the TUFLOW modelling against the results contained in the *Nepean River Flood Study* and adjusting as required to achieve good agreement between the two models. The process for the validation was as follows:

- Establish hydrology, peak flows and hydrograph for modelled events;
- Establish TUFLOW Model using defined parameters;
- Compare results of TUFLOW modelling with South Creek Study including flood depths, flood levels (taking into account the use of consistent DTM's), flood extents and hydraulics. The comparison is made at the peak of the predicted parameters;

- Adjust roughness factors to align TUFLOW flood depths and to within 100mm of *Nepean River Study* Results.

Hydrology and peak flows were established as described in **Section F2** of this report. The hydrological information used in the TUFLOW model is consistent with those of the Nepean River Study.

A number of trial models and iterations of the TUFLOW model were performed. Adjustment of roughness parameters were used to align the flood levels with those compiled in the Nepean River Study.

The comparison of the flood level results shows good alignment of those produced in the TUFLOW model when compared with those of the Nepean River Study. Flood water levels were seen to have a difference less than 100mm and generally in the order of 30-70mm through the floodplain areas. The predicted flood extent is consistent between the two models for the different flood events modelled.

Given the differences in modelling techniques, parameters, predicted model accuracy (+/-200mm) and model components these differences are considered acceptable for the base model and for continuation of post-developed scenario modelling.

F.4 MODEL OUTPUT

Model output for pre and post development conditions for the Nepean River flooding events as discussed in earlier sections have been included in the following Figures.

We note figures represent predicted values at the peak of each event.

The model output shows that the 1% AEP level is RL25.28m AHD and the 0.5% AEP flood level is 25.94m AHD.

The assessment shows that sufficient a flood-way is available during the 0.5% AEP event. Further that flood afflux is negligible during the 1% AEP event, and within council recommendations during the 0.5% AEP event. The modelling output also shows a minor afflux in flood levels of 250mm during the 0.5% AEP post developed flooding events locally within the site boundaries and dedicated flow paths. This would be considered acceptable in terms of the requirements of Councils Part C3 DCP and Clause 7.2 of the LEP2010.

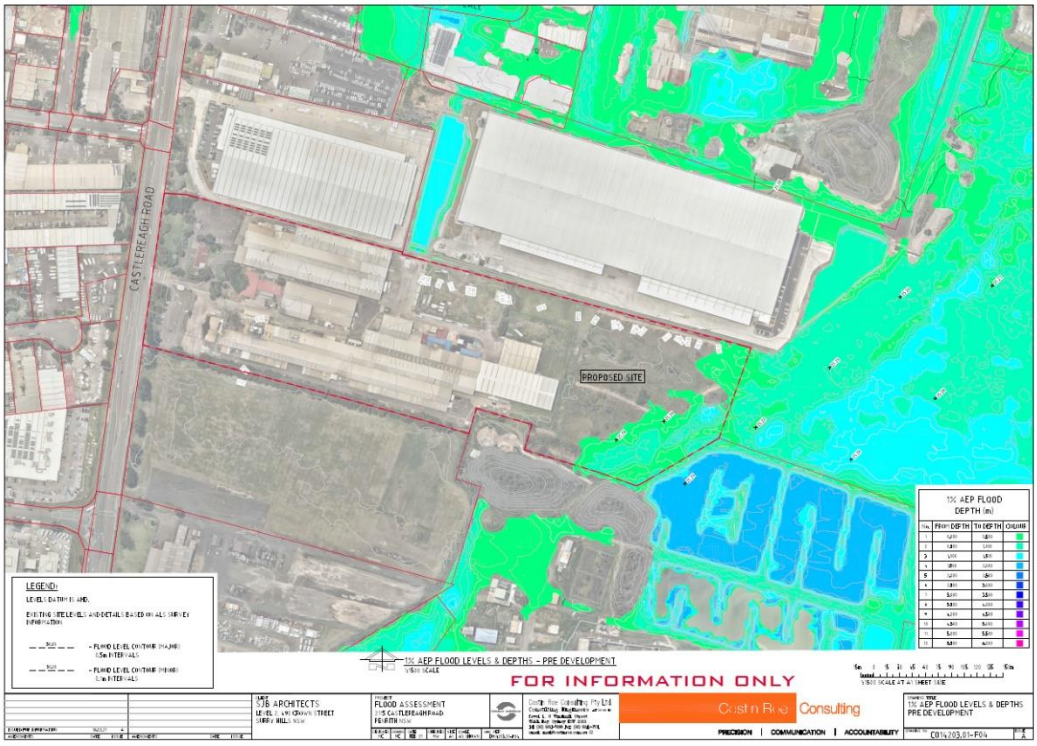


Figure F5 – 1% AEP Flood Depths – Pre-Development

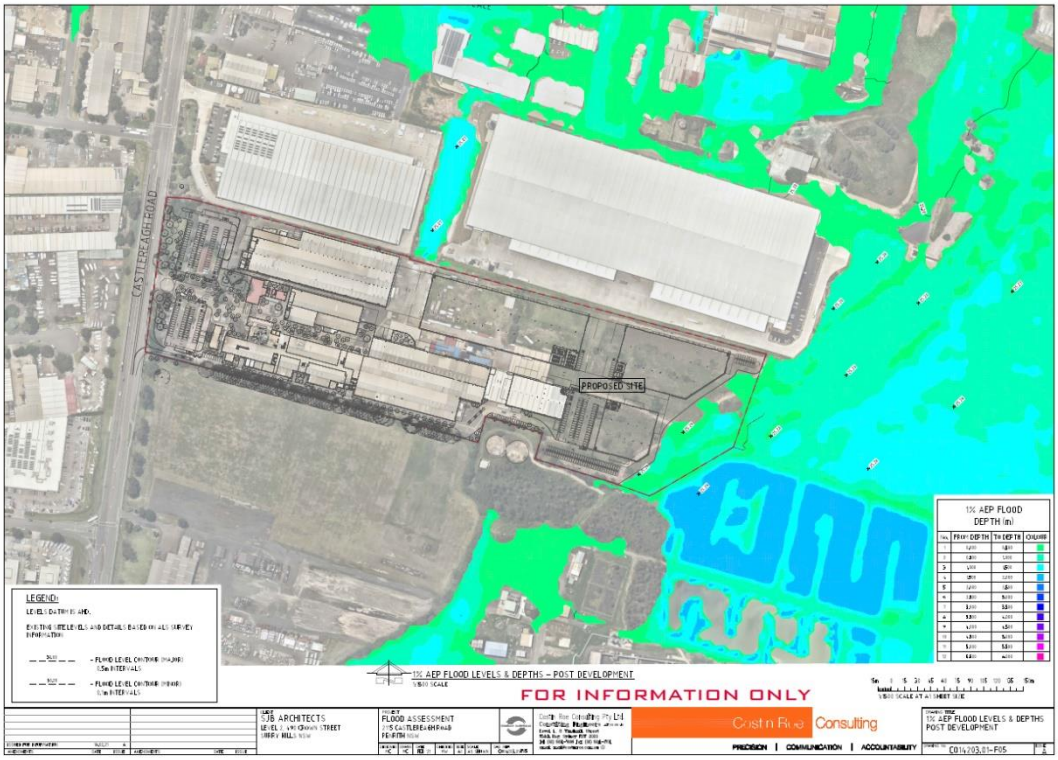


Figure F6 – 1% AEP Flood Depths – Post Development

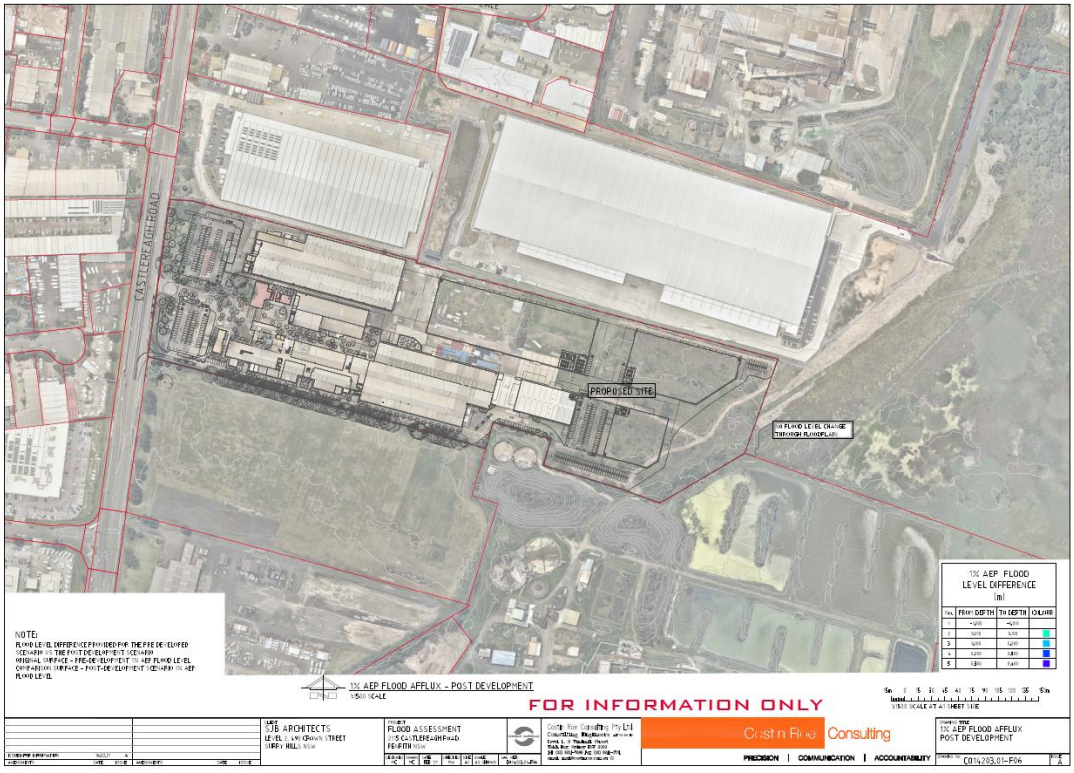


Figure F7 – 1% AEP Flood Level Afflux

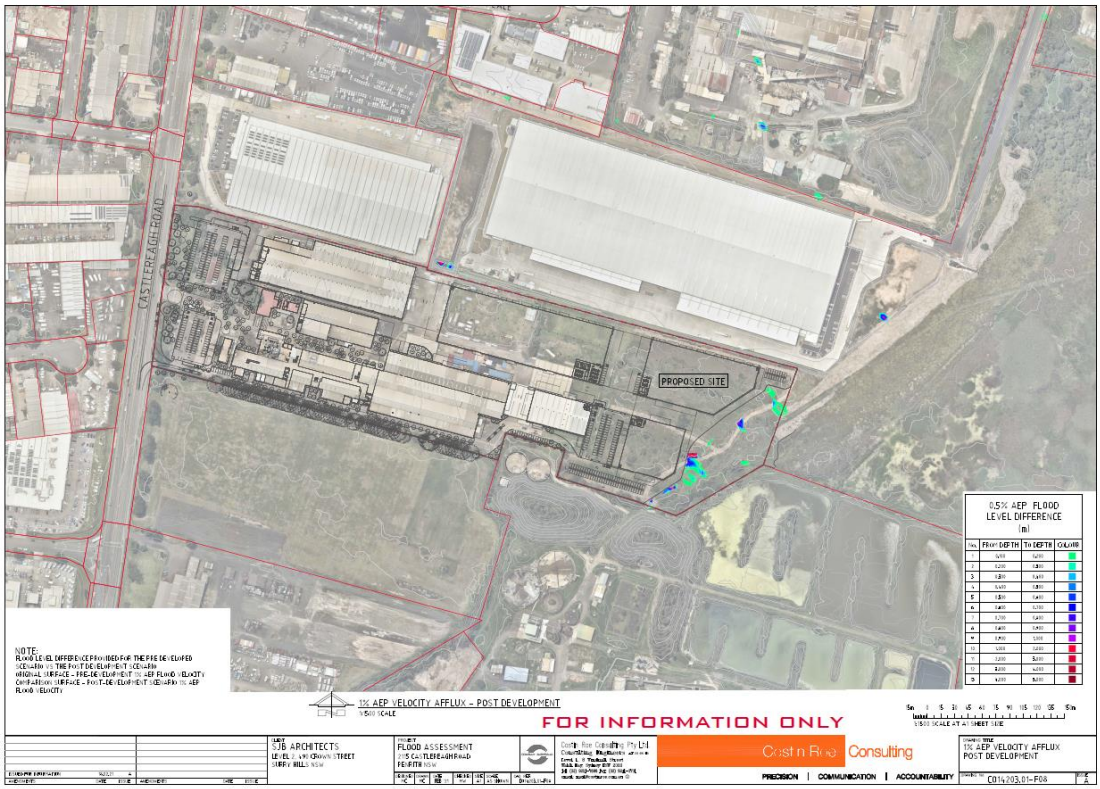


Figure F8 – 1% AEP Flood Velocity Afflux

Figure F9 – 0.5% AEP Flood Depth & Level – Pre-Development

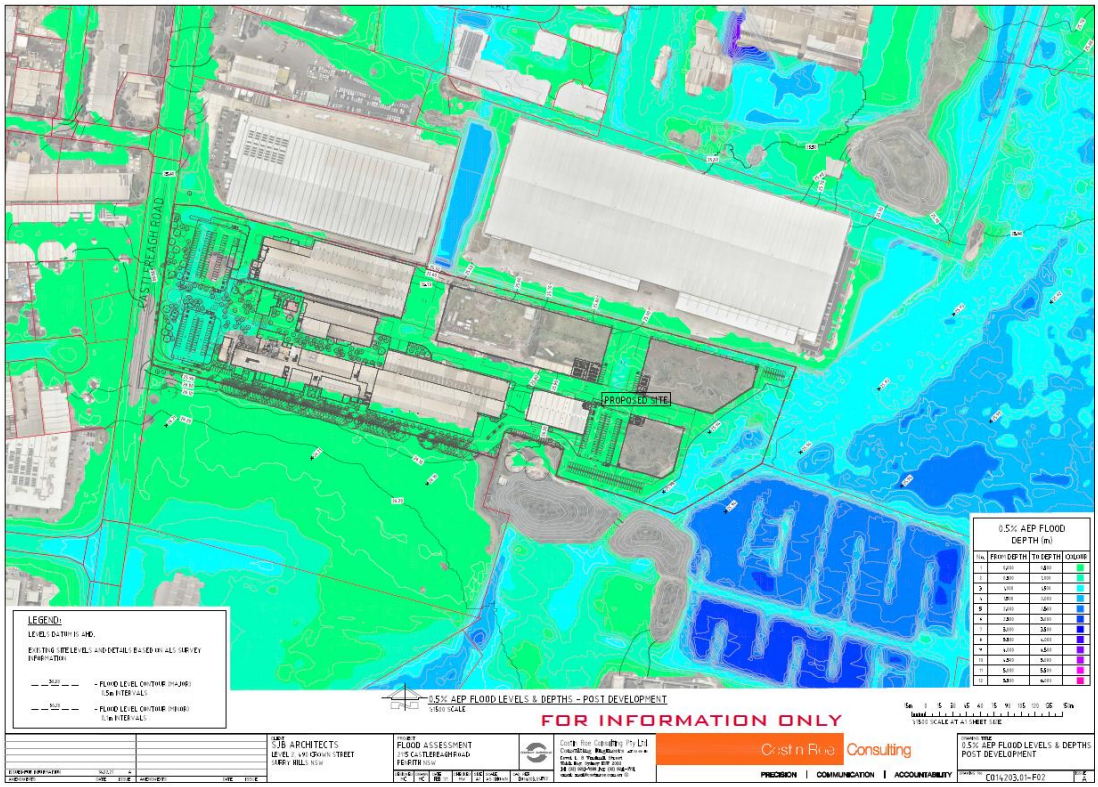


Figure F10 – 0.5% AEP Flood Depth & Level – Post Development

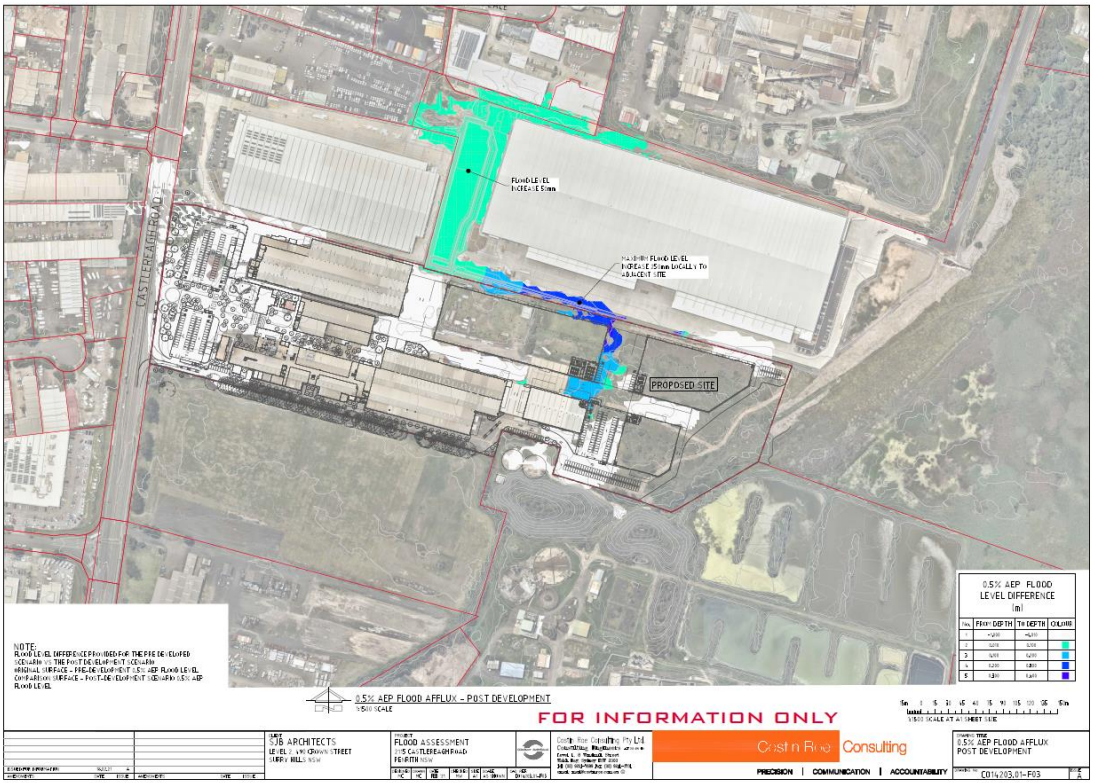


Figure F11– 0.5% AEP Flood Level Afflux

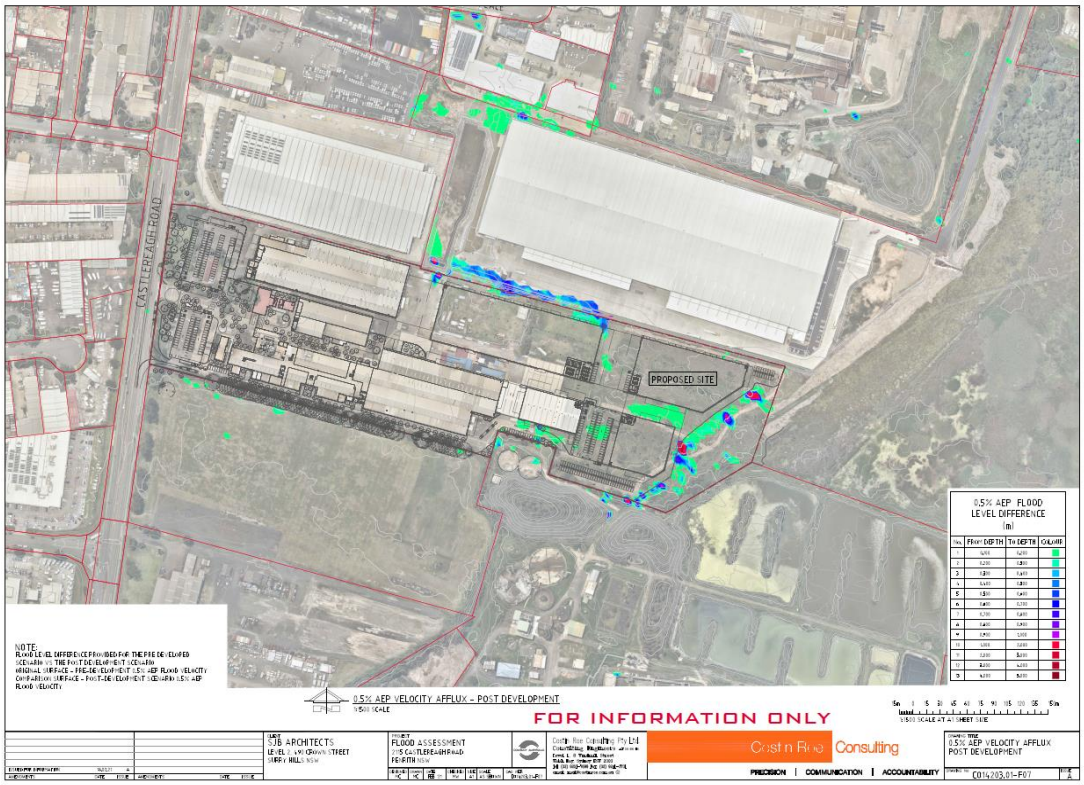


Figure F12 – 0.5% AEP Flood Velocity Afflux

F.5 FLOOD SAFETY AND EVACUATION

F5.1 Introduction

This section of the report presents the relevant information in relation to egress and evacuation during the approach of a significant flood event, consistent with the requirements of both *Council's DCP C3 – 25 (6)*, and *Clause 7.2 of Penrith City Council Local Environmental Plan (LEP) 2010.*

This framework has been completed with consideration to the State Emergency and Rescue Management Act 1989 (NSW), the State Emergency Service Act 1989 (NSW), and the Penrith City Council Local Flood Plan 2012 and Hawkesbury Nepean Flood Plan 2015. The analysis is based on modelling results, prepared as part of the Nepean River Flood Study, and review of evacuation procedures outlines in the Hawkesbury River Flood Emergency Sub Plan 2015. The Sub Plan indicates that flood warnings and evacuation planning across the site would be based on monitoring of the Victoria Bridge Flood Gauge.

It is noted that the information in this report is provided as a framework for the development of an operation specific flood management plan which would be expected to be implemented as part of occupation of the site.

It is noted that this site is flood free from Nepean River flooding up to the 2% AEP (1in 50 year ARI) event, and the proposed building has been sited greater than 0.5m above the 1% AEP event. It is imperative that the occupants of the facility are aware that flood strategies need to be undertaken in events of magnitude below the 1% AEP event. Further noting that the local floodplain management plan and associated flood evacuation strategy will be implemented in flood events which are of lower magnitude than the 2% AEP where safe egress to areas which are not flood affected with sufficient lead times of greater than 5hours. Further discussion on this is provided in following sections.

It is further noted that the rate of rise within the Nepean River has been quoted in the *Hawkesbury River Flood Emergency Sub Plan 2015* as being between 0.5-0.7m/hour. Based on this rate of rise and expected travel time from the site to flood free areas of less than 5 minutes, this would equate to an increase in flood waters of 0.06m and access to Castlereagh Road.

F5.2 Preparedness

Warning Systems

The proposed facility will require a facility specific plan which sets out the flood warden, evacuation zones and responsible persons. As noted the advice in this report can be used as a framework for the preparation of a site-specific flood plan, in conjunction with Penrith Council and SES sub plans as required.

The NSW SES Penrith Local Controller is responsible for monitoring the flood risk over the area and for issuing flood warnings to the community. Any person or group occupying the precinct at the time of flood danger should adhere to any warnings issued. The warning message will normally be issued via SMS (phone

text) by the SES. During periods of heavy or forecast heavy rainfall it is important that one or some of the occupants of a facility should be able to receive such messages. The occupants must then immediately follow the flood evacuation plan in this report or the instructions of the SES controller in the area.

As described in **Section F5.3** below, the SES/ BOM Warning System is based on gauges on the Nepean River at the Victoria Road Bridge and at Windsor Road bridge. This river directly increases flood levels around the proposed site as described earlier, noting that this site is flood free from Nepean River flooding up to the 1 in 50 year ARI event.

The SES system will provide good initial guidance, however in addition to the SES flood warning system, it is recommended that an in-house or precinct wide warning system also be employed to cover more localised flood events including visual observations of the adjoining wetland.

Review of the *Nepean River Flood Study*, in conjunction with the *Hawkesbury River Flood Emergency Sub Plan 2015* shows that Minor, Moderate and Major warnings correspond roughly to the 1 in 2yr, 1 in 15yr and 1 in 40yr design flood events respectively. All of these are noted to be flood events which do not affect this site.

Utilising the rate of rise of the PMF of 0.7m/hour (which has quicker rate of rise of flood water due to shorter critical duration than other events) there would be **at least 19, 12 and 5 hours warning time available for evacuation following the issuance of Minor, Moderate and Major warnings respectively**.

In order to allow sufficient time to address site flood protection procedures we would recommend the site be on alert following a minor flood warning, begin proceedings for flood evacuation following a moderate and to leave the site at or before a major warning is issued.

In addition to the SES/BOM warning system, it would be recommended that a visual system is also included in the flood response plan. The recommended flood triggers within this flood evacuation framework should be followed when the water level meets or exceeds the 5% AEP depth marker and be placed on alert at the 10% AEP depth.

Preparation Steps

It is the responsibility of the occupants of the facility to understand the risks and dangers of flooding across the precinct, and the need to evacuate in such an event.

It is recommended that the users of the facility are registered to receive flood warning messages via SMS from the NSW SES.

Lastly, the evacuation framework, including the evacuation route, contained in this report must be understood and adapted to this specific facility. It is recommended that a copy or copies of this route and plan are kept at several locations on site such as the maintenance manager, and office administrator.

F 5.3 Flood Response

Response Operations

The response operations by the SES will begin once a trigger is prompted.

- On receipt of the first of a Bureau of Meteorology Flood Watch, Preliminary Flood Warning or Flood Warning for the Nepean River;
- When other evidence leads to an expectation of flooding within the Penrith local government area.

First triggers by SES will be when the flood gauge on Victoria Bridge Reaches RL 22.0m AHD, which as noted will allow 19 hours to prepare for flood response. Response strategy for the site are listed below.

Response Strategies

Following the reception of a **Minor Flood Warning** message (19hours to affectation), the response operations should commence. This normally begins with necessary property protection for the site. This could include sandbagging, moving any furniture, machinery or stock that may be affected by flood levels greater than flood planning levels allow for. As noted, all developed land has been sited at the 0.5% AEP flood level plus 500mm freeboard or higher, so this step may not be necessary and individual plans should be made for the facility to ensure damage to property is minimised.

Following issuance of a **Moderate Flood Warning** message (12 hours to affectation) proceedings for flood evacuation should be made, and on site visual review of water levels within the adjacent wetland should be made. As previously advised, evacuation of the site should be made prior to water levels being within 0.35m of the lowest point of the access driveway.

Following the issuance of a **Major Flood Warning** message (5 hours to affectation), if not already completed all personnel should have left or be in the process of leaving the site and heading east on Andrews Road to non-flood affected areas, or as directed by the SES.

As shown in **Figure F17** it is recommended that evacuation of the site be directed to Castlereagh Road. As noted these events would be larger than those to which SES evacuation procedures would be actioned. Further the proposed route is consistent with the proposed route as included in the *Hawkesbury River Flood Emergency Sub Plan 2015*.

Table F4 provides information relating to differing AEP storm events, SES warnings and the status of the vehicular evacuation route. It is noted that there is no direct correlation data published between AEP events and the SES flood warning levels within the Penrith City Council.

Design Flood (AEP)	Flood Warning (SES/ BOM)	Victoria Bridge Gauge Level (m)	Predicted Flood Level at Site^ (m)	Status of Evacuation Route & Approx Time to Impact
-	Minor	18.0	-	Not Impacted/ 19 hours
20%		20.1	-	Not Impacted
10%		21.6	-	Not Impacted
-	Moderate/ Level 1	22	-	Not Impacted 12 hours
5%	-	23.4	-	Not Impacted
-	Major/ Level 2-	24.5	-	Not Impacted 5 hours
2%	-	24.9	-	Not Impacted
1%	-	26.1	25.3	Cut
0.5%	-	27.1	25.8	Cut

Table F4. Flood Route Evacuation Status

The final route to an Emergency Refuge Centre would need to be assessed in more detail as part of a site-specific plan. This analysis has sought only to confirm that safe flood evacuation routes would be available for the site which are consistent with the *Hawkesbury River Flood Emergency Sub Plan 2015.*

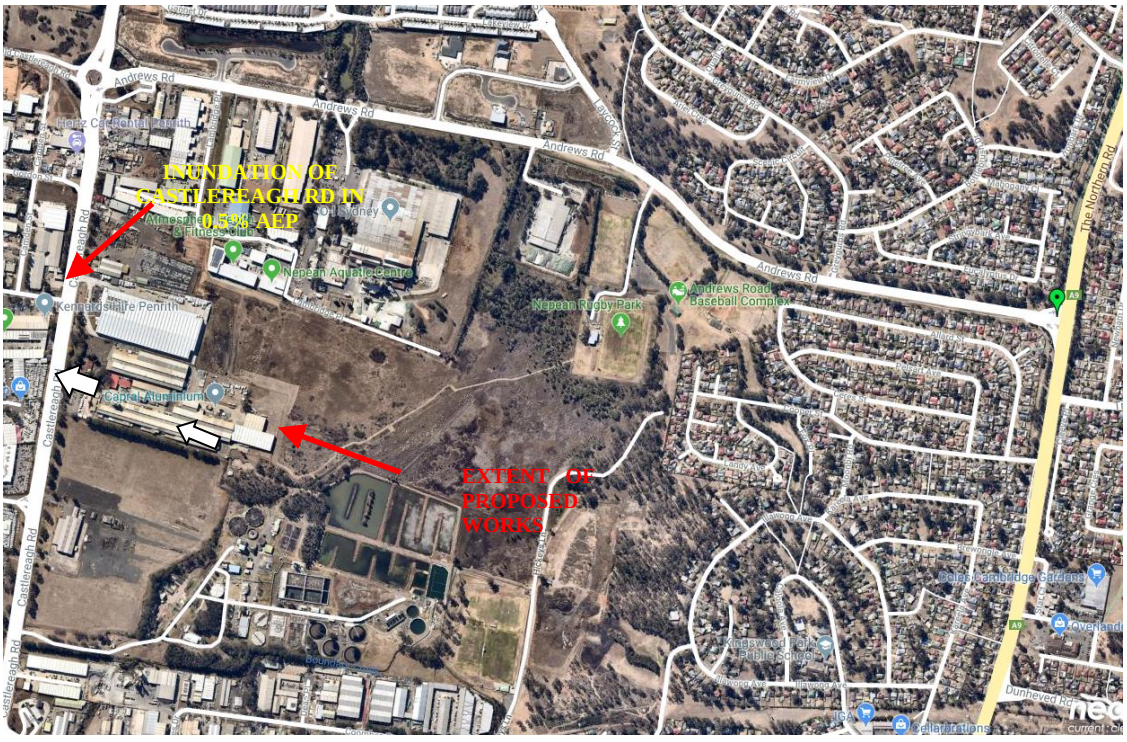


Figure F5. Potential Flood Evacuation Route

The transport by which the affected occupants travel along the evacuation route is private vehicle. If one does not own a private vehicle, then alternate transport for evacuation should be sought. However, in the event that flood waters have encroached the flood evacuation route, it is important that under no circumstances should flood waters be driven through, noting vehicles can be swept away by flood water at depths of only 200mm. On-site refuge is available for flooding events up to the 0.5% AEP. For events exceeding this, no refuge is available and emergency evacuation will be required.

End of Response Operations

Once the flood levels recede below the trigger level and the danger posed by flooding has passed, the NSW SES Liverpool Local Controller will issue an "all clear" message which will be conveyed in the same format as the warning message, via SMS. Building occupiers can then return to the precinct.

F.6 PENRITH CITY COUNCIL LOCAL ENVIRONMENTAL PLAN 2010

This section of the report presents confirmation of how each of the provisions of *Clause 7.2* of *Penrith City Council Local Environmental Plan (LEP) 2010*have been satisfied.

We provide the following response and confirmation relating to Clause 7.2 of the LEP 2010.

Clause	*Item* & **Response**
1	*The objectives of this clause are as follows:* *(a) to minimise the flood risk to life and property associated with the use of the land,* **A flood assessment and flood safety strategy is proposed to ensure the development of the land provides appropriate measures to ensure risk to life and property is consistent with the local council policies, NSW Flood Planning Manuel and local floodplain management plans.** **The proposed development minimises the risk to life through the implementation of a robust flood egress strategy as further described below.** **The proposed development minimises the flood risk to property by setting the proposed floor level with appropriate freeboard and through detailed flood assessment to ensure existing flood conditions are not adversely affected as further described below.** *(b) to limit uses to those compatible with flow conveyance function and flood hazard,* **To ensure the proposal is compatible with flow conveyance and function, the proposed warehouse building has been sited above the 1 in 100 year ARI flood event and allows for greater than 0.5m freeboard to the 1 in 100 year ARI event. Areas of the development which would be subject to flood waters (around the perimeter of the development site) are to be constructed of flood compatible materials and allow for flood conveyance and function.** **Further a development impact assessment has been completed which shows the development does not affect upstream, downstream or adjoining properties in the 1 in 100 year ARI and 1 in 200 year ARI events, including maintaining major 1 in 200 year ARI flow paths as required of council, as set out in Section F.4 of this report.** *(c) to manage uses to be compatible with flood risks,*

	Refer to Clause 1(b) response. *(d) to enable safe and effective evacuation of land,* **A robust framework for safe and effective egress from the development site has been formulated based on modelled rate of rise, automatic flood levels gauges and the local floodplain management plan (Hawkesbury Nepean Flood Plan 2015) to enable safe and effective evaluation of land.** **Reference to Section F.5 should be made for flood egress strategy and information pertaining to rate of rise, timing of flood strategy implementation and flood egress routes.** *(e) to ensure the existing flood regime and flow conveyance capacity is not compromised,* **The existing flood regime and flow conveyance capacity has been assessed and confirmed in relation to the proposed development and found to be acceptable. Refer Clause 1(b) response.** *(f) to avoid detrimental effects on the environment that would cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or waterways.* **The proposed development does not overlay change existing flow paths or increase the risk of erosion in and throughout the adjacent flood affected areas.**
2	*This clause applies to the following land:* *(a) land at or below the flood planning level,* *(b) land identified as "Flood planning land" on the Clause Application Map.* **It is understood that this clause applies to the subject land and the development application submission considers flood planning requirements for the development and complies with this clause.**
3	*Development consent is required for any development on land to which this clause applies.* **Development consent is understood as a requirement for this development and this document forms part of a robust development application submission for assessment by Penrith City Council.**

4	*Development consent must not be granted for development on land that is at or below the flood planning level unless the consent authority is satisfied that the development:* *(a) is compatible with the flood hazard of the land, and* **The proposed development is compatible with the flood hazard for the land because the warehouse building has been sited above the 1 in 100 year ARI flood event and allows for greater than 0.5m freeboard to the 1 in 100 year ARI event. Areas of the development which would be subject to flood waters (around the perimeter of the development site) are to be constructed of flood compatible materials and consider flood conveyance and function.** **Further a development impact assessment has been completed which shows the development does not affect upstream, downstream or adjoining properties in the 1 in 100 year ARI and 1 in 200 year ARI events, including maintaining major 1 in 200 year ARI flow paths as required of council, as set out in Section F.4 of this report.** *(b) if located in a floodway, is compatible with the flow conveyance function of the floodway and the flood hazard within the floodway, and* **Refer Clause 2 response.** *(c) is not likely to adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and* **The included flood afflux drawings confirm that there is no detrimental increases in the potential flood affectation to upstream, downstream or adjacent properties.** *(d) is not likely to significantly alter flow distributions and velocities to the detriment of other properties or the environment, and* **The TUFLOW modelling confirms that there is no significant flow or velocity re-distributions associated with the development.** *(e) is not likely to adversely affect the safe and effective evacuation of the land and the surrounding area, and* **A robust framework for safe and effective egress from the development site has been formulated based on modelled rate of rise, automatic flood levels gauges and the local floodplain management plan (Hawkesbury Nepean Flood Plan 2015) to**

	ensure that the development does not adversely affect the safe evacuation of the land. **Reference to Section F.5 should be made for flood egress strategy and information pertaining to rate of rise, timing of flood strategy implementation and flood egress routes.** **Further, because there modelling confirms there is no adverse changes to other properties, the proposal does not adversely affect safe and effective evacuation from the surrounding area.** *(f) is not likely to significantly detrimentally affect the environment or cause avoidable erosion, destruction of riparian vegetation or affect the restoration and establishment of riparian vegetation, or a reduction in the stability of river banks or waterways, and* **The TUFLOW modelling confirms that there is no significant flow or velocity re-distributions associated with the development. As such, the development does not significantly detrimentally affect the environment or cause erosion, scour or destruction of riparian vegetation.** *(g) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding, and* **Given the flood modelling shows no affectation to upstream, downstream or adjacent properties and the proposed buildings have appropriate freeboard above the 1% AEP event, this development is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.** *(h) incorporates appropriate measures to manage risk to life from flood, and* **A robust framework for safe and effective egress from the development site has been formulated based on modelled rate of rise, automatic flood levels gauges and the local floodplain management plan (Hawkesbury Nepean Flood Plan 2015) to appropriately mange the risk to life from flood.** **Reference to Section F.5 should be made for flood egress strategy and information pertaining to rate of rise, timing of flood strategy implementation and flood egress routes.** *(i) is consistent with any relevant floodplain risk management plan.* **A robust framework for safe and effective egress from the development site has been formulated based on modelled rate**

	of rise, automatic flood levels gauges and the local floodplain management plan (Hawkesbury Nepean Flood Plan 2015).
5	*Development consent must not be granted for development on land identified as "Flood planning land" on the Clause Application Map, unless the consent authority is satisfied that the development will not adversely affect the safe and effective evacuation of the land and the surrounding area.* **We consider a robust flood assessment and management framework has been provided which meets the requirements of Penrith City Council DCP Part C3, Clause 7.2 of LEP 2010 and is also consistent with the Hawkesbury Nepean Flood Plan 2015 and the NSW Government's Floodplain Development Manual therefore confirming the development will not adversely affect the safe and effective evacuation of land and the surrounding area.**
6	*A word or expression used in this clause has the same meaning as it has in the NSW Government's Floodplain Development Manual(ISBN 0 7347 5476 0) published by the NSW Government in April 2005, unless it is otherwise defined in this clause.* **It is noted and understood that writing of this clause is consistent with the NSW Government's Floodplain Development Manual.**
7	*In this clause:* *flood planning level means the level of a 1:100 ARI (average recurrence interval) flood event plus 0.5 metres freeboard.* **Flood planning for this development has been based on the 1 in 100 year ARI event plus 0.5m freeboard.** **It is further noted that provision for major flow paths in the 1 in 200 year ARI event have been considered, and that egress from the site will be undertaken prior to the 1 in 100 year ARI event being consistent with the flood egress strategy adopted in the Hawkesbury Nepean Flood Plan 2015**

F.7 FLOOD ASSESSMENT CONCLUSION

This Appendix to the Civil Engineering Report for 2115 Castlereagh Road, Penrith, has been prepared to assess the effect of flooding on the proposed development, and also to confirm no affectation on upstream downstream or adjoining properties. Further the assessment was also completed to ensure that sufficient flood-ways are available, post development, during the 0.5% AEP flood event.

A TUFLOW hydrodynamic flood model has been completed and the pre and post development flood events assessed for flooding as a result of the Nepean River banks overtopping during a regional flood event. Peak flows were assessed for the critical duration associated with flooding from the Nepean River.

The flood assessment confirms the 1% AEP level of RL25.28m AHD and 0.5% AEP level of 25.94m, and that the proposed development (being sited at RL 26.30m AHD) meets flood planning requirement of the 1% AEP plus 0.5m. Further noting the proposed building development is above the 0.5% AEP event.

The assessment of the 0.5% AEP event confirms that floodway paths are available to the west, north and north-west of the building. There is negligible effect on flood water local to the development and no off-site affectation.

Further it has been demonstrated that safe egress and evacuation from the facility can be made to areas which are not flood affected and that the evacuation strategy is consistent with the *Hawkesbury River Flood Emergency Sub Plan 2015*.