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CIVIL ENGINEERING REPORT
INCORPORATING
WATER CYCLE MANAGEMENT
STRATEGY

SSD 10272349
LOTS 59 & 60 DP 259135, MAMRE ROAD
KEMPS CREEK NSW

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***Rev*: A**

DOCUMENT VERIFICATION

Project Title	Lots 59 & 60 DP 259135, Mamre Road
Document Title	Civil Engineering Report Incorporating Water Cycle Management Strategy
Project No.	Co13874.06
Description	SSD Report for future industrial estate
Client Contact	Mr Matt Jordan, GPT Group

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File Name	13874.06-04a.rpt	

Document History

Date	**Revision**	**Issued to**	**No. Copies**
15 Apr. 2021	DRAFT1	Mr Matt Jordan, GPT Group	PDF
30 Apr. 2021	DRAFT2	Mr Matt Jordan, GPT Group	PDF
1 June 2021	A	Mr Matt Jordan, GPT Group	PDF

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1 INTRODUCTION & SCOPE

Costin Roe Consulting Pty Ltd has been commissioned by The GPT Group to undertake a *Civil Engineering Report & Water Cycle Management Strategy* (WCMS) to accompany a State Significant Development Application (SSDA) with the NSW Department of Planning, Industry and Environment (DPIE) for an industrial estate comprising five development lots and construction of Buildings 3 & 5. This report presents a civil engineering assessment of a property bounded by Mamre Road, Lot 1 DP104956, Lots 56-58 DP259135 & Lots 34-37 DP258949. The development will be referred to *The Yiribana Logistics Estate* (YLE) in this report.

This report provides an assessment of the civil engineering characteristics of the development site and technical considerations of the following aspects:

- Earthworks & geotechnical considerations;
- Roads and Access;
- Water Cycle Management Strategy (WCMS).

The WCMS comprises several key areas of stormwater and water management which are provided below. These key areas have been established with the aim to reduce impacts from the YLE development on the surrounding environment and neighbouring properties. The water cycle management strategy identifies the management measures required to meet the targets set. The key water cycle management areas assessed in this report are:

- Storm Water Quantity;
- Storm Water Quality;
- Water Supply and Reuse;
- Flooding; and
- Erosion and Sediment Control

This engineering analysis is based on development for industrial warehouse and logistic facilities consistent with industrial estates in the surrounding areas and indicative Masterplan provided by GPT.

A request for SEAR's has been completed by Urbis. Reference to **Appendix C** should be made for SSD_10272349 SEAR's dated November 2020, and **Section 10** of this report for specific responses to civil engineering and water management related items included in the SEAR's.

2 DEVELOPMENT SITE

2.1 Location

The proposed development is located in the suburb of Kemps Creek on Mamre Road on Lots 59 & 60 DP259135 as shown in **Figure 2.1**.

The site is bounded on the west by Mamre Road, semi-rural farmland to the north, south and east. We understand that the land to south is proposed to be developed by Mirvac, the land to the east by Frasers Property Australia, and the land bounded by the GPT site by Altis Property. Some consideration to this has been made in the assessment and design drawings included in the submission.

The land comprises a total area of approximately 33Ha. The current land-use is predominantly rural-commercial and rural-residential.

The site generally falls from north-east to south-west. The highest elevation on the land is RL84m AHD at the north-eastern corner of the site. The lowest levels are located at the Mamre Road frontage at RL 40m AHD. Grades over the land vary from 0.5% to 25% with the grades becoming flatter in the western portion of the land adjacent to Mamre Road.

The site is noted to be located within an area comprising rural/agricultural use, however nearby to existing and future industrial development areas, and noted as being recently rezoned by the NSW DPIE as IN1 General Industrial.

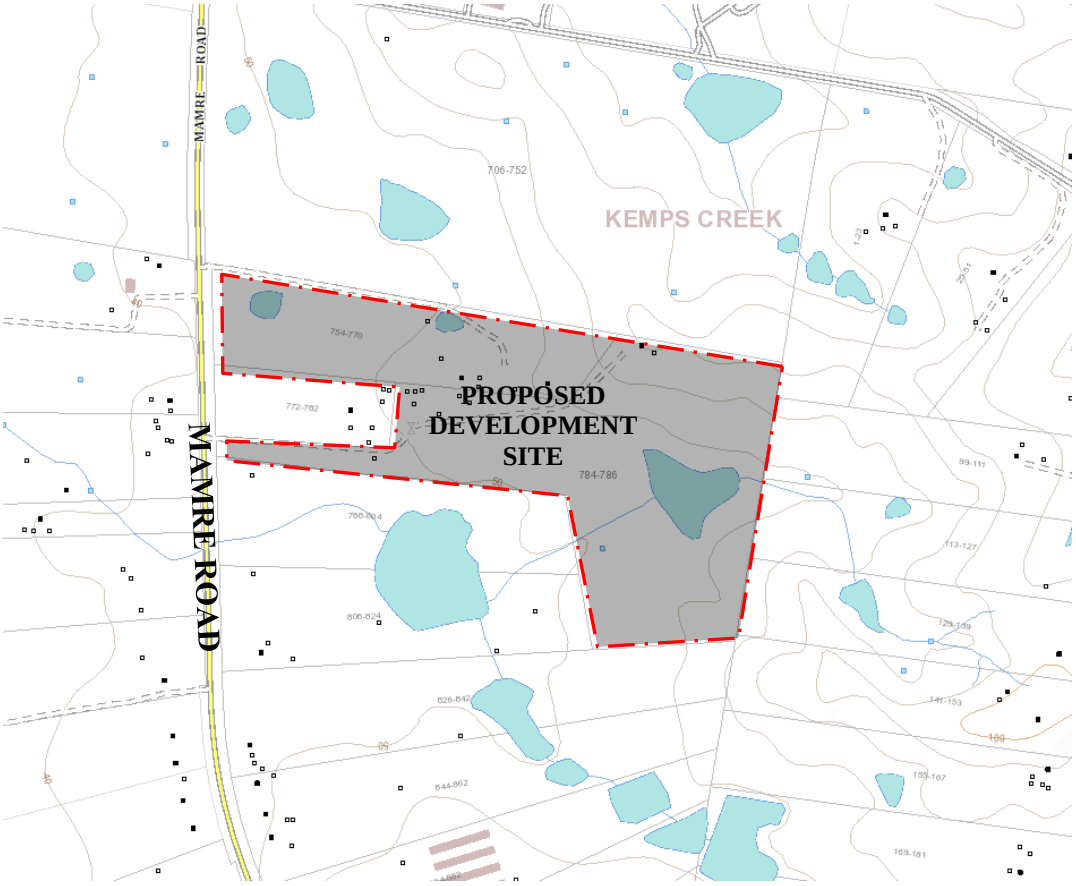

Figure 2.1 Locality Plan

2.2 Existing Site

The site is located on the eastern side of Mamre Road approximately 0.5km south of the intersection of Mamre Road and Bakers Lane, and 2.5km north of the intersection of Mamre Road and Abbotts Road. The nearest residential receivers are approximately 1.5km south-east of the site in Mount Vernon.

The property is currently comprising rural-commercial use. The existing semi-rural sheds are located in the central portion of the site and include several small dwelling-type buildings with detached sheds, carports and other minor structures. Two large, flat material storage areas are present in the northern portion of the site. Otherwise the majority of the site is undeveloped pasture and grassed fields.

The site is noted to be located within an area comprising rural/agricultural use, however nearby to existing and future industrial development areas, and noted as being recently rezoned by the NSW DPIE as IN1 General Industrial.

The site comprises a pistol-shaped block with two frontages on Mamre Road. The front (Mamre Road) boundary, with frontages of 180m & 40m, is less than half the width of the 498m wide rear boundary. The depth of the site is approximately 1,020m . The area of the development site is approximately of 33.15 Ha.

Two catchments are present on the property. Catchment 1 is approximately defined by the Lot 59 boundary and falls to the south-west through the adjacent Lot 58 site at two distinct locations. One discharge point is located along the western boundary interface with Lot 58, the other fronting Mamre Road. Catchment 2 is approximately defined by the Lot 60 site boundary and falls to the west to Mamre Road.

Lot 59 generally falls in a south-westerly direction, from RL85.00 in the north-east corner to RL48.5 along the south-western boundary interface with the Lot 58 property. The lot continues to fall towards Mamre Road at RL41.50. Falls are approximately 20% in the North eastern portion of the lot , flattening to around 1-2% approaching Mamre Road.

Lot 60 generally falls in an east-to-west direction, from RL 78.00 in the north-east corner to RL 41 at the western frontage to Mamre Road. Falls are approximately 15% in the eastern third of the site, flattening to around 1-2% approaching Mamre Road. Two large, flat pads are present in the centre of the lot.

2.3 Proposed Development

The proposed development is for an industrial estate, earthworks and infrastructure for future industrial development over an area of 33 Ha. An indicative lot layout is shown in **Figure 2.2**. Infrastructure works will include bulk earthworks, provision of services, road & intersection construction, and stormwater management and has completed in accordance with the Development Masterplan.

The preliminary masterplan layout provided by The GPT Group shows development lots will vary between 4 Ha and 7.5 Ha in size. Siting of the development lots and levels will consider the topography of the land (understanding the constraint to develop large flat building pads), access, and flood planning requirements.

Access to all lots in the ultimate condition would be made via either the new North-South Access Road, or via the new East-West Local Industrial Road which feeds from the Access Road. The new access road and associated intersection will be constructed to The Mamre Road Draft DCP requirements (refer **Section 4**) and ownership transferred to Penrith City Council. Initial access to the site will be via a left in and out intersection with Mamre Road. This will be in place until such time that the internal precinct roads and permanent intersection to the south is constructed by the adjoining landowner, Mirvac.

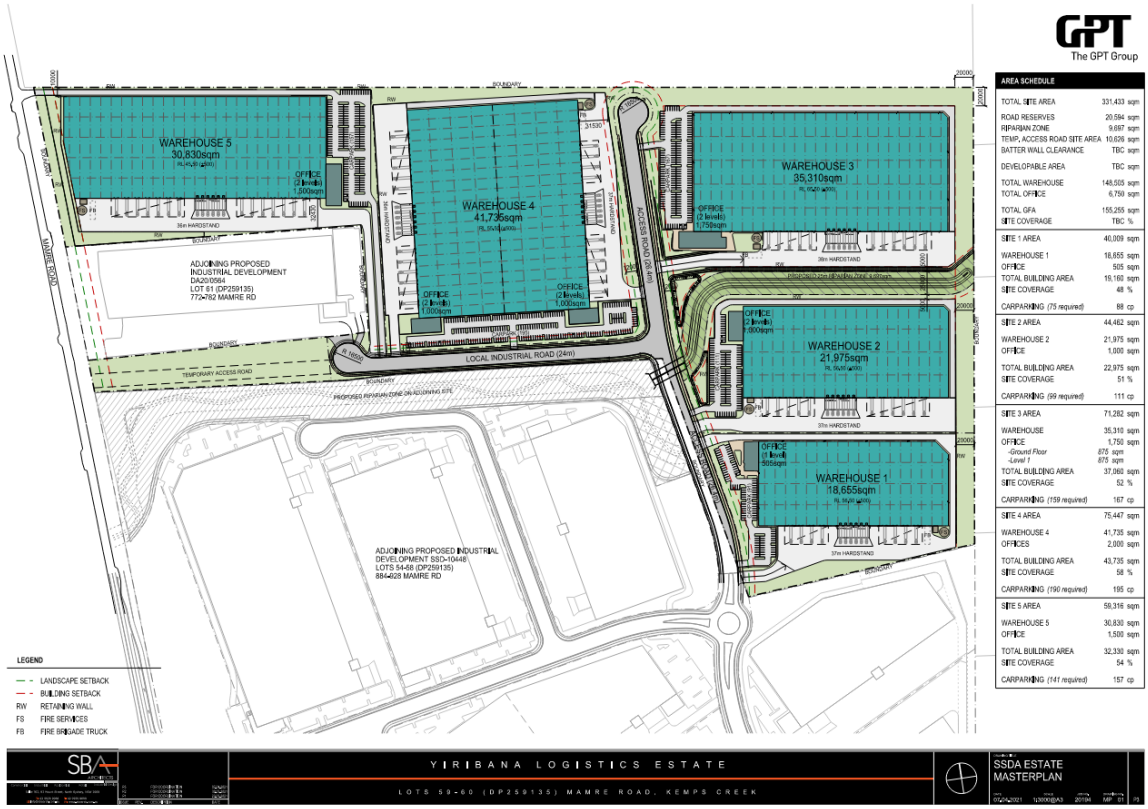

Figure 2.2. Development Masterplan (Source: SBA Architects)

3 SITE WORKS

3.1 Soil and Geological Conditions

The 1:100,000 Sydney Geological Map indicates the site is underlain by (Rwb) shale, carbonaceous claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff.

Investigations by PSM Geotechnical shows the soil profile to comprise residual clay soils with depths of 1-3m overlaying highly to medium weathered shale.

3.2 Bulk Earthworks and Benching Levels

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 Mamre Road and proposed estate roads, to drain the site stormwater via gravity, and to keep building levels above the 1 in 100-year ARI flood level with a minimum freeboard of 500mm.

The development and proposed benching levels respond to the topography by providing development pads which step from progressively from the existing high point on the east of the development site, to the lowest part of the site on the west adjacent to Mamre Road.

Consideration to the anticipated development levels on the adjacent sites to the south and west, contemplated by the adjacent landowners Mirvac and Altis Property Partners, has also been made. Consultation with the respective landowners/ developers (as noted) has been made throughout the development application design development.

Overall, it can be anticipated that, on a development site which has a level differences of approximately 44m, and proposed large format industrial warehouse (as zoned) that level changes and retaining structures will be required to facilitate flat building pads and benching suitable for logistics and distribution. This is a fundamental requirement for the effective development over the entire Mamre Road Precinct and a point that has been discussed with DPIE and Council.

High level earthworks and volume estimates have been completed and are shown on drawing **Co13874.06-SSDA300** of **Appendix A**. The earthworks volume estimates are based on a lot layout with flat building pads. 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. The primary drivers for the proposed earthworks levels are access and draining the site via gravity. This results in large amounts of fill import being required for the site.

The earthworks volume estimates are as follows in **Table 3.1**:

Item	Apparent Volume (m^3)
Cut	-428,100
Fill	+580,000
Topsoil Strip	-66,200
Detailed Excavation	-66,200
Balance	**+86,700 Fill Over Cut**

Table 3.1. Earthwork Volume Estimates

The volume estimate is based on a 66,200m^3 topsoil strip (200mm over the site area) to be either removed from the site, blended or placed and used within non-developable vegetation zones. Given the large volume and associated cost this would impose to dispose the topsoil, geotechnical advice is recommended to confirm options for borrow pit arrangement or blending non-organic topsoil component with site won fill material, so disposal of topsoil is reduced. Consideration to the short- and long-term performance of the blended fill, including effect on settlement, soil modulus, CBR and bearing capacity should be made in any geotechnical advice. If high-bay or other settlement sensitive uses are proposed on the site, then topsoil blending should not be adopted.

A minor import of earthworks has been shown in the concept analysis to enable buildings to be sited above the 1% AEP event with 500mm of freeboard and to enable drainage of sites by gravity. Consideration to bulking of cut materials including rock and clay materials should be allowed for. Bulking of clay would normally be expected to be 4% of the removed volume and rock bulking can be expected in the range of 8-12%.

Further it is noted that import of fill is unlikely, however if required this would comprise Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM), or other approved in writing by the EPA. Where possible any import or export would be sourced from within the precinct as recommended in the *DRAFT Mamre Road Precinct DCP*.

Soil erosion and sediment control measures including sedimentation basins will also be provided for the development – please refer to the Soil and Water Management Plan in **Section 10** of this report. All Soil and Sediment Control measures will be performed in accordance with Penrith City Council requirements and *Landcom Managing Urban Stormwater, Soils and Construction (1998) – The Blue Book.*

3.3 Retaining Walls

The civil engineering objective is to minimise retaining walls within the constraints of the masterplan layout, levelling of the site to suit large format industrial buildings, allowable grading to suit industrial use external to the building footprint and batters in landscaped areas where possible.

Retaining walls will be required throughout the estate at site boundaries and between development lots. Location and indicative heights of retaining walls are shown on drawing **CO13874.06-SSDA600 & SSDA650**.

Retaining wall alignments, setbacks and tiering requirements have been completed in accordance with *Section 4.4* of the *DRAFT Mamre Road Precinct DCP* and include 1.5m tiers for walls greater than 3m fronting the public domain and a 2m setback of walls greater than 1m in height from public domain. It is noted that shallow soil planting (as opposed to deep soil planting) has been provided between successive tiers of walls. This would achieve an effective landscaping outcome and one similar to nearby industrial areas, including Eastern Creek Business Hub. Shallow soil planting over deep soil planting between tiers is required to ensure structural stability of retaining wall structures.

Level differences along the property frontage and fronting the realigned E2 corridor are noted to comprise a stepped arrangement, in conjunction with the proposed stormwater management plan.

3.4 Embankment Stability

To assist in maintaining embankment stability, permanent batter slopes will be no steeper than 3 horizontal to 1 vertical while temporary batters will be no steeper than 2 horizontal to 1 vertical. This is in accordance with the recommended maximum batter slopes for residual clays and shale which are present in the area.

Permanent batters will also be adequately vegetated or turfed which will assist in maintaining embankment stability.

Stability of batters and reinstatement of vegetation shall be in accordance with the submitted drawings and the *DRAFT Soil and Water Management Plan* in **Section 9**.

3.5 Supervision of Earthworks

All geotechnical testing and inspections performed during the earthwork's operations will be undertaken to Level 1 geotechnical control, in accordance with AS3798-1996.

3.6 Groundwater

A groundwater assessment has been undertaken by Arcadis (ref: 30081949_GMP_FINAL dated 30 April 2021) based on geotechnical assessments completed by PSM.

The geotechnical investigations undertaken by PSM Geotechnical encountered groundwater two of the test locations at a depth of approximately 3m depth. Groundwater was encountered in test pits situated in low-lying areas of the site. It could be expected that groundwater may be experienced at depth or around the normal dry weather water level of South Creek, and that this level would have some seasonal variation and variation associated with periods of high rainfall. In any event, groundwater if present would be at depth below the proposed filled pad levels and interaction with existing groundwater paths would be negligible.

We confirm that the development does not propose to utilise surface or groundwater water sources. An assessment of the impact on these items is not relevant for the warehouse distribution center construction.

Surface water management, including conveyance of surface runoff, management of water quantity (through on-site detention) and water quantity (through on-site and estate wide management systems using WSUD principles and best practice pollution reduction objectives) has been proposed in the design.

In relation to groundwater affectation, this is expected to be negligible. The geotechnical investigations undertaken by Arcadis encountered groundwater in any of the test locations. Further, the majority of the site and site earthworks involve filling, hence any interaction with existing groundwater or groundwater flow paths would negligible and hence not be impacted.

3.7 Acid Sulphate Soils

An assessment of the potential for acid sulphate soils has been requested as part of the SEAR's requirements.

Reference to the *NSW Land & Water Conservation Acid Sulphate Soils Map 92_Liverpool* shows the subject land clear of any known occurrence of acid sulphate soils.

An Acid Sulfate Soils assessment has been undertaken by JBS&G for the development – ref *JBS&G 60539-136377* dated 31 March 2021 – as included in the EIS. The JBS&G letter showed that the risk of acid sulphate soils were low and this site is not subject to any policies relating to acid sulfate soils. As such no specific requirements relating to management of these soils are considered necessary. Refer to the JBS&G report for more detail on acid sulfate soil management during construction.

4 ESTATE ROADS & ACCESS

4.1 Introduction

Integration with the broader transport strategy for the area will be required including the Mamre Road upgrade and Mamre Precinct DCP. This includes the provision of signalised intersections with Mamre Road which will be required to be designed and constructed to the requirements of TfNSW.

The current posted speed limit for Mamre Road is 80kM/hr. surrounding road networks are expected to be posted at 50kM/hr. The corresponding design speeds for the two roads in the Yiribana Logistics Estate are 50kM/hr. A new unsignalised intersection is proposed for access into the development site as part of this submission.

The proposed road alignments will need to be designed to meet the new Mamre Precinct DCP requirements. The proposed road layout will incorporate best practice for both horizontal and vertical alignments with empathy to the landform. Road layouts currently proposed are consistent with those proposed in the Mamre Draft DCP and per the Landowners Group (LOG) which have been consulted with Council and the DPIE.

4.2 Internal Roads

The estate road will need to be designed and constructed as an industrial road consistent with the agreed cross section and hierarchy in the Mamre Precinct DCP. The proposed road width is noted to be greater than the Penrith City Council *Development Control Plan 2014, Part C10 Transport, Access and Parking*. The road cross section as defined in council DCP is shown in **Table 4.1** and **Figure 4.1**, noting the adopted cross sections include 26.4m and 24.0m overall reserve widths as shown in **Figure 4.2** & **Figure 4.3**.

Road Type & Traffic Volume	**Parking Lane Provision**	**Dedicated Travel Lanes**	**Verge Width (Footpath Pedestrian)**	**Total Road Reserve**	**Number of lanes**	**1.5m Footpath or 2.5m Shared Path**
PCC DCP 2014 Industrial	6.0m (2 x 3.0m)	7.0m (2 x 3.5m)	3.8m (2x 3.8m)	20.6m	2 travel/ 2 parking lane	1.5m Both sides
Adopted per LOG/ DPIE – Distributor Road	8.4m (2 x 4.20m)	7.0m (2 x 3.5m) +0.8m Median	5.6m & 4.6m	26.4m	2 travel/ 2 parking lane	2.5m & 1.5m
Adopted per LOG/ DPIE – Industrial Road	8.0m (2 x 4.00m)	7.0m (2 x 3.5m)	5.0m & 4.0m	24.0m	2 travel/ 2 parking lane	2.5m & 1.5m

Table 4.1. Estate Road Cross Section - PCC DCP2014 and Mamre DCP2021

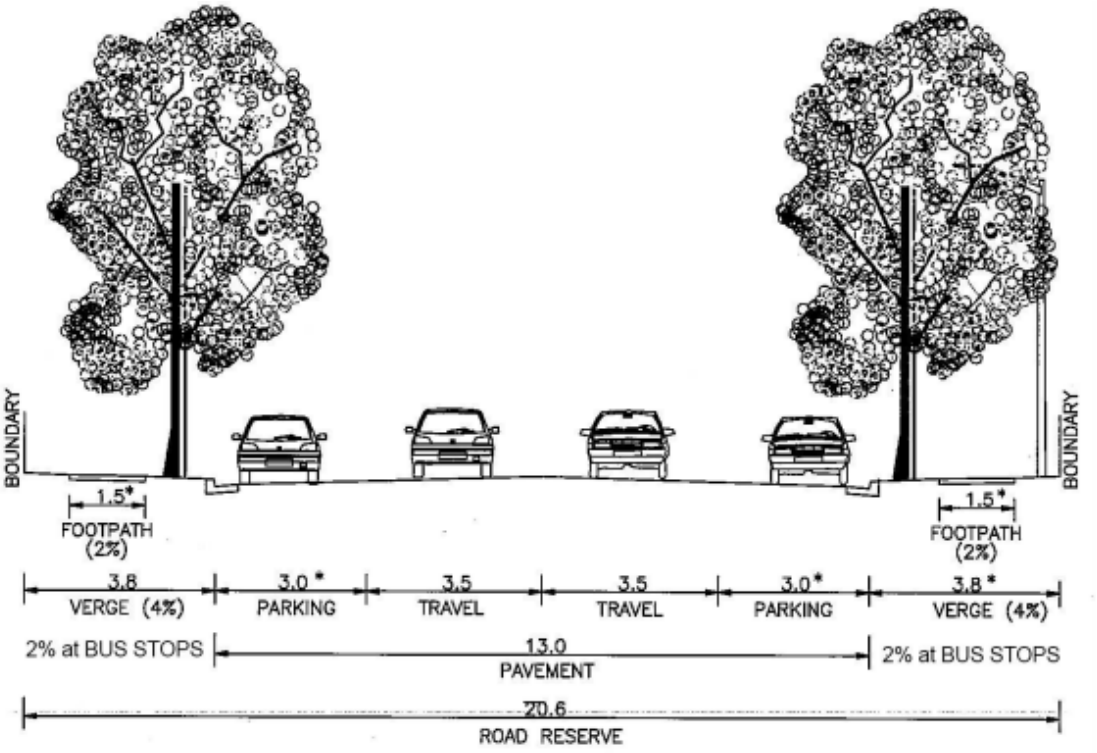

Figure 4.1. Penrith DCP Road Cross Section (source: PCC DCP2014 Part C10)

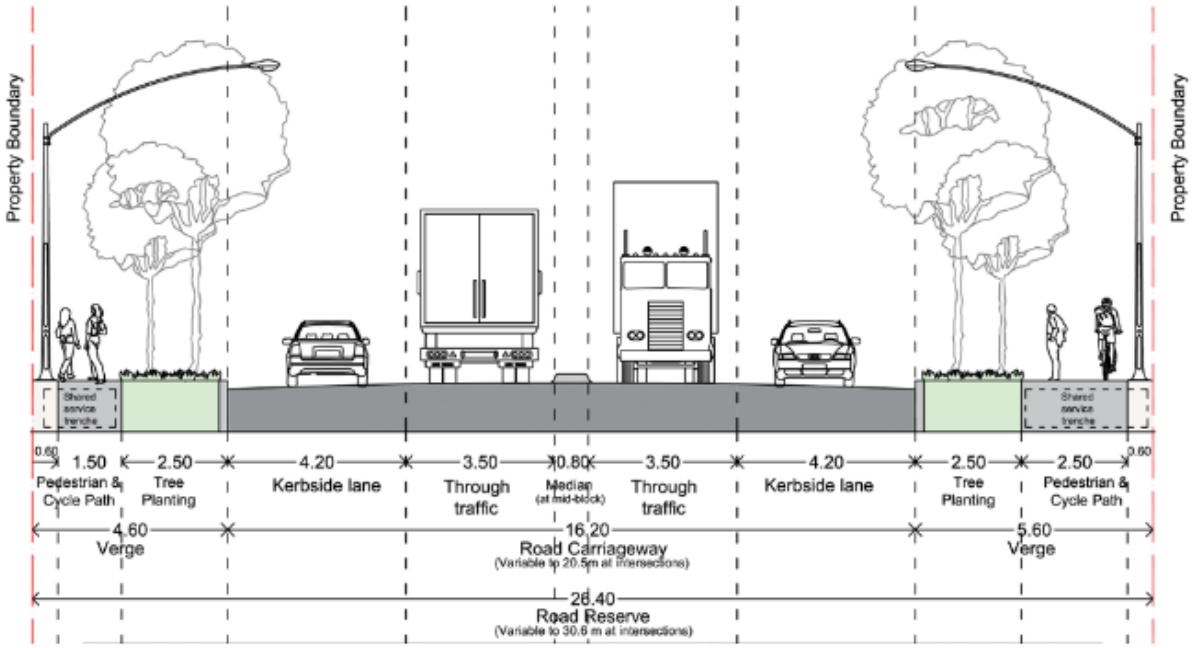

Figure 4.2. Mamre Precinct DCP Distributor Road Cross Section (as adopted)

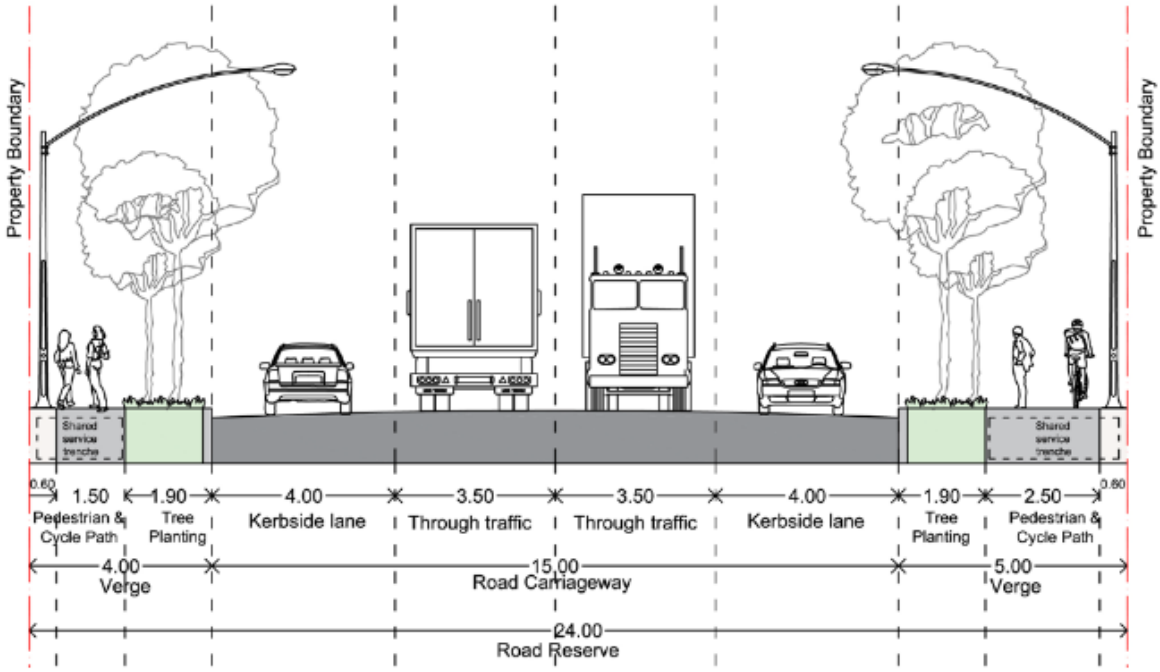

Figure 4.3. Mamre Precinct DCP Industrial Road Cross Section (as adopted)

4.3 General Requirements

All roads will have concrete kerb and gutter and carriageway surface finished with asphaltic concrete as per the requirements of Penrith City Council.

The design for the proposed pavement for internal roads is to be based on *Austroads Pavement Design – A Guide to the Structural Design of Road Pavements.* Council DCP requires the pavement design to be based on a minimum traffic loading of $1x10^7$ ESA. This loading is typical of an industrial road and would meet the needs of the estate, depending on the final traffic studies being undertaken for the precinct DCP. The final adopted traffic loading will be based on the DCP.

We recommend that further review of the proposed pavement construction specification and design loading allowance be undertaken for the internal roads when this becomes available.

In accordance with the estate master plan and council requirements, a 1.5m pedestrian path will need to be located on one side of the road cross section with a 2.5m shared path on the other as included in **Table 4.1** and **Figure 4.2**.

4.4 Mamre Road Intersection

A temporary intersection will be required to Mamre Road. This intersection and access road will be utilised during the period prior to the internal precinct roads, and permanent intersection to the south of the subject land, are constructed by the adjoining landowner/ developer, Mirvac.

Access to all lots in the ultimate condition would be made via either the new North-South Access Road, or via the new East-West Local Industrial Road which feeds from the Access Road. Initial access to the site will be via a left in and out intersection with Mamre Road.

The intersection will need to align with either the proposed Mamre Road upgrade, or the existing road alignment depending on the timing of construction of both site access and Mamre Road upgrades, and will require consultation and agreement on the layout with TfNSW.

Reference to the Traffic Report by Ason Group provides details on performance of the intersections both pre and post development, and general arrangement for the intersections.

Functional layouts of the intersections based on the general arrangement defined in the Traffic Report, for current and ultimate Mamre Road construction conditions, have been prepared by our office as shown below in **Figure 4.4-4.5** and included as drawings in **Appendix A**.

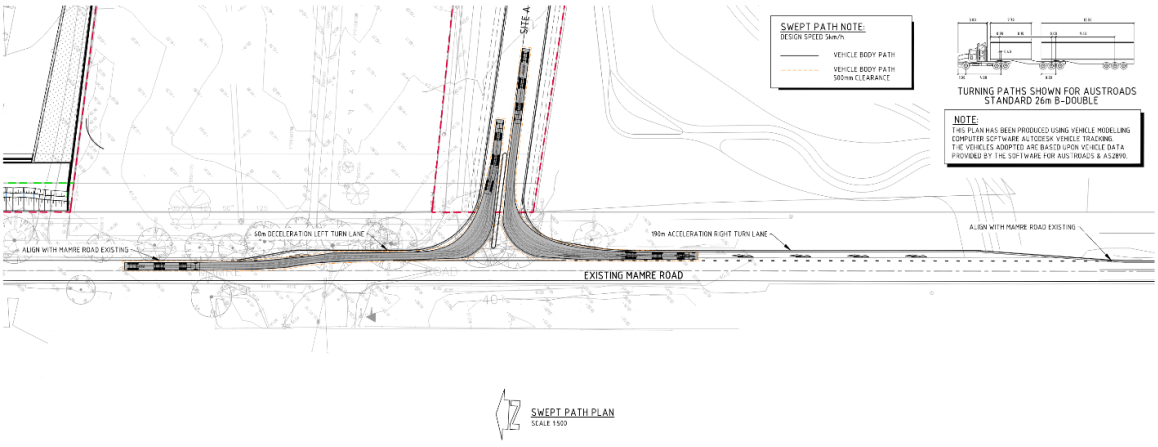

Figure 4.4. Functional Layout (existing Mamre Road conditions)

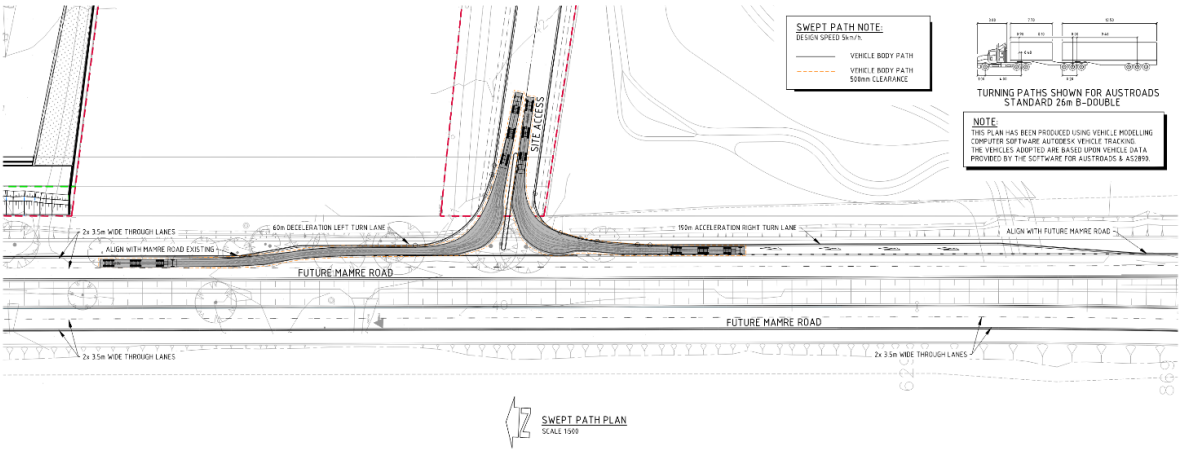

Figure 4.5. Functional Layout (ultimate Mamre Road Conditions)

5 WATER CYCLE MANAGEMENT STRATEGY & DRAINAGE METHODOLOGY

5.1 Key Areas and Objectives

Water Cycle Management (WCM) is a holistic approach that addresses competing demands placed on a region's water resources, whilst optimising the social and economic benefits of development in addition to enhancing and protecting the environmental values of receiving waters.

Developing a WCMS at the SSD stage of the land development process provides guidance on urban water management issues to be addressed for the estate and development as a whole. This assists urban rezoning and estate infrastructure planning for the industrial development proposed on the land.

This WCMS has been prepared to inform DPIE that the development is able to provide and integrate WCM measures into the stormwater management strategy for the estate and for future development sites in the estate. It presents guiding principles for WCM across the precinct which includes establishing water management targets and identifying management measures required for future building developments to meet these targets.

Several WCM measures have been included in the WCMS and engineering design, which are set out in this report and the attached drawings. The key WCM elements and targets which have been adopted in the design are included in **Table 5.1** following.

Element	Target	Reference
Water Quantity	Maintaining or improving the volume of stormwater and peak flows from this site. "*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*".	Penrith Council - *Stormwater Management Policy, Section 3.3.3*
Water Quality	Load-based pollution reduction targets based on an untreated urbanised catchment: Gross Pollutants 90% Total Suspended Solids 85% Total Phosphorus 60% Total Nitrogen 45% Total Hydrocarbons 90% <u>*Pollution Concentration Targets*</u> Total Nitrogen (TN) 1.67mg/L Ammonium (NH4) 0.09mg/L Total Phosphorous (TP) 0.14mg/L Turbidity 29NTU Conductivity 1081 uS/cm pH 7.27-7.69	Penrith Council DCP Part C3 *DRAFT Mamre Road Precinct DCP 2020*
Flooding	Buildings and road set 500mm above 1% AEP. No affectation to upstream downstream or adjoining properties as a result of development	Penrith Council DCP Part C3. NSW Floodplain Development Manual. Penrith Council DCP Part C3
Water Supply	Reduce Demand on non-potable water uses. Provide minimum 80% reduction of non-potable uses.	Penrith Council DCP Part C3.
Erosion and Sediment Control	Appropriate erosion and sedimentation control measures must be described in the environmental assessment for all stages of construction to mitigate potential impacts to surrounding properties.	Landcom Blue Book Penrith City Council DPI
Waterway and Stream Health	Confirmation of pre and post stream forming flows and Stream Erosion Index (SEI) no greater than 2.0.	*Western Sydney Engineering Design Manual*, Western Sydney Planning Partnership (2020)

Table 5.1. WCM Targets

A summary of the how each of the WCM objectives will be achieved are described below. Reference to the relevant sections of the report should be made for further and technical details relating to the WCM measures:

- *Stormwater Quantity Management (Refer **Section 6)***

  The intent of this criterion is to reduce the impact of urban development on existing drainage system by limiting post-development discharge within the receiving waters to the pre-development peak, and to ensure no affectation of upstream, downstream or adjacent properties.

  Attenuation of stormwater runoff from the development is proposed to be managed via three estate level basins. The intention is for no water quantity measures (other than rainwater reuse) to be provided on individual development lots. This will mean that future building developments can be assessed, approved and constructed without the need for site specific detention, based on the provision of the estate level detention basins. There are three proposed basins, two of which are located at the downstream/ western end of the property adjacent to Mamre Road, and the third is at the NE of the property.

  Sizing of the detention systems has been completed using DRAINS modelling software in accordance with the Penrith City Council Policy for the 50% AEP to the 1% AEP storm for various durations. The modelling accounts for the drainage system provided for the adjacent sites and conveyance of upstream catchments around the site.

  Refer to **Section 6** of the document for detailed sizing of detention systems.

- *Stormwater Quality Management (Refer **Section 7**)*

  There is a need to target pollutants that are present in stormwater runoff to minimise the adverse impact these pollutants could have on downstream receiving waters.

  The required pollutant reductions are included in **Table 5.1** of this document and MUSIC modelling has been completed to confirm the reduction objectives can be met for the estate.

  A series of Stormwater quality improvement devises (SQID's) have been incorporated in the design of the estate. The proposed management strategy will include the following measures:

  - Primary treatment of the whole of the development catchment (including roads and development sites) will be made via one of two gross pollutant traps (GPT's). GPT's will be located upstream of each of the stormwater management basins.
  - Tertiary treatment of the whole of the development catchment will be made via one of two estate level bio-retention basins. Bio-retention treatment will be provided within the stormwater management basins and are sized to treat the whole of the estate catchment. Refer to drawings **Co13874.06-SSDA400, SSDA431, SSDA432.**
  - Some treatment will also be present by provision of rainwater reuse tanks on development sites through reuse and settlement within the tanks. Allowance for

this treatment is noted to not be included in MUSIC modelling produced for the development.
- Development sites will not require any lot specific treatment systems due to the estate wide management systems proposed.

Reference to **Section 7** of this document should be made for detailed Stormwater Quality modelling and measures.

- *Flood Management (refer **Section 8**)*

  The proposed development considered flooding and large rainfall events in relation to runoff from upstream properties primarily on the north-eastern overland flow path where a series of farm dams are currently present.

  Consideration to flood requirements has been made per Penrith City Council DCP and the proposed recommendations for DCP criteria included in the DRAFT Exhibition South Creek Floodplain Management Study. It is noted that this site is clear of the South Creek Floodplain however, forms part of a contributing catchment of South Creek. Refer **Section 6** for details.

  The following measures have been incorporated in the design:

  - All buildings are sited 500mm above the 1% AEP design flood level of South Creek.
  - Requirements of Penrith City Council DCP Part C3 have been met regarding works in and around flooding areas;
  - Stormwater detention measures have been included to manage pre and post development runoff as discussed above and in **Section 6**; and
  - Overland flow paths to manage runoff in large storm events have been made including achieving at least 500mm freeboard to building levels from the flow paths.
- *Water Demand Reduction/ Rainwater Reuse*

  Rainwater reuse measures will be provided as part of future building development designs. Rainwater reuse will be required to reduce demand on non-potable uses by at 80%. The reduction in demand will target non-potable uses such as toilet flushing and irrigation. **Refer Section 7.6**.

- *Waterway Health (Stream Erosion Index (SEI))*

  An SEI assessment for discharge from the development to South Creek has been completed based on industry accepted modelling technique for stream health.

  The SEI focuses on channel form with a critical flow threshold is estimated for the stream whereby excess flow is summed over time to produce a measure of the erosion potential in the stream. Results are compared to a baseline scenario (PCC requires less than 3.5, this application has adopted 2.0 based on Western Sydney Planning Partnership).

  This adoption of the SEI metric for stream health, over a mean annual runoff volume (MARV), as proposed in the DRAFT Mamre Precinct DCP, is explored further in **Section 7.5**.

5.2 Existing Drainage System & Overland Flows

The site is currently undeveloped rural land with undulating topography which has been described in **Section 2.2**. There is no formal drainage currently on the site however several local depressions, natural gullies and farm dams are present. There are also several dams which are used for the currently rural farming operations on the land which lie in relation to the natural gullies.

The site is affected by overland flow from minor upstream catchments to the east of the site. A catchment of approximately 24 Ha is conveyed through the site via existing farm dams to Mamre Road.

A smaller catchment currently drains through the site from the north.

Existing twin 1200x600 RCBC's are located at the low point on Mamre Road and drain runoff from the property west toward South Creek through existing gully within rural properties on the western side of Mamre Road. This has been shown on drawing **Co13874.06-SSDA401 and Figure 5.1** below. Conveyance of these flows has been included in the estate infrastructure stormwater design.

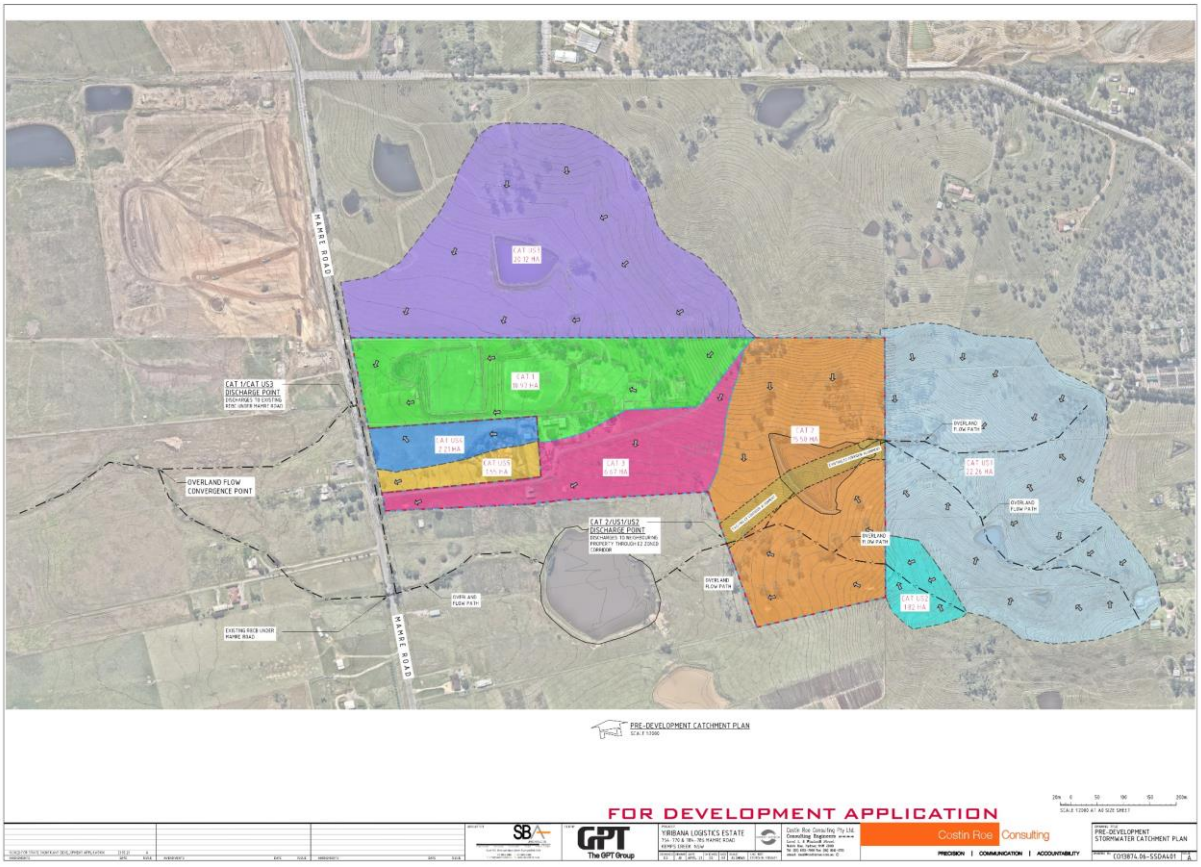

Figure 5.1. Existing Site Catchments and External Contributing Catchment.

5.3 Proposed Estate Drainage System

As per general engineering practice and the guidelines of PCC, the proposed stormwater drainage system for the estate development will comprise a minor and major system to safely and efficiently convey collected stormwater run-off from the development to the legal point of discharge.

The minor system is to consist of a piped drainage system which has been 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 will be designed to cater for storms up to and including the 1 in 100-year ARI storm event (Q100). The major system will employ the use of defined overland flow paths, such as roads and open channels, to safely convey excess run-off from the site.

The design of the stormwater system for this site will be based on relevant national design guidelines, Australian Standard Codes of Practice, the standards of PCC and accepted engineering practice. Runoff from buildings 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).

Water quality and re-use are to be considered in the design to ensure that any increase in the detrimental effects of pollution are mitigated, PCC Water Quality Objectives are met and that the demand on potable water resources is reduced.

The proposed drainage system will be required to convey the overland flow from upstream catchments east of the property through the site.

The legal point of discharge is a point specified by Council where stormwater from a property can be discharged. The legal point of discharge is usually Council's stormwater infrastructure (where available), the street kerb and channel for smaller developments or downstream receiving waters like an existing stream or gully, lake, pond or waterbody.

Legal discharge for the western portions of the site is via the existing culverts on Mamre Road. Legal point of discharge for the eastern portion of the site is via the existing gully and farm dam in the Stage 1 condition and in Stage 2 will be via precinct road drainage. Final coordination of drainage discharge will be required with Mirvac.

The drainage system proposed can be described as follows:

- Road drainage system designed to the 5% AEP (1 in 20yr ARI);
- Stub connections for all development lots connecting to road drainage.
- All road drainage and development site drainage directed to one fo the three stormwater management basins;
- Stormwater management basins comprising stormwater detention to limit post development runoff to pre-development runoff and bio-retention system to complete final stormwater polishing.
- Inter-allotment drain to collect runoff from the northern external catchment, drains

- Inter-allotment drain to convey runoff through the north-eastern site portion, noting that the Stage 1 design allows for runoff to be conveyed through the site within an open channel.

5.4 Hydrologic Modelling and Analysis

5.4.1 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.

Runoff from buildings 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" (1987 Edition), Volumes 1 and 2 (AR&R).

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

5.4.2 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.

5.4.3 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.

5.4.4 Runoff Models

In accordance with the recommendations and standards of Penrith City Council, the calculation of the runoff from storms of the design ARI has been calculated with the catchment modelling software DRAINS for internal drainage only. Refer Section 8 for discussion pertaining to overland flow runoff models.

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 the recommendations as defined by council and parameters for the area and are as follows:

Table 5.1. DRAINS Parameters

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	

5.5 Hydraulics

5.5.1 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 perform to or exceed the required standard.

5.5.2 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/ grate level, for the peak runoff from the Minor System runoff.

The calculated water surface for the peak runoff from the Major System runoff will not exceed a freeboard level of 300mm below the finished floor level of the building/ development pads.

5.5.3 Public Safety

For all areas subject to pedestrian traffic, the 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.

5.5.4 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).

5.5.5 Overland Flow (development lots)

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.

5.6 External Catchments & E2 Zone Realignment

With reference to **Figure 5.2** below, an E2 Environmental Conservation Zone is shown to bisect the eastern portion of the site, its alignment being based on an existing gully/ watercourse.

The existing watercourse is recognised by NSW Natural Resources Access Regulator (NRAR) as a first order watercourse, though not considered as waterfront land as defined by the Water Management Act 2000. This was confirmed by NRAR in a meeting held on 3 August 2020 and also in the Cumberland Ecology letter referenced 19200 – Let6 dated 16 July 2020.

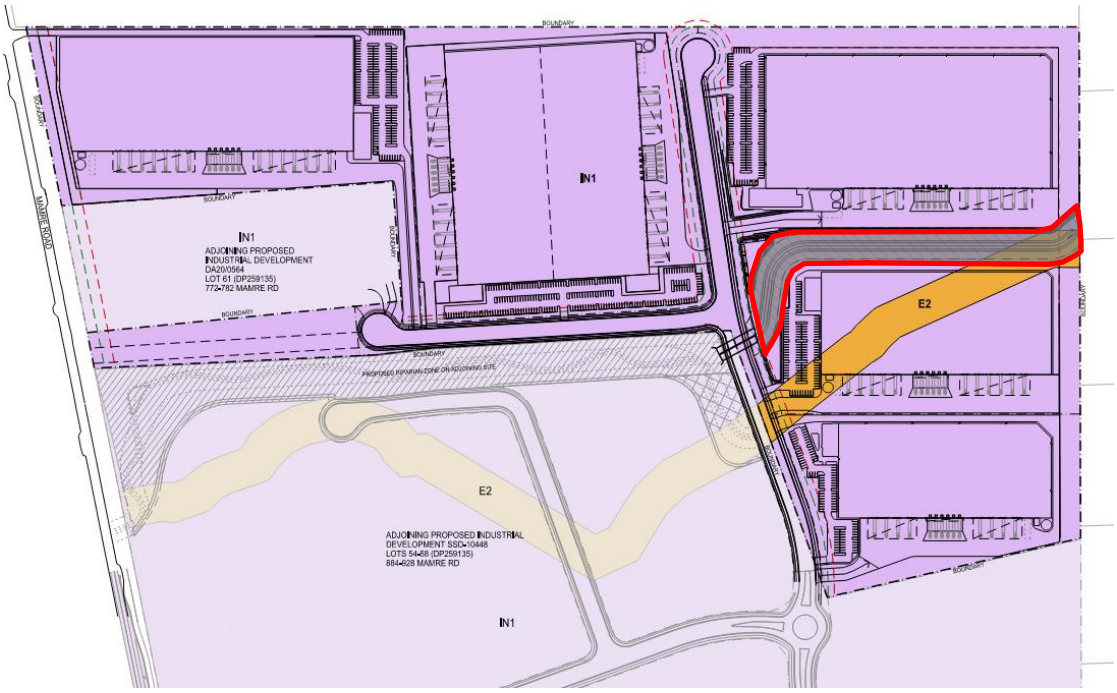

Figure 5.2. Existing E2 Conservation Zone & Proposed Realignment.

The watercourse is noted to have a contributing catchment of 22.2Ha and subsequent 1% Average Exceedance Probability (AEP) design flow of approximately 4.4m^3/s. During dry weather there would be limited or no baseflow given the relatively small contributing catchment. The existing watercourse is noted to be located within land currently utilised in a rural capacity and is clear of trees, has several farm dams and limited to no ecological value as concluded by Cumberland Ecology.

It is proposed by The GPT Group to realign the E2 Zone currently shown by DPIE and watercourse as part of the proposed development. With reference to drawing **Co13874.06-SSDA420** in **Appendix A**, flows from the contributing catchment are proposed to be conveyed within a new engineered, though naturalised, channel. The channel concept and a typical cross section in shown on the drawing. The section is noted to contain a 5m wide channel, with a 3.8m base and natural rock line channel banks. A 10m Vegetated Riparian Zone (VRZ) is proposed on either side of the main channel in accordance the requirements for a second order stream, as set out in the NRAR guidelines for works within controlled areas – refer **Appendix F**. The 10m VRZ will comprise battered vegetated slope. An overall 25m zone for the E2 Zone corridor and watercourse realignment is proposed.

In relation to conveyance capacity and stormwater management, as noted above, the calculated peak flow in the 1% AEP storm event is 4.4m^3/s. This peak flow is noted to be able to be conveyed within the proposed cross section at a depth of approximately 0.7m. The advanced concept designs will ensure that the channel is maintained with a naturalised feel, per the recommendations of NRAR. Refer to detailed flood modelling included in **Section 8** and **Appendix E** of this report for confirmation of pre and post development flooding, hydrology and hydraulics of the watercourse.

A 90-degree change in direction, with a prolonged curved radius, is proposed through the lower portion of the channel and at the entry to the culvert. The curved radius is noted to be approximately 35m in length, and the corresponding radius at the entry to the culvert is 25m – refer **Figure 5.3**. The final design is anticipated to include a meandering low flow channel, stilling ponds, drop sills, scour protection measures as required to ensure improved ecological conditions in the system.

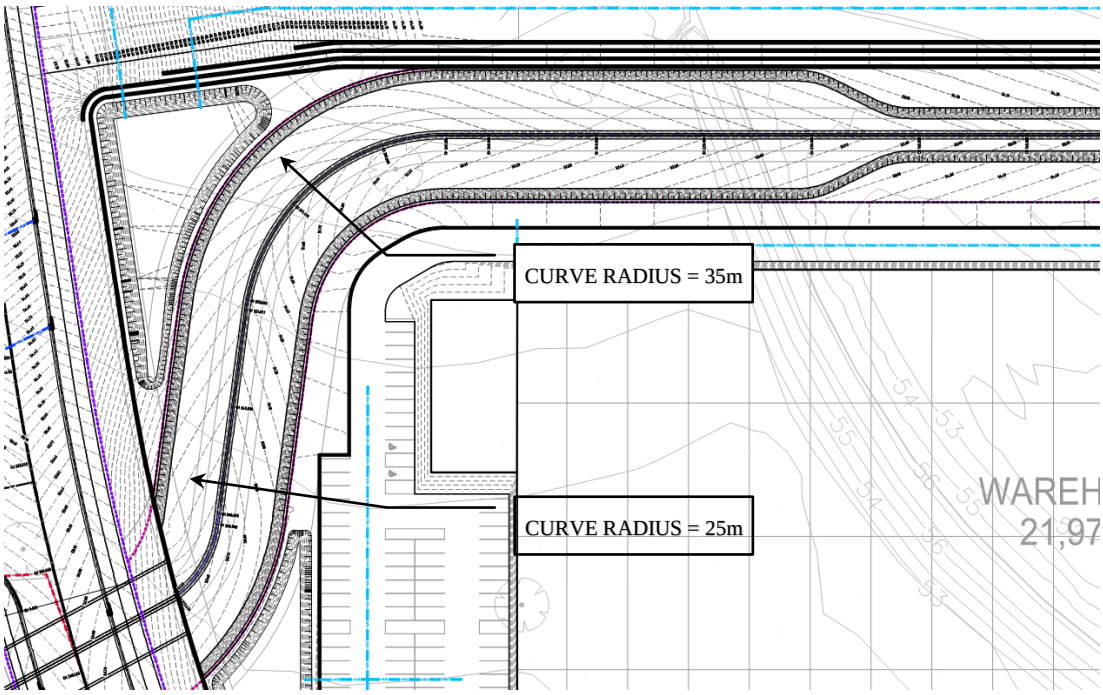

Figure 5.3. Proposed Channel Curves and Radius.

Review of recommended practice for naturalised creeks has been made using accepted industry methods for naturalised creek design, included in documents such as the *Queensland Urban Drainage Manual 2013*, and Brisbane City Councils *Natural Channel Design Guidelines 2003*. Within these documents recommended minimum radius of bends are recommended, based on the bank full width of the watercourse. The recommended minimum radius for a constructed bend is 3 times the bank full width.

For this project, noting the bank full width of 5m, the minimum acceptable design radius of curvature as such is 15m. As shown in **Figure 1**, the proposed minimum radius is 25m, and where the larger change in direction is proposed (35m radius) the radius is noted to be 3.6 times greater than the minimum recommended curve radius.

The proposed geometry allows for generous curvature at changes in direction that are considered acceptable based on the noted literature, accepted industry and naturalised channel design practices. As noted in this report, additional design elements would be included as the design progresses.

Consideration to a meandering low flow conveyance area will be integrated into the channel, and where changes in direction occur (including adjacent to the proposed road) consideration to additional scour protection via natural rock rip-rap and other suitable scour protection means will be made. Consideration to bio-diversity corridor (refer Cumberland Ecology letter) can be achieved in the 10m zone either side of the flow conveyance channel. Design progression of the naturalised channel would also include integration of naturalised watercourse elements such as a low flow channel, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice for a naturalised channel design. The realignment of the watercourse would be reflective of similar realignments in nearby industrial precincts including Upper

Angus Creek (Eastern Creek Business Hub Stage 4) and Eskdale Creek, Eastern Creek Drive.

Refer to detailed flood modelling included in **Section 8** and **Appendix E** of this report for confirmation of pre and post development flooding, hydrology and hydraulics of the watercourse.

6 WATER QUANTITY MANAGEMENT

6.1 Water Quantity Management Objectives

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*".

6.2 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.

6.3 Existing & Post Development Peak Flows

Table 6.1 to Table 6.3 show the existing and developed flows at the downstream boundary for the three existing catchments on the property.

Table 6.1. Q2, Q20 & Q100 ARI Peak Flows from Catchment 1

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Undeveloped	Developed	
		Site	Site (no atten.)	**Site (+ atten.)**
2	30	1.31	3.36	**0.97**
	60	1.56	3.44	**1.14**
	120	1.37	2.98	**1.03**
20	30	4.84	8.28	**2.91**
	60	5.19	7.90	**3.17**
	120	4.59	7.12	**3.08**
100	30	7.61	11.53	**3.97**
	60	7.82	10.84	**5.03**
	120	6.96	9.73	**4.36**

Table 6.2. Q2, Q20 & Q100 ARI Peak Flows from Catchment 2

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Undeveloped	Developed	
		Site	Site (no atten.)	**Site (+ atten.)**
2	30	2.44	3.86	**1.29**
	60	2.52	3.85	**1.47**
	120	2.39	3.34	**1.29**
20	30	7.93	9.19	**6.22**
	60	6.83	8.46	**6.32**
	120	7.11	7.87	**5.68**
100	30	10.70	12.79	**9.96**
	60	9.76	12.00	**9.76**
	120	10.10	10.85	**8.80**

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.

6.4 Proposed Water Quantity Management

As previously discussed, detention storage on the development site is required to reduce local outflows. The proposed site layout allows for provision of a combined OSD/Bio-Retention basin. The ultimate discharge location will be to the existing table drains along the Mamre Road frontage.

A number of combinations of storages and outlet arrangements have been modelled. The adopted arrangement models the basin configuration shown in **Table 5.3** and the proposed layout can also be observed on drawing **Co13874.06-SSDA431 & SSDA432**.

Table 5.3 OSD Detention Characteristics (Post Developed)

ARI	Duration (mins)	Peak Flow (m^3/s)					Depth (mm)	Storage (m^3)
		Discharge Location	No Atten.	With attenuation				
				Low	High	Total		
2	120	1	3.439	0.563	0	0.563	1560	1,975
		2	3.852	1.45	0	1.450	1610	2,025
20	60	1	7.901	.579	1.62	2.16	1960	3,090
		2	8.460	1.28	4.95	6.23	2000	3,950
100	60	1	8.37	0.543	3.10	3.64	2080	3,420
	30	2	10.70	1.308	8.309	9.62	2210	4,890

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

7 STORMWATER QUALITY, REUSE AND MAINTENANCE

7.1 Stormwater Quality Objectives

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. The reduction objectives noted in **Section 5.1** and **Table 5.1** of this report are presented in terms of annual percentage pollutant reductions on a developed catchment.

Consideration to the controls included in the *DRAFT Mamre Road Precinct DCP 2020 Section 2.6.2* has also been made in the impact assessment. The *DRAFT Mamre Road Precinct DCP 2020* considers controls for the concentration of pollutants at discharge in addition to pollution reduction targets which are based on the interim water quality and waterway health values for Wianamatta-South Creek. The reduction targets in the Mamre DCP are noted to be a function of the outcomes of the MARV and pollution concentration targets and noted as a guide only.

Pollution Concentration Targets - DRAFT Mamre Road Precinct DCP 2020

Total Nitrogen (TN)	1.67mg/L
Ammonium (NH4)	0.09mg/L
Total Phosphorous (TP)	0.14mg/L
Turbidity	29NTU
Conductivity	1081 uS/cm
pH	7.27-7.69

Pollution Reduction Targets - DRAFT Mamre Road Precinct DCP 2020

Gross Pollutants	100%
Total Suspended Solids	95%
Total Phosphorus	75%
Total Nitrogen	68%

It is noted that total phosphorous and total nitrogen are the two measurable concentrations able to be modelled through MUSIC.

7.2 Proposed Stormwater Treatment System

Developed impervious areas including roof, hardstand, car parking, roads and other extensive impervious areas are required to be treated by the Stormwater Treatment Measures (STM's). The STM's shall be sized according to the whole catchment area of the development. The STM's for the development shall be based on a treatment train approach to ensure that all the objectives above are met.

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

- Primary treatment to development lots and proposed roads are via a vortech type GPT (Rocla CDS, OceanSave or similar approved). Pre-treatment of the stormwater will assist in mitigating the potential for early onset sedimentation of the bio-retention systems;
- Tertiary treatment to the catchment will be provided by bio-retention system within each of the three proposed estate detention systems.

7.3 Stormwater Quality Modelling

The MUSIC model was chosen 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 5.1** of this report were used as a basis for assessing the effectiveness of the selected treatment trains.

The parameters used in the MUSIC model are presented in **Appendix B**. **Figure 7.1** below shows the MUSIC model layout.

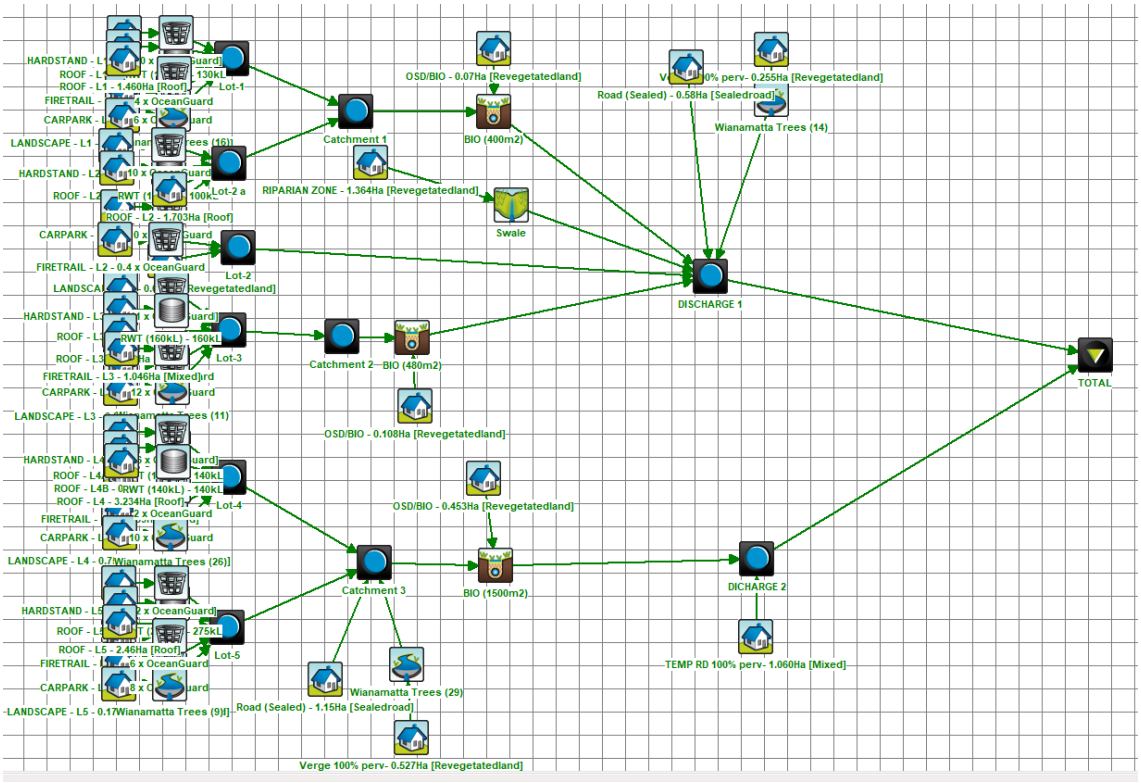

Figure 7.1. MUSIC model layout

Table 7.1 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.

Table 7.1. MUSIC analysis results - % reductions

	Source	Residual Load	% Reduction
Total Suspended Solids (kg/yr)	22800	3390	85.2
Total Phosphorus (kg/yr)	48.2	18.1	62.5
Total Nitrogen (kg/yr)	369	182	50.7
Gross Pollutants (kg/yr)	4530	96.1	97.9

Table 7.2. MUSIC analysis results % reduction and Mamre DCP Comparisons

Pollutant	% reduction achieved	% per Penrith DCP & Growth cts	% per Mamre DCP	Mean Conc achieved	Conc. achieved 98%tile	Conc. Achieved 95%tile	Required per Mamre DCP
TSS	85.7	85	95	NA	NA	NA	NA
TP	63.5	60	75	0.064mg/L	0.21mg/L	0.18mg/L	0.14mg/L
TN	52.3	45	68	0.642mg/L	2.00mg/L	1.72mg/L	1.67mg/L
GP	97.9	90	100	NA	NA	NA	NA

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

The MUSIC modelling has shown that the proposed treatment train of STM will provide stormwater treatment which will meet Council's and typical growth centre water quality reduction objective requirements in an effective and economical manner.

The modelling shows that treatment objectives included in the DRAFT Mamre Road Precinct DCP and noted to be very close to meeting GP's however below those for TSS, TP and TN requirements. 98%tile & 95%tile maximum concentrations are below for TN TP. It is noted however that mean TN and TP discharges are less around 50% of the maximum discharge quoted and standard deviation values (0.0759 and 0.651 for TP and TN respectively) suggest the statistical spread between mean, maximum and quoted percentiles is large, and quoted maximums are likely over inflated due to modelling limitations. Overall the proposed water quality system is considered to be robust and provides adequate water quality outcomes consistent with growth centre DCP, in fact significantly higher than most developments. The differences between the outcome achieved and the DRAFT precinct controls are considered to be minor in nature and acceptable based on councils current DCP and growth centre objectives.

Given the expected low source loadings of hydrocarbons and oil/grease and removal efficiencies of the treatment devices we consider that the requirements of the Penrith City Council have been met. Further discussion on hydrocarbons can be found in **Appendix B.**

7.4 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 is not proposed for the estate development, however future individual development lots will require re-use for non-potable applications. Internal uses include such applications as toilet flushing while external applications will be used for irrigation. The aim is to reduce the water demand for the development and to satisfy the requirements of PCC DCP2014. Objectives have been set out in **Section 5.1** of this document.

In general terms the rainwater harvesting system will be an 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 for future development lots and application will need to have harvesting systems sized with reference to the NSW Department of Environment and Conservation document *Managing Urban Stormwater: Harvesting and Reuse*, using either a simple water balance analysis to balance the supply and demand, based on the base water demands and the requirement of PCC DCP2014 Part C3, or via MUSIC.

The objectives, as included in **Section 5.1**, are to provide a reduction in non-potable water demand with a minimum demand reduction of 80% based on a rainwater balance assessment.

7.5 Stream Health/ Stormwater Discharge Assessment

It is proposed that Stream Erosion Index (SEI) metric is adopted for stream health for this development. A baseline SEI of 2.0 will be adopted for the development.

Penrith City Council's current DCP requires that the post development duration of stream forming flows shall be no greater than 3.5 times the pre-development duration of stream forming flows.

The reduced target of 2.0 has been adopted in response to the alternate MARV control of 1.9ML/Ha/Yr included in the *DRAFT Mamre Road Precinct DCP Section 2.6*. The adoption of the SEI over the MARV is considered a good balance between the desire from the DPIE to achieve acceptable waterway impact to South Creek with the ability to provide practical and economic measures to achieve the similar waterway health outcomes.

The use of MARV as the only hydrologic indicator for stream health is overly simplistic and has limited scientific justification. In this regard it is noted that a significant portion of MARV is often associated with large and infrequent rainfall events. Increases in volume due to development during such events will have minimal impact to waterway values, particularly relative to small/ frequent runoff events. The recent rainfall event seen over the five days between 18 to 23 March 2021, and similar events in February 2020 typify these large runoff volume events. It is considered that acceptable stream health from an SEI when compared to the proposed MARV can be achieved without overly stifling the ability to develop within the industrially zoned land.

It is noted that the *Western Sydney Engineering Design Manual* prepared by the Western Sydney Planning Partnership (including Penrith Council, DPIE and surrounding Councils

in the Growth Centres), proposes the same approach based upon adoption of a Stream Erosion Index (SEI), when considering impact to sensitive waterways. The proposed SEI adopted in the Planning Partnership document is noted to be 2.0.

Our SEI assessment is as follows.

SEI Assessment

The SEI has been calculated for the site area relating to the new development of 20.25 Ha.

The four following steps, as defined in the council document, were used in estimating the SEI:

1. Estimate the critical flow for the receiving waterway above which mobilisation of bed material or shear erosion of bank material commences.
2. Develop and run a calibrated MUSIC model of the area of interest for predevelopment conditions to estimate the mean annual runoff volume above the critical flow.
3. Develop and run a MUSIC model for the post developed scenario to estimate the mean annual runoff volume above the critical flow.

Use the outputs from steps 3 and 4 to calculate the SEI for the proposed scenario.

The critical flow for the receiving water (25% of the 2-year ARI) has been estimated at 0.15m^3/s.

A pre-developed model was set up based on the site being modelled as 100% pervious agriculture land. The pre-development runoff volume, above the critical flow, based on the calibrated MUSIC model was calculated at 17.28 ML/yr.

The post-development runoff volume, above the critical flow, based on the post-developed MUSIC model was calculated at 30.20 ML/yr. The post development model is based on the MUSIC model submitted and approved as part of this development approval documentation.

The SEI for the development has been calculated at **1.74**. This can be seen to be below the maximum proposed target of 2.0, hence the requirements of the SEI assessment have been met.

Reference to **Figure 7.2 and 7.3** should be made for pre and post developed scenarios**.**

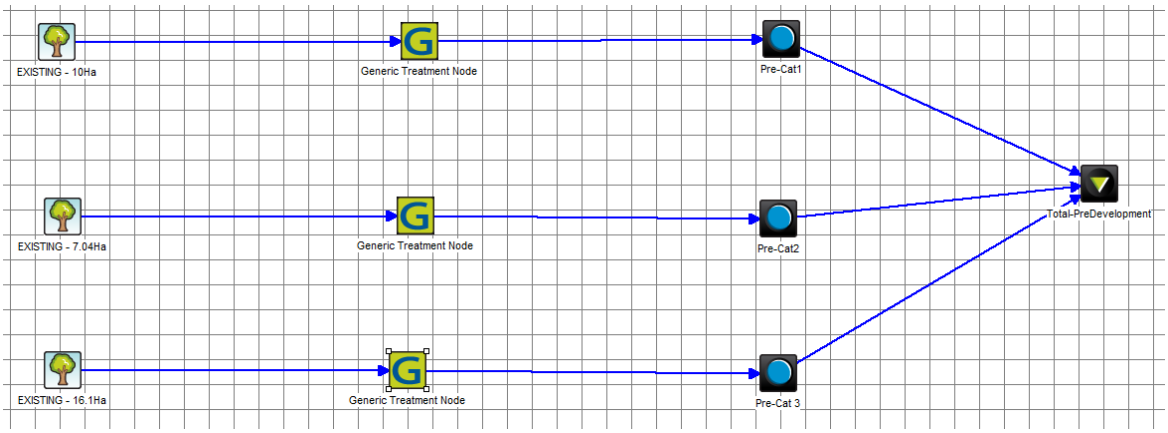

Figure 7.2. MUSIC Model Configuration – SEI pre-development

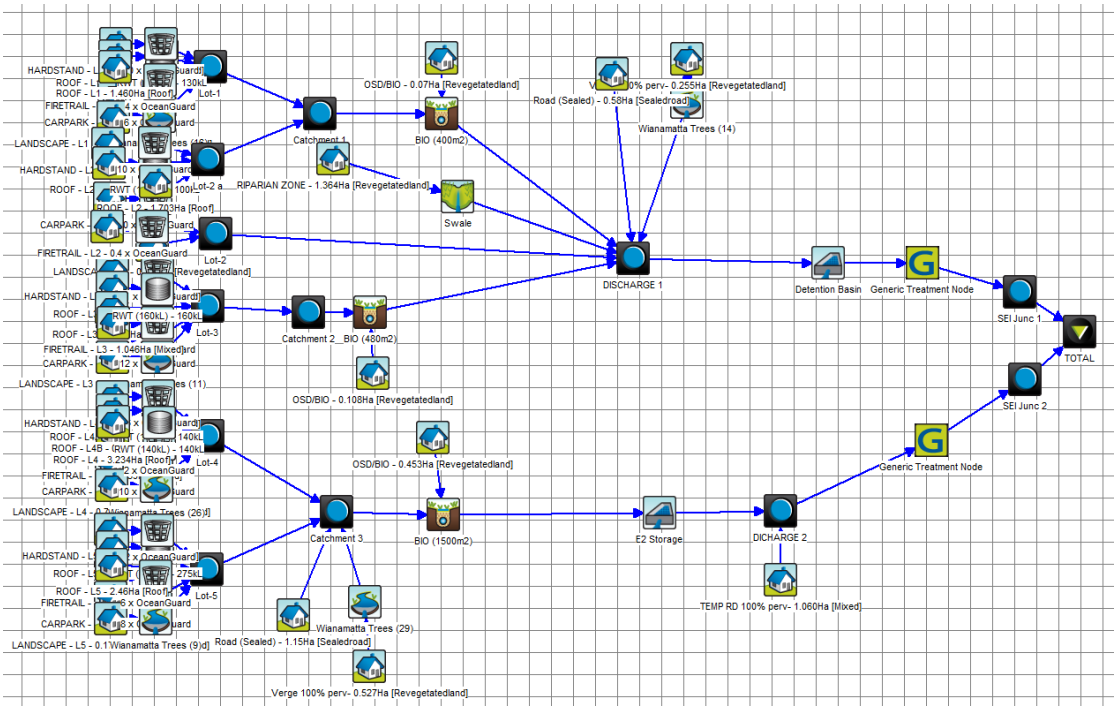

Figure 7.3. MUSIC Model Configuration – SEI post-development

7.6 Maintenance and Monitoring

It is important that each component of the stormwater system and water quality treatment train is properly operated and maintained. In order to achieve the design treatment objectives, an indicative maintenance schedule has been prepared and included as **Appendix D** to assist in the effective operation and maintenance of the various water quality components.

Inspection frequency may vary depending on site specific attributes and rainfall patterns in the area. In addition to the below nominated frequency it is recommended that inspections are made following large storm events.

8 FLOODING AND OVERLAND FLOW

8.1 Introduction

The site has been identified by Penrith City Council as being affected by overland flow from the existing gully and series of farm dams on the north-east of the property

We note that the site is clear of the South Creek Floodplain however the site contributes to one of the sub-catchments of South Creek and ultimately runoff from the property drains to South Creek.

An overland flow and flood assessment has been completed for the development approval submission in relation to the north-eastern flow path. The following sections of the report describe the catchment description, flood description and proposed flood management.

Detailed technical information pertaining to the TUFLOW modelling and output completed by our office is included in **Appendix E**.

8.2 Catchment Description & Existing Flood Behaviour

The contributing upstream catchment to the east is approximately 22Ha and is shown below in **Figure 8.1** and also as **Figure E2.1**. A smaller catchment of approximately 18.6Ha enters the site from the north.

The catchment comprises rural land use and >90% pervious surfaces. Future development is noted to require detention and as such has been modelled as per existing impervious surface breakdown.

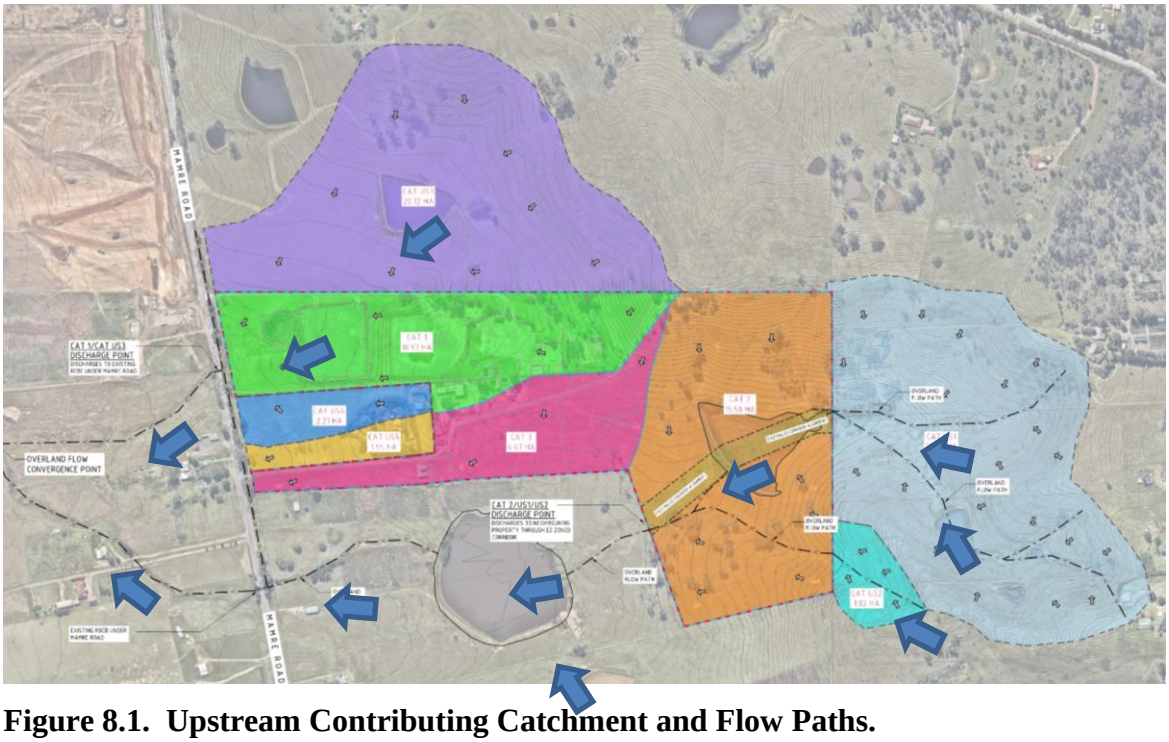

Figure 8.1. Upstream Contributing Catchment and Flow Paths.

Penrith Council is noted to have undertaken a regional assessment of local tributaries Penrith Overland Flow "*Overview Study – Flood Analysis for Central Urban (Zone 1),*

Northern Rural (Zone 2), Southern Rural (Zone 3)" – Cardno 2006. The site is located within the Southern Rural (Zone 3) and an excerpt of the flood model output is shown in **Figure 8.2 and also Figure E1.1 of Appendix E**. Councils' assessment shows overland flow is present along the series of farm dams in the north-eastern corner of the property. The modelling shows the flood extent to be limited to the gully and dams only, and not extending to areas away from the local watercourse. The area shown on the southern portion of the site as being flood affected in the PMF event is noted to comprise a farm dam only which is fully within the proposed development extent and as such has not been included in the current overland flow assessment.

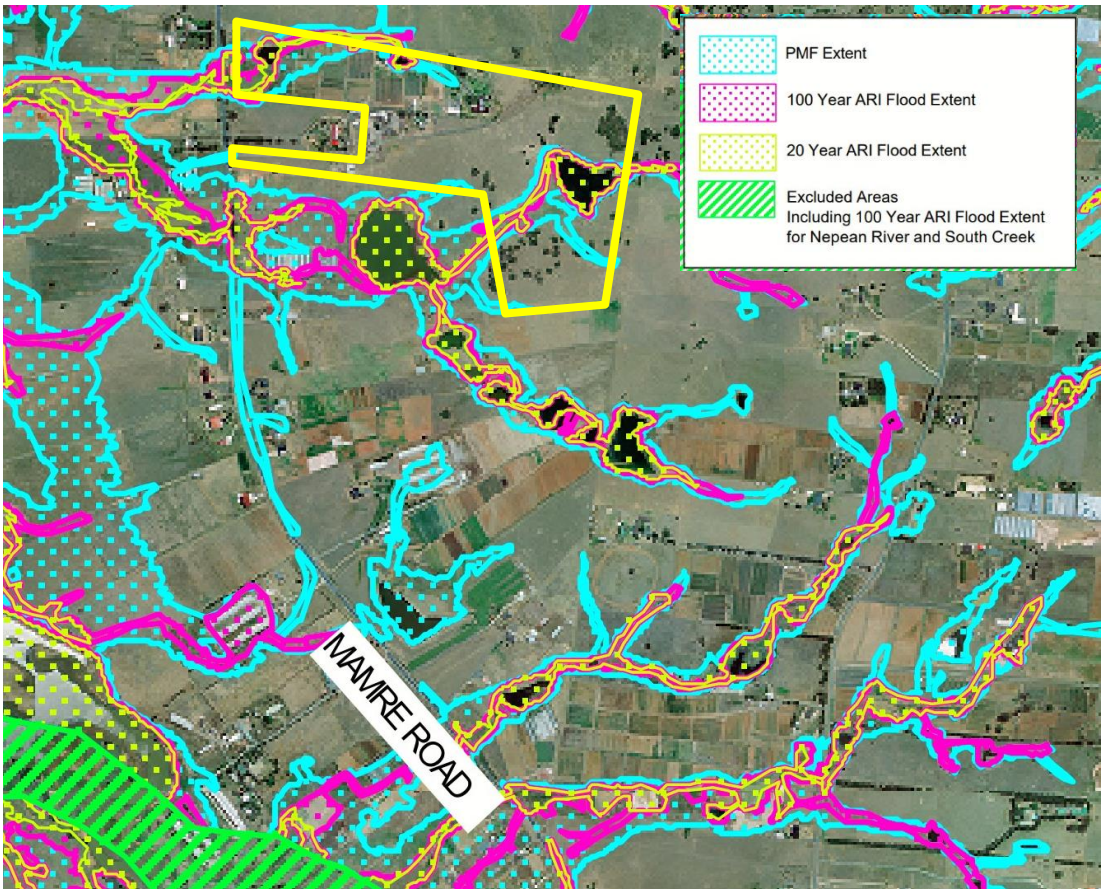

Figure 8.2. Excerpt of Figure 6.1k of Cardno 2006 Study

8.3 Proposed Overland Flow Management Strategy

Council requires an assessment of the pre and post development overland flow conditions for the 1% AEP storm event. Further that the overland flow from the upstream catchment is able to be conveyed through the site without affection of upstream, downstream or adjacent properties in the 1% AEP.

A TUFLOW model has been prepared for the assessment as set out in the following sections of the report. The proposed management strategy involves conveying overland flow from the eastern contributing through the development site within an open channel in the realigned E2 corridor (as discussed in Section 5) and the northern catchment to be

drained via an inter-allotment pipe (subject to the final agreed drainage with the northern property developer.

The final conveyance arrangement will be subject to the precinct layout and trunk drainage strategy for the precinct.

8.4 Costin Roe Consulting Modelling

8.4.1 Introduction

A detailed site specific TUFLOW model of the pre and post development conditions has been completed by Costin Roe Consulting. The assessment being completed with consideration to BCC policy and the *NSW Floodplain Development Manual*. Technical parameters and detail included in the TUFLOW model are included as **Appendix E.**

The pre-developed model has been prepared utilising the flood levels and hydrographs as completed by our office, with introduction of the proposed stage 1 development proposed by Mirvac in the post development conditions, in addition to the proposed GPT Group development layout. Validation of modelling was completed with comparison to Councils 2006 flood assessment.

8.4.2 Pre-Development 1% AEP

Reference to **Figure 8.4** shows the pre-developed 1% AEP output for depth and levels. **Figure 8.5** shows velocity and **Figure 8.6** show true hazard categorisation.

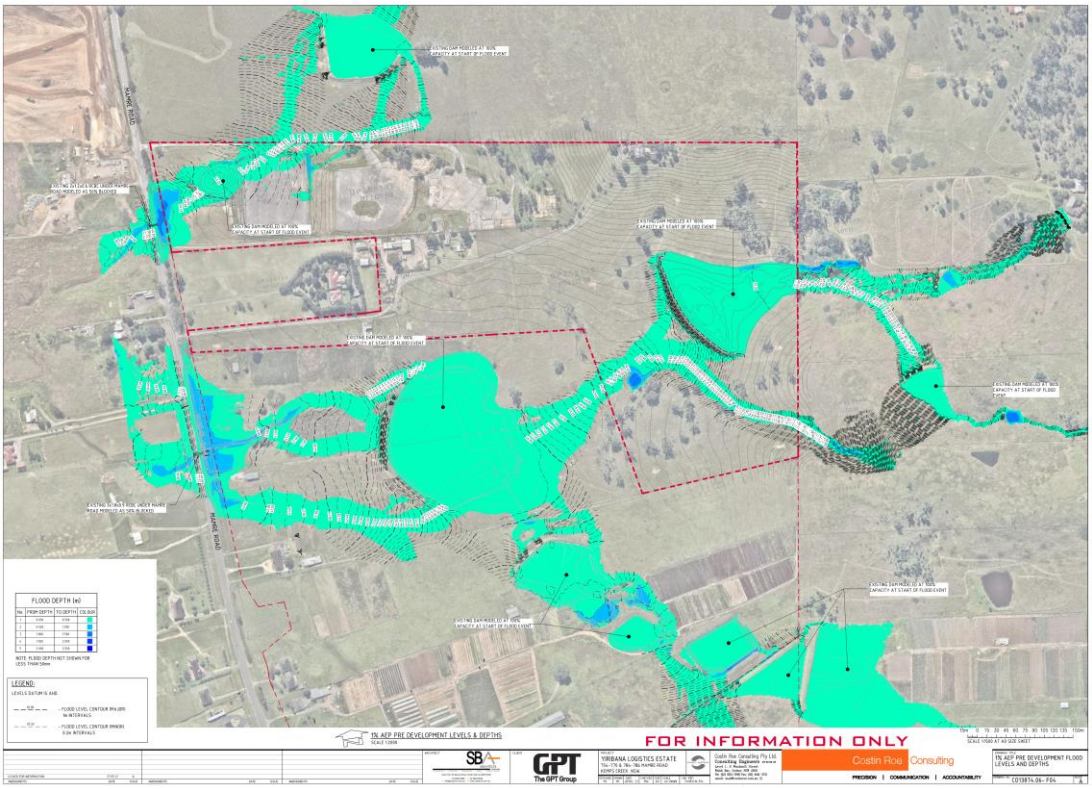

Figure 8.4: 1% AEP Pre-developed Level and Depth Output

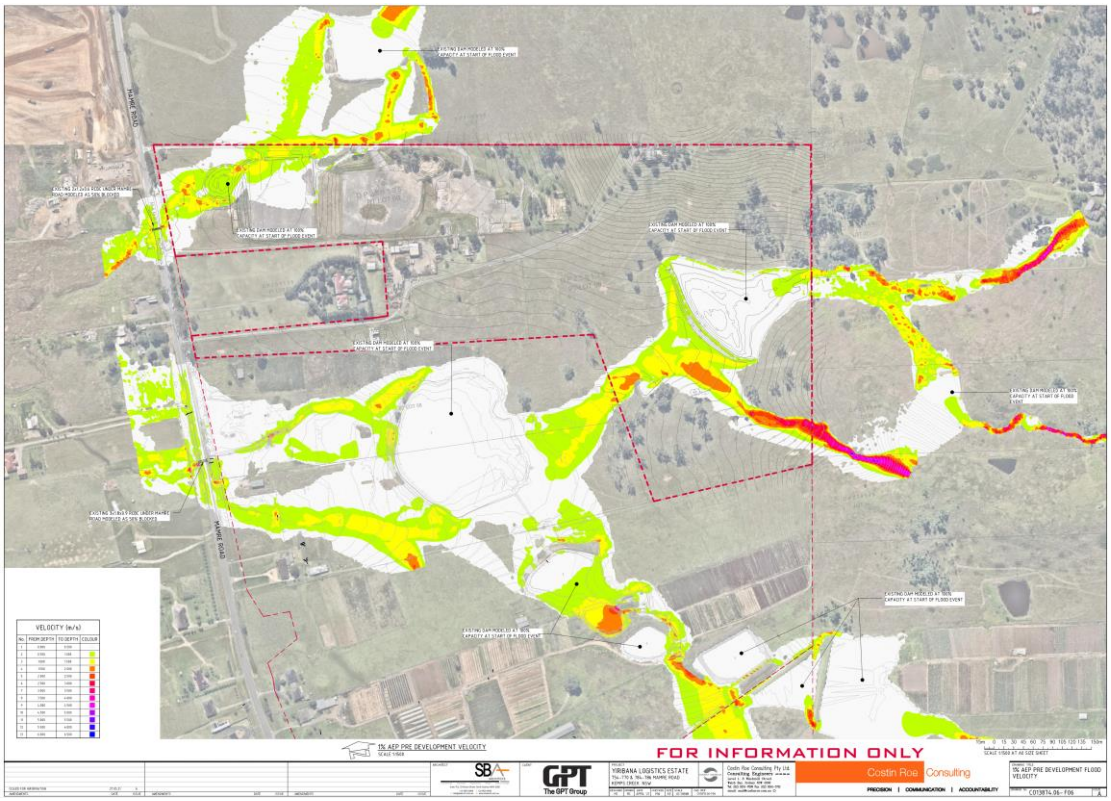

Figure 8.5: 1% AEP Pre-developed Velocity

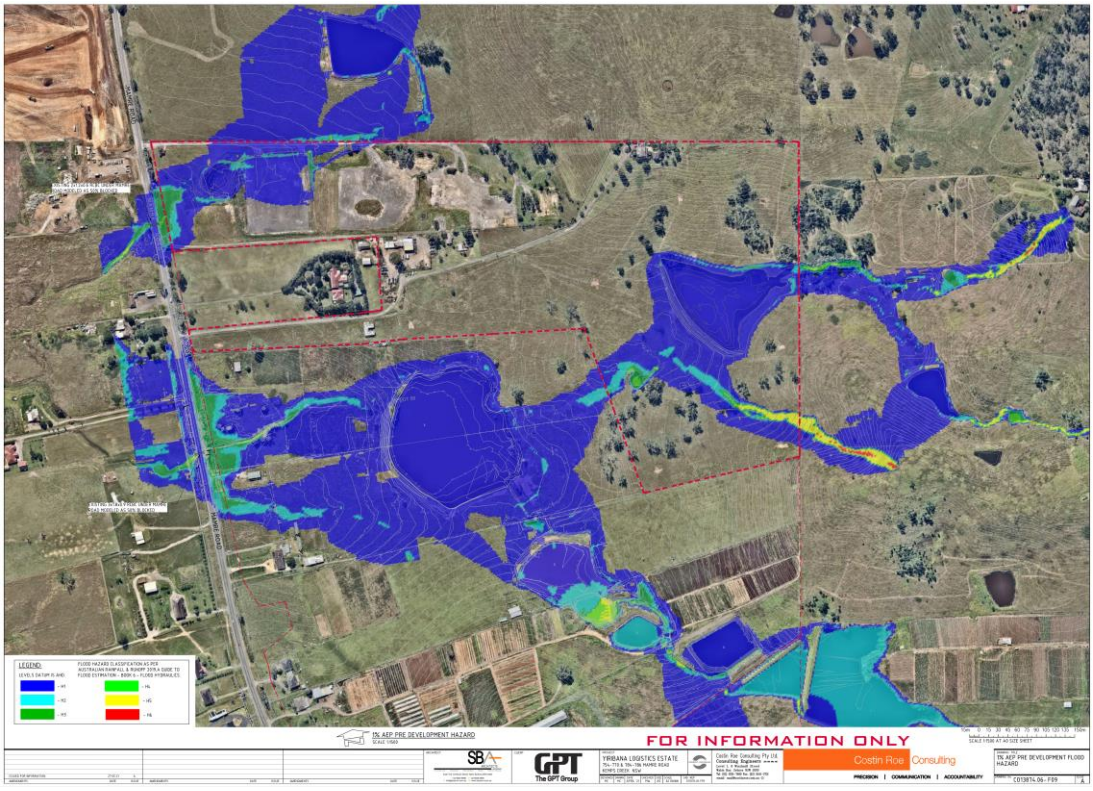

Figure 8.6: 1% AEP Pre-developed Flood Hazard Categorisation

8.4.3 Post-Development 1% AEP

Reference to **Figure 8.7** shows the post-developed 1% AEP output for depth and levels. **Figure 8.8** shows velocity and **Figure 8.9** show true hazard categorisation.

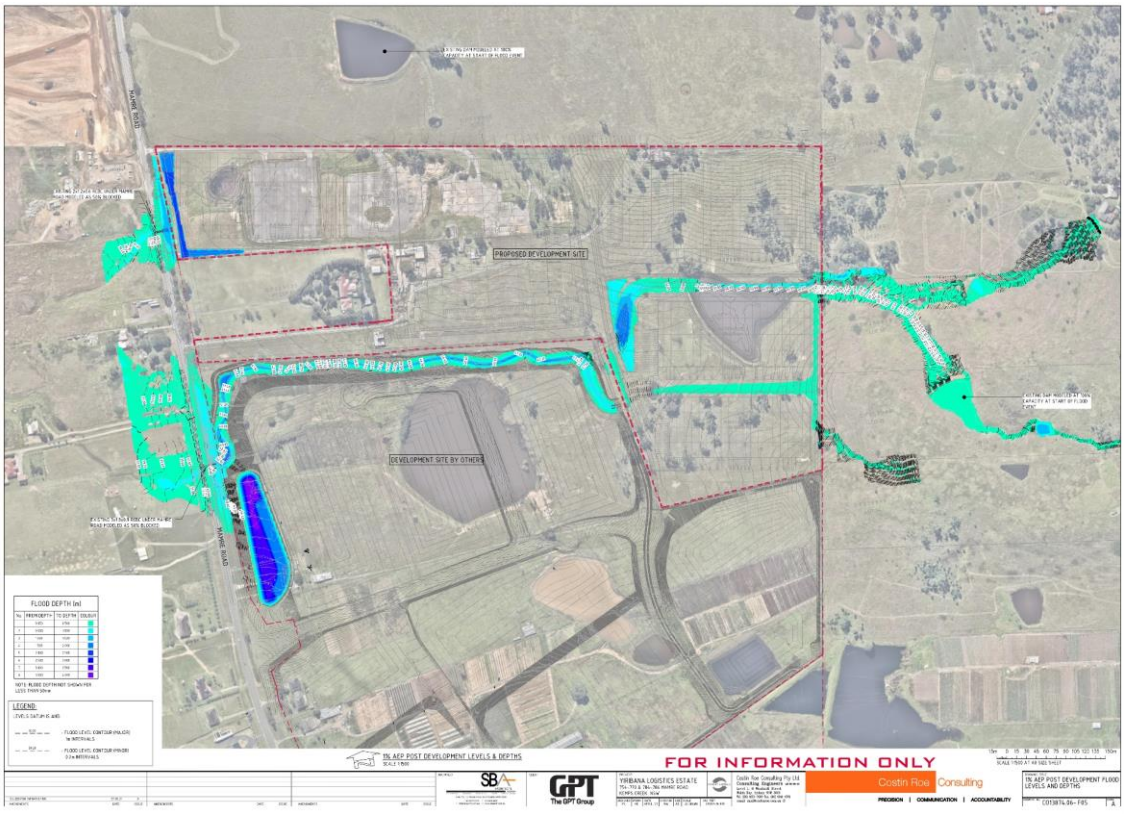

Figure 8.7: 1% AEP Post-developed Level and Depth Output

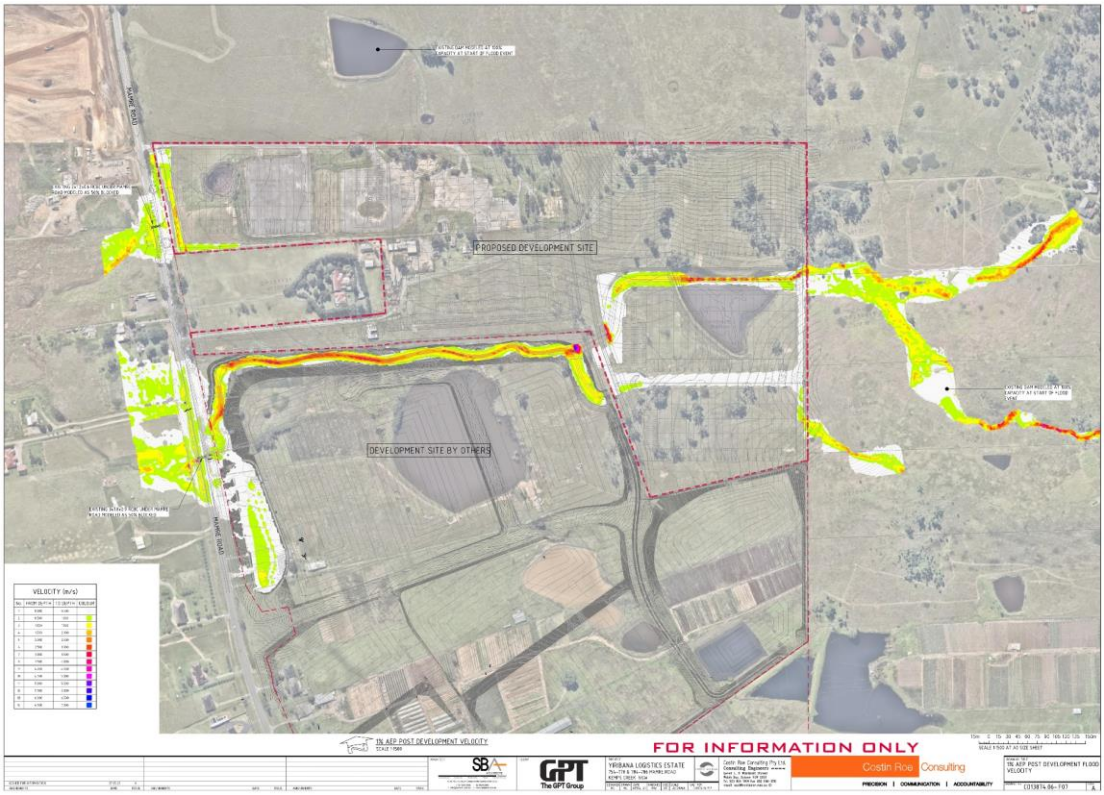

Figure 8.8: 1% AEP Post-developed Velocity

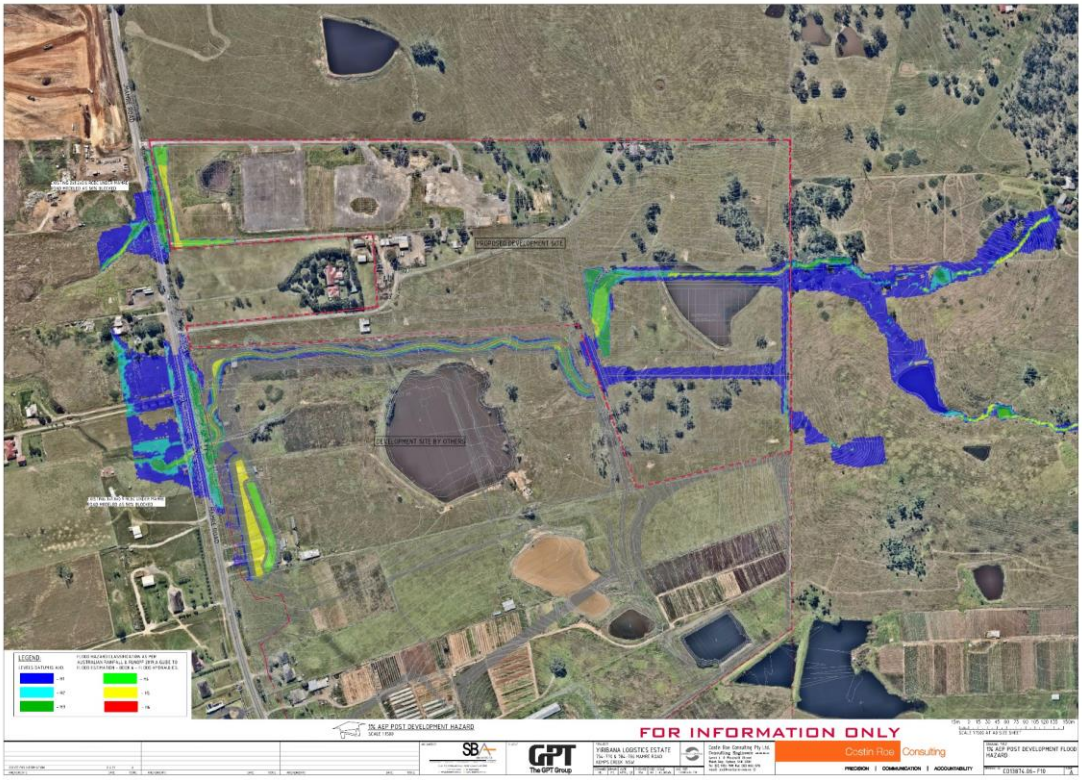

Figure 8.9: 1% AEP Post-developed Flood Hazard Categorisation

8.4.4 1% AEP Comparison

Figure 8.10 shows the 1% AEP flood level afflux (flood level difference) and **Figure 8.11** shows the 1% AEP velocity afflux, associated with the development.

The output for the 1% AEP storm event shows that:

- There is no upstream change to flood levels or velocity for any of the flow paths which enter the site;
- Flows within the E2 corridor are able to be conveyed within the proposed open channel and realigned E2 corridor within the Mirvac Property;
- At the culverts on Mamre Road adjacent to Lot 5, the output shows there is less than 20mm water level change; and
- Afflux at the culverts adjacent to Mirvac development are consistent with the flooding assessment submitted by Mirvac in their EIS, as completed by Cardno. Water levels changes at this location, although shown in our modelling, do not form part of the assessment and approval of the GPT Group development or submission.

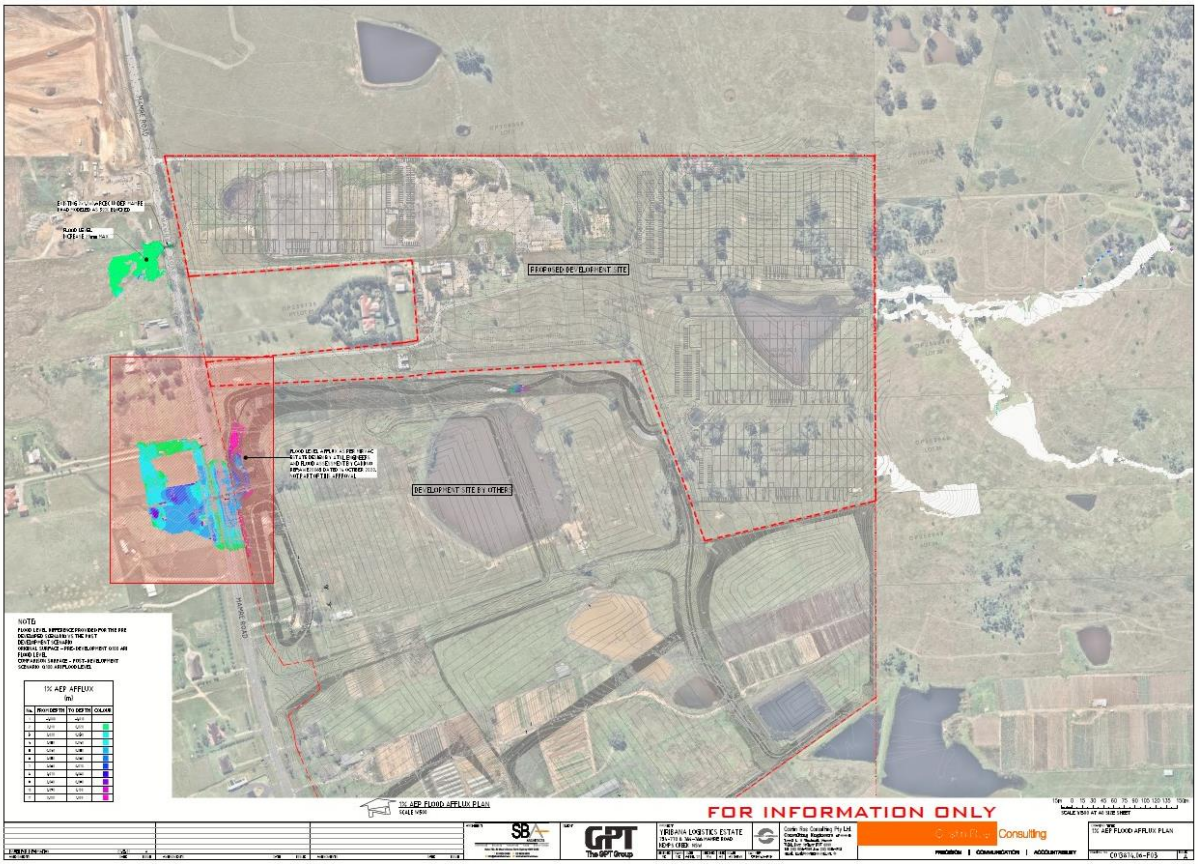

Figure 8.10: 1% AEP Post Developed Flood Level Afflux

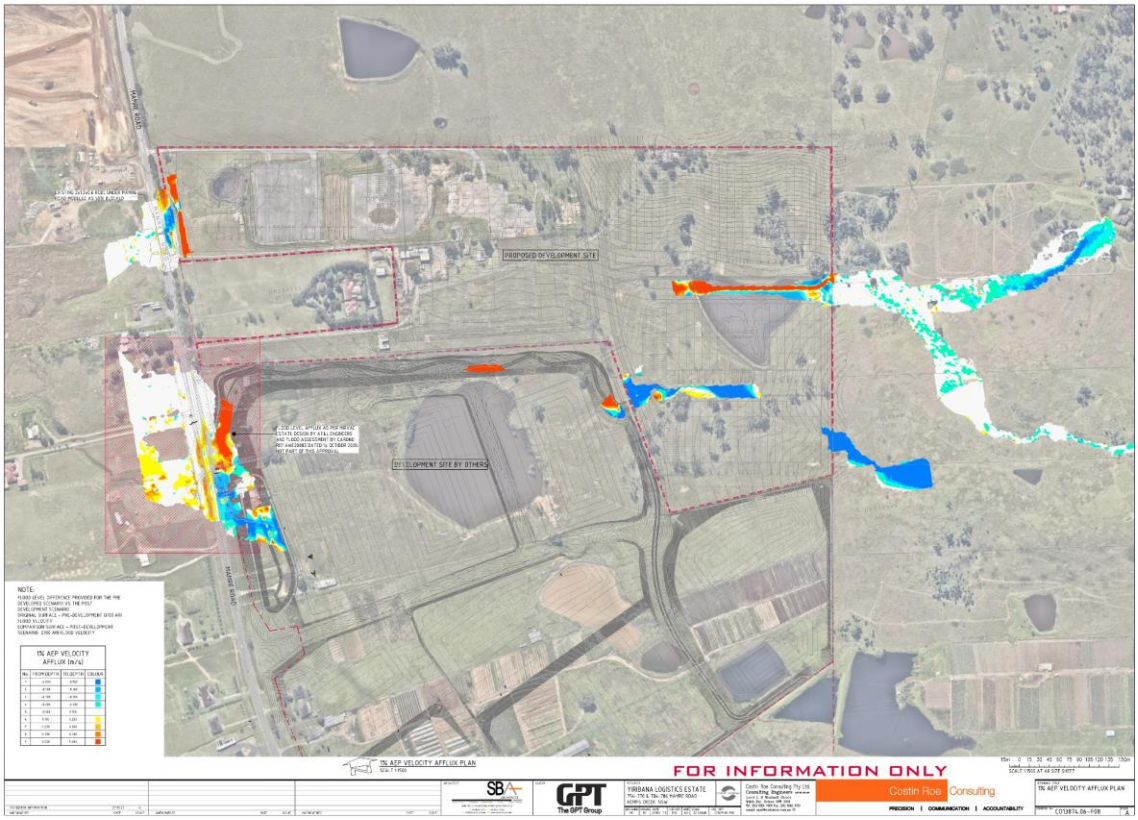

Figure 8.11: 1% AEP Post Developed Flood Velocity Afflux

8.5 Flood Planning and Hazard Categorisation

Penrith City Council has advised that the minimum floor level to be a minimum of 0.5m above 1% Annual Exceedance Probability flood level. The flood planning level (FPL) for the development is based on a minimum floor level of 1% AEP flood level plus 0.5m of freeboard.

For this site the proposed development requires a minimum FPL of RL 56.50m AHD, based on a 1% AEP level of 56.00m adjacent to the existing upstream catchment inflow point to the property on the east of the site.

Flood hazard categories are broken down into high and low hazard for each hydraulic category. High hazard areas are defined as those where there is a possible danger to personal safety and the potential for significant structural damage. Able-bodied adults would have difficulty in wading to safety. With low hazard areas, should it be necessary, a truck could evacuate people and their possessions, and able-bodied adults would have little difficulty in wading to safety.

Flood hazard criteria and mapping has been completed for the 1% AEP and PMF post development conditions as per criteria set out in the *Australian Rainfall and Runoff (2019), A Guide to Flood Estimation – Book 6 – Flood Hydraulics* and *Figure 6.7.9* as included as **Figure 8.12** below. Refer **Section 8.5** and **Appendix E** for hazard mapping.

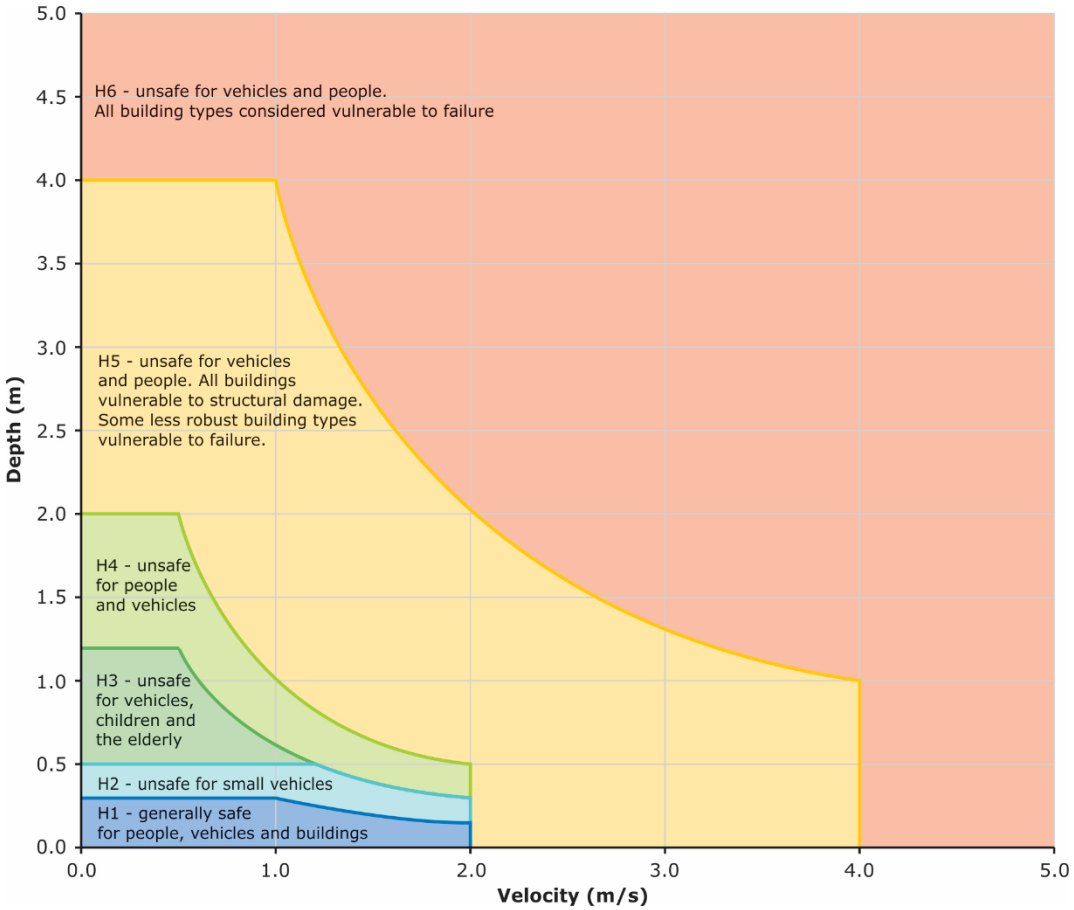

Figure 6.7.9. Combined Flood Hazard Curves (Smith et al., 2014)

Table 6.7.3. Combined Hazard Curves - Vulnerability Thresholds (Smith et al., 2014)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles. children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Table 6.7.4. Combined Hazard Curves - Vulnerability Thresholds Classification Limits (Smith et al., 2014)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

Figure 8.1. Adopted Hazard Criteria and Provisional Flood Hazard Chart (Australian Rainfall and Runoff 2019)

8.6 Confirmation of Councils Development Control Pan Part C3 Requirements

With reference to **Section 8.5** and modelling results contained in **Appendices E** we provide confirmation in **Table 8.1** that the criteria set out in the *Penrith Council Development Control Plan C3* (and listed in **Section 3.3**) for filling within flood affected land for the 1% AEP event.

We also provide, as **Table 8.2**, confirmation of Penrith Councils proposed adjusted DCP criteria as included in the Exhibition DRAFT of their *South Creek Floodplain Risk Management Plan Section 3.3* for the 1% AEP event.

8.6.1 Council DCP Part C3 (1% AEP Comparison)

Table 8.1. Confirmation of DCP Part C3 Criteria (1% AEP)

DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
Criteria 1 Flood levels are not increased by more than 0.1m by the proposed filling. *Post Note:* *As part of discussions with Council and the NSW DPE on recent nearby projects, Item i) above has been revised to ensure that no effect to upstream or downstream properties were to occur. The maximum offsite water level change confirmed for the assessment was to be 10-20mm or less. On-site changes would need to be within the 100mm as stipulated in Council DCP.*	The development proposes conveyance of flows up to the 1% AEP meeting councils limit on off-site affectation. Offsite water level changes resulting from this development are shown to be below councils threshold of 20mm in the 1% AEP event. Refer confirmation in **Section 8.5**. Flood level increase criteria is considered to be met.
Criteria 2 Downstream velocities are not increased by more than 10% by the proposed filling	Velocity assessment shows limited change to velocity offsite. Any increases in velocity are noted to be on site and generally around proposed drainage infrastructure and inlets where it would be anticipated that velocities would change. Velocity change criteria is considered to be met.

DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
Criteria 3 Proposed filling does not redistribute flows by more than 15%	Flow conveyance is based on meeting existing inlet and outlet positions for overland flow. As such there is no redistribution of flow proposed as a result of development. Flow distribution criteria is considered to be met.
Criteria 4 The potential for cumulative effects of possible filling proposals in that area is minimal	The development ensure that there is no offsite impacts. Further, future developments proposed to coordinate conveyance of flows within dedicated precinct drainage systems. There is limited or no potential for cumulative impacts as part of this development. Cumulative effect criteria is considered to have been met.
Criteria 5 There are alternative opportunities for flood storage.	The overland flow is noted to be confined to existing gully and farm dams, without limited flood storage. All assessments have been completed based on the existing farm dams being full at the start of the storm event. The proposed development includes for detention storage for all catchments which could act as flood storage for some events. Generally as a conveyance area, flood storage is not required, however as noted above some storage will be available. Flood storage criteria is considered to have been met.
Criteria 6 The development potential of surrounding properties is not adversely affected by the filling proposal	The development ensures that there is limited and has demonstrated acceptable offsite changes. Further, future developments proposed to coordinate conveyance of flows within dedicated precinct drainage systems. There is limited or no potential

DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
	for adverse effect on future development potential of surround properties as a result of the proposed development.
Criteria 7 The flood liability of buildings on surrounding properties is not increased	The flood liability of surrounding developments is not affected by the development proposal. surrounding buildings or properties.
Criteria 8 No local drainage flow/runoff problems are created by the filling	We confirm that no local drainage flow/runoff problems are created by the proposed filling. All local tributaries and flow paths will either operate in a similar manner to the existing regime or form part of the overall stormwater management system for the estate.
Criteria 9 The filling does not occur within Floodway Corridor	There is no floodway corridor defined or required to be considered for flows within the existing gully. The existing gully on site is noted to be a first order watercourse that only conveys runoff during periods of rainfall and runoff which currently flows in the watercourse is considered in the estate drainage system.
Criteria 10 The filling does not occur within the drip line of existing trees	Filling is proposed within the development land. It is expected that trees within development land will be affected by the civil works and future industrial development, consistent with the nature of the future development and zoning of the land. This is also noted to be consistent with the zoning of the land and discussion with Council.

8.6.2 South Ck Floodplain Risk Management Plan Recommended DCP Criteria (1% AEP Comparison)

Table 8.2. Confirmation of DCP Part C3/ South Creek Floodplain Risk Management Plan Recommended Criteria (1.0% AEP)

South Creek Floodplain Risk Management Plan Recommended DCP Criteria	**Post Development Scenario Confirmation (1% AEP Event)**
Recommended Criteria 1 Flood levels are not increased by more than 0.02m (20mm) outside of the development site.by the proposed filling.	The development proposes conveyance of flows up to the 1% AEP meeting councils limit on off-site affectation. Refer confirmation in **Section 8.5**. Offsite water level changes resulting from this development are shown to be below councils threshold of 20mm in the 1% AEP event. Flood level increase criteria is considered to be met.
Recommended Criteria 2/ 3 On the development site itself, flood hazard is not increased to greater than "low" based on current ARR criteria for hazard. Low hazard zones are defined in ARR as where D.V < 0.4 m^2/s for children and D.V < 0.6 m2/s for adults and should be applied depending on the type of development. Isolated areas of high hazard may be considered at Council's discretion where people are prevented from entering the area i.e. dedicated flow paths. Hazard should never increase to exceed 0.8 m2/s as this is the limiting working flow for experienced personnel such as trained rescue workers. Flood hazard should be assessed for the duration of the event and is not necessarily the flood hazard at the time of the peak flood level. Flood hazard on surrounding properties should not increase.	Flood hazard and velocity mapping has been included in **Section 8.5** of this report. The assessment shows acceptable hazard ratings and limited change in existing hazard rating. Velocity and flood hazard change criteria is considered to be met.

South Creek Floodplain Risk Management Plan Recommended DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
Recommended Criteria 4 The potential for cumulative effects of possible development proposals in that area is minimal	The development ensures that there is limited and acceptable offsite changes. Further, future developments proposed to coordinate conveyance of flows within dedicated precinct drainage systems. There is limited or no potential for adverse effect on future development potential of surround properties as a result of the proposed development. Cumulative effect criteria is considered to have been met.
Recommended Criteria 5 Where possible, any losses in floodplain storage are to be offset by compensatory cut at the same or a similar elevation.	The overland flow is noted to be confined to existing gully and farm dams. The proposed development includes for detention storage for all catchments which could act as flood storage for some events. Generally as a conveyance area, flood storage is not required, however as noted above some storage will be available. Flood storage criteria is considered to have been met.
Recommended Criteria 6/7 The flood liability and flood hazard of surrounding land is not adversely affected by the filling proposal	The flood liability of surrounding developments is not affected by the development proposal. surrounding buildings or properties.
Recommended Criteria 8 No local drainage flow/runoff problems are created by the development.	We confirm that no local drainage flow/runoff problems are created by the proposed development. All local tributaries and flow paths will either operate in a similar manner to the existing regime or form part of the overall stormwater management system for the estate.
Recommended Criteria 9 The filling does not occur within Floodway Corridor	There is no floodway corridor defined or required to be considered for flows within the existing gully.

South Creek Floodplain Risk Management Plan Recommended DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
	The gully is noted to be a first order watercourse that only conveys runoff during periods of rainfall.
Recommended Additional Criteria (i) Additional controls for critical facilities (eg schools, hospital, aged care facilities). (ii) Requirements for Flood Impact Asssessment (FIA) and Flood Risk Assessments (FRA) commensurate to development size, type and flood risk. (iii) Climate Change	(i) The proposed development is for industrial use and not considered to involve critical facilities. (ii) This report provides the necessary FIA and FRA. (iii)Given the limited catchment and site being located at the top of the catchment climate change assessment is not considered necessary for this development.

8.7 Climate Change Sensitivity Assessment

An assessment has been undertaken for the effect of climate change on the development. The assessment takes into consideration potential effect from increased rainfall intensity and sea level rise.

An assessment of the 0.2% AEP and 0.5% AEP was included as a proxy for the effect of climate change and is considered a conservative assessment for a 10% increase in flow to the 1% AEP event. Modelling has been undertaken for the 0.2% AEP and 0.5% AEP and flood afflux results are shown in **Figures 8.12 & 8.13**. Afflux results show minimal flood level change on the western side of the Mamre Road in the 0.5% AEP and 0.2% AEP when compared to the 1% AEP event. There is minor increase in flood afflux within. This assessment shows that the proposed stormwater drainage system and existing overland flow paths would have sufficient capacity to manage the increased peak flows and water volume with minor increase in peak water level at areas surrounding the Mamre Road culvert crossing. We confirm the increase in rainfall intensities will achieve the required minimum 0.5m freeboard to the proposed development levels in relation to overland flow paths from external & local catchments.

Overall, flood immunity of the proposed development sites would not be compromised given a large available freeboard amount much larger than minimum 0.5m values generally adopted.

The site is situated well upstream from any tidally influenced receiving waters including expected potential sea level rise of 0.4m. We confirm the development will not affect or be affected by potential sea level rise.

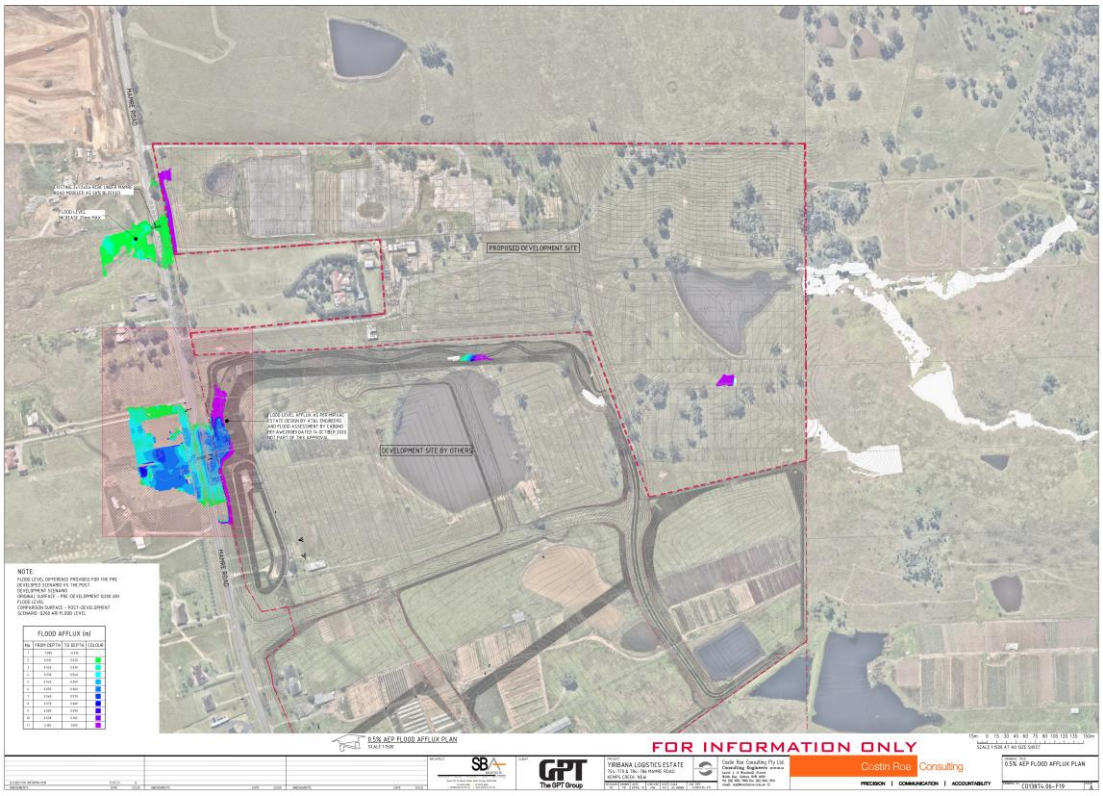

Figure 8.12: 0.5% AEP Post Developed Flood Level Afflux

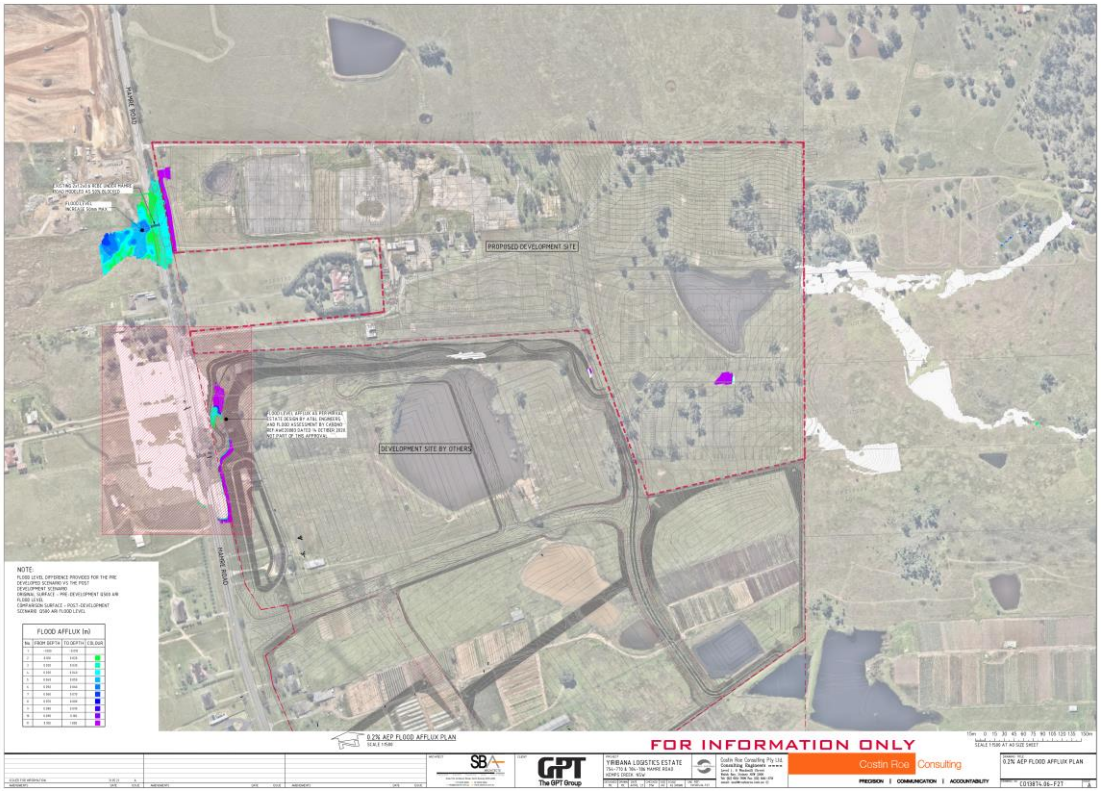

Figure 8.13: 0.2% AEP Post Developed Flood Level Afflux

8.8 Flood Assessment Conclusion

A TUFLOW hydrodynamic flood model has been completed and the pre and post development flood events assessed for flooding as a result of a 1% AEP rainfall event within the catchment.

The assessment of the 1% AEP event confirms that conveyance paths are available to the eastern and northern side of the proposed estate development. There is negligible effect on flood water local to the development. The TUFLOW Modelling completed by Costin Roe Consulting and confirmation of DCP Criteria in **Section 8.7** confirms there is no affectation of upstream, downstream or adjoining properties.

9 SOIL AND WATER MANAGEMENT

9.1 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.

9.2 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 Mamre Road and other public roads.

9.3 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.

10 SEAR's & AGENCY RESPONSE ITEMS

10.1 SEARS Introduction

The following sections of the report include responses to items included in the NSW Department of Planning and Environment SEARS letter dated November 2020, reference SSD_10272349, and the associated agency response letters from Penrith City Council, NSW Department of Primary Industries (DPI) and NSW Office of Environment & Heritage (OEH).

Further reference to the EIS prepared by Urbis Planning should be made for confirmation of how the SEAR's have been addressed for non-civil engineering or WCM related items.

10.2 SEAR's Response Items

SEARS – General Requirements
A topographic assessment and justification of the proposed earthworks are site responsive and contextually appropriate Response The development responds to the topography by providing development pads which step from progressively from the existing high point on the east of the development site, to the lowest part of the site on the west adjacent to Mamre Road. Consideration to the anticipated development levels on the adjacent sites to the south and west, contemplated by adjoining landowner/ developers Mirvac and Altis Property Partners, through consultation with these respective developers has also been made. Overall, it can be anticipated that, on a development site which has a level differences of approximately 44m, and proposed large format industrial warehouse (as zoned) that level changes and retaining structures will be required to facilitate flat building pads and benching suitable for logistics and distribution. This is a fundamental requirement for the effective development over the entire Mamre Road Precinct and a point that has been discussed with DPIE. Refer to **Section 3.2** and **3.3,** and drawings included in **Appendix A**.
An assessment of potential impacts to soil and water resources, topography, hydrology, groundwater, groundwater dependent ecosystems, drainage lines, downstream assets such as warragamba pipelines corridor, watercourses and riparian lands on or nearby to the site. This will include mapping and a description of existing background conditions and cumulative impacts and measures proposed to reduce and mitigate impacts. Response Refer to **Section 5, 6 & 7** for assessment of water resources, hydrology, watercourses and riparian lands.

Refer to **Section 3** for assessment of soil resources. Refer to **Section 2 & 3** for background conditions. Refer to separate report, completed by Arcadis, in relation to groundwater and groundwater dependent ecosystems. The development is noted to be approximately 1km south of the Warragamba Pipeline. There are no watercourses which drain toward or through the Warragamba Pipeline from the subject land. The proposed development has no impact or works associated with the Warragamba Pipeline and no additional assessments are required in relation to the development and the pipeline.
Consideration of the NSW Aquifer Interference Policy (2012) and the guidelines for Controlled Activities on Waterfront Land (2018) Response Consideration to the guidelines for Controlled Activities on Waterfront Land (2018) has been made in relation to the E2 corridor and watercourse which is present on the land, including consultation with NRAR. It is proposed that the watercourse be realigned, in conjunction with the adjoining land developer, Mirvac. The design of the realigned watercourse has been completed in accordance with the noted guidelines as discussed in detail in **Section 5.6** and documented on Civil Design Drawings included in **Appendix A**.
A detailed Site water balance including identification of water requirements for the life of the project, measures that would be implemented to ensure an adequate and secure water supply is available for the development, and a detailed description of the measures to minimize the water use at the site. Response Water supply for the development will be provided by Sydney Water, an adequate and secure supplier. Measures including rainwater reuse are proposed for non-potable water use with the demand on non-potable being reduced by 80%.
Demonstrate satisfactory arrangements for drinking water, wastewater, and if required, recycled water services have been made. Response Reference to the services infrastructure reporting should be made pertaining to driking water and wastewater supply.
Characterization of water quality at the point of discharge to surface and/or groundwater against the relevant water quality criteria (including proposed mitigation measures to manage any impacts to receiving waters and monitoring activities and methodologies)

Response Stormwater assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report. **Section 7** provides demonstration of the key criteria being met, based on MUSIC modelling. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.
A site- specific integrated water management strategy with details of a stormwater/ wastewater management system including how it will be designed, operated and maintained, including the capacity of onsite detention system(s) Response A stormwater management assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report. **Section 6** provides demonstration of the water quantity management, including on-site detention system storage capacity operation, hydrology and hydraulics. **Section 7** provides demonstration of the key water quality criteria being met, based on MUSIC modelling. Also included in **Section 7** is stormwater harvesting (via rainwater reuse), stream health and maintenance and monitoring requirements. Further detail on maintenance and monitoring can be found in **Appendix D**. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.
A description of the measures to minimize water usage Response Refer to **Section 7.4** for stormwater harvesting (via rainwater reuse). Refer to EIS for other measures specific to building and site measures
A detailed flooding impact assessment is provided. Response Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed

amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Descriptions of the proposed erosion and sediment controls during construction are provided, as well as consideration of salinity and acid sulphate soil impacts. Response Refer to **Section 9** for soil and water management measures, drawings in **appendix A** for associated erosion and sediment control drawings, and **Appendix C** for a Draft Soil and Water Management Plan. These sections show proposed measures, based on the Landcom document *Managing Urban Stormwater – Soils & Construction Volume 1 ('Blue Book')(Landcom, 2004),* are proposed during the construction of the development. Measures proposed will limit potential for offsite impact associated with water runoff and soils during construction. Consideration to management of salinity and acid sulphate has been made based on the recommendations of the geotechnical investigations and noted Landcom document.

10.3 Agency Responses

DPIE (Water) – ref: OUT20/13032
The SEARS should include: *The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased.* Response Water supply for the development will be provided by Sydney Water, an adequate and secure supplier. No water entitlements are required to be purchased.
A detailed and consolidated site water balance. Response Reference to **Sections 5, 6** and **7** of this report should be made for surface water assessments.
Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.

Response Refer to **Section 5, 6 & 7** for assessment of water resources, hydrology (including quality and quantity), watercourses and riparian lands. Refer to **Section 3** for assessment of soil resources. Refer to **Section 2 & 3** for background conditions. Refer to separate report, completed by Arcadis, in relation to groundwater and groundwater dependent ecosystems. There are no proposed water licenses and adjacent properties are noted to be contemplating similar developments.
Proposed surface and groundwater monitoring activities and methodologies. Response There are no proposed or required surface and groundwater monitoring activities.
Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans (available at https://www.industry.nsw.gov.au/water). Response Consideration to the guidelines for Controlled Activities on Waterfront Land (2018) has been made in relation to the E2 corridor and watercourse which is present on the land, including consultation with NRAR. It is proposed that the watercourse be realigned, in conjunction with the adjoining land developer, Mirvac. The design of the realigned watercourse has been completed in accordance with the noted guidelines as discussed in detail in **Section 5.6** and documented on Civil Design Drawings included in **Appendix A**.

DPIE (EES) – ref:DOC20/892052	
Water & Soils	
Item 6	***The EIS must map the following features relevant to water and soils including:***
Item 6a	*Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map).* Response Refer separate geotechnical investigation for mapping, and **Section 3.7** of this report for discussion on acid sulfate soils.

Item 6b	*Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method).* Response There are no rivers, streams, wetlands or estuaries (as described in s4.2 of the Biodiversity Assessment Method) within the study area. A first order water course is noted to be present on the site, within the zoned E2 corridor as discussed in **Section 5.6** and shown on Civil Engineering Drawings included in **Appendix A**.
Item 6c	*Wetlands as described in s4.2 of the Biodiversity Assessment Method.* Response There are no wetlands within the study area.
Item 6d	*Groundwater.* Response Refer separate report by Arcadis which includes the groundwater assessment and recommendations. **Section 3.6** of this report confirms how the civil engineering design includes the recommendations of the groundwater assessment.
Item 6e	*Groundwater dependent ecosystems* Response Refer separate report by Arcadis which includes the groundwater assessment and recommendations. **Section 3.6** of this report confirms how the civil engineering design includes the recommendations of the groundwater assessment.
Item 6f	*Proposed intake and discharge locations* Response There are proposed intake or discharge locations on the project.
Item 7	***The EIS must describe background conditions for any water resource likely to be affected by the development, including:***
Item 7a	*Existing surface and groundwater.* Response Refer **Sections 2, 5, 6, 7 & 8** for assessment of surface stormwater management including assessments of hydrology, watercourses, and drainage lines.

Item 7b	*Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations.* Response Refer **Sections 2, 5, 6, 7 & 8** for assessment of surface stormwater management including assessments of hydrology, watercourses, and drainage lines.
Item 7c	*Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters* Response Stormwater assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report. **Section 7** provides demonstration of the key criteria being met, based on MUSIC modelling. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.
Item 7d	*Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government* Response Stormwater assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report. **Section 7** provides demonstration of the key criteria being met, based on MUSIC modelling. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.
Item 7e	*Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* *http://www.environment.nsw.gov.au/research-and-publications/publications-search/risk-based-framework-for-considering-waterway-health-outcomes-in-strategic-land-use-planning* Response Stormwater assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater

	objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report. **Section 7** provides demonstration of the key criteria being met, based on MUSIC modelling. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.
Item 8	***The EIS must assess the impact of the development on hydrology, including:***
Item 8a	*Water balance including quantity, quality and source.* Response Refer to **Section 5, 6 & 7** for assessment of water resources, hydrology (including quality and quantity), watercourses and riparian lands.
Item 8b	*Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas.* Response Refer to **Section 7.5** which discusses, assesses, and provides demonstration of acceptable stream health outcomes, consistent with best practice and consideration of the 9 stream health metrics recommended for assessment of stream health.
Item 8c	*Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems.* Response Refer to separate report, completed by Arcadis, in relation to groundwater and groundwater dependent ecosystems.
Item 8d	*Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches).* Response Refer to **Section 7.5** which discusses, assesses, and provides demonstration of acceptable stream health outcomes, consistent with best practice and consideration of the 9 stream health metrics recommended for assessment of stream health. Refer to ecological report in relation to aquatic connectiveity, habitat and other ecological related assessments.
Item 8e	*Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water.*

	Response No changes to environmental water availability are proposed as part of the development.
Item 8f	*Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options* Response Refer to **Section 5, 6 & 7** for assessment of water resources, hydrology (including quality and quantity), watercourses and riparian lands during operation. Refer to **Section 9** for soil and water management measures during construction, drawings in **appendix A** for associated erosion and sediment control drawings, and **Appendix C** for a Draft Soil and Water Management Plan. These sections show proposed measures, based on the Landcom document *Managing Urban Stormwater – Soils & Construction Volume 1 ('Blue Book')(Landcom, 2004)*, are proposed during the construction of the development. Measures proposed will limit potential for offsite impact associated with water runoff and soils during construction. Consideration to management of salinity and acid sulphate has been made based on the recommendations of the geotechnical investigations and noted Landcom document.
Item 8g	*Identification of proposed monitoring of hydrological attributes.* Response Refer **Appendix D** for DRAFT Maintenance and Monitoring requirements associated with the specified drainage system and water quality measures.
Flooding & Coastal Areas	
Item 9	*The EIS must map the following features relevant to flooding as describes in the floodplain development manual 2005 (NSW Government 2005) Including:* *a) Flood prone land,* *b) Flood planning areas, and the areas below the flood planning level,* *c) Hydraulic Categorization (floodways and flood storage areas) and lastly,* *d) Flood hazards.*

	Response Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item10	*The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP, flood levels and the probable maximum flood, or an equivalent extreme event.* Response Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. This watercourse presents low hazard to the development and future occupants of the development site.

	The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 11	*The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenario:* *a) Current flood behaviour for a range of design events as identified 14 above. This includes the 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.* <u>Response</u> Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 12a	*Modelling in the EIS must consider and document:* *The existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies.* <u>Response</u> The modelling contemplates existing studies including Penrith Councils *South Creek Flood Study (Advisian 2014)* and Penrith

	Council *Overview Study – Flood Analysis for Central Urban (Zone 1), Northern Rural (Zone 2), Southern Rural (Zone 3)*" – Cardno 2006
Item 12b	*The impact on existing flood behavior for a full range of flood event including up to the probable maximum flood, or an equivalent extreme flood.* Response The assessment includes a range of storms for pre and post development conditions with modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP. The 0.5% AEP, 0.2% AEP events assessed as proxies for climate change.
Item 12c	*The impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow, velocities, flood levels, hazard categories and hydraulic categories.* Response The assessment includes a range of storms for pre and post development conditions with modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP. The 0.5% AEP, 0.2% AEP events assessed as proxies for climate change.
Item 12d	*Relevant provisions of the NSW Floodplain Development on flood behaviour.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.

Item 13a	***The EIS must assess the impacts on the proposed development on flood behaviour, including:*** *Whether there will be detrimental increases in the potential flood affection of other properties, assets and infrastructure.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*. The assessment confirms there will be no detrimental increase in the flood potential of other properties, assets and infrastructure.
Item 13b	*Consistency with council floodplain risk management plans.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13c	*Consistency with any rural floodplain management plans.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13d	*Compatibility with the flood hazard of the land.* Response The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP

	proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13e	*Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land* Response The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13f	*Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13g	*Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*. Refer to **Section 7.5** which discusses, assesses, and provides demonstration of acceptable stream health outcomes, consistent with best practice and consideration of the 9 stream health metrics

	recommended for assessment of stream health. This includes consideration and management of erosion, stability of watercourses and riverbanks.
Item 13h	*Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council.* Response Refer to **Section 8**. The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level roadways are affected during flooding, on site refuge is available. The development presents low/ no risk to existing community emergency management arrangements.
Item 13i	*Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council.* Response Refer to **Section 8**. The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level roadways are affected during flooding, on site refuge is available. The development presents low/ no risk to existing community emergency management arrangements.
Item 13j	*Emergency management, evacuation and access, and contingency measures for the development considering the full range of flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of the Council and the NSW SES.* Response Refer to **Section 8**. The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood

	extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level roadways are affected during flooding, on site refuge is available. The development presents low/ no risk to existing community emergency management arrangements.
Item 13k	*Any impacts the development may have on the social and economic costs to the community as consequence of flooding.* Response It is confirmed there is no change in flooding conditions, social or economic cost to community as a result of the development.

TfNSW – ref:CD20/08907
The EIS shall provide a flood impact assessment to understand the potential impacts of the development on flood evacuation is to be carried out. The EIS will assess the impacts of the proposed development, information for pre and post- development scenarios including modelling of the local overland flows are to be provided to allow assessment of the impact of the development. Response Refer to **Section 8**. The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level roadways are affected during flooding, on site refuge is available. The development presents low/ no risk to existing community emergency management arrangements.

DPIE (Urban Design) – ref: Melissa Rassack email Dated 5 Nov 2020
The SSD will need to Address *the E2 Environmental Conservation zoning through the site. There is an important ecological/ riparian corridor connecting Wianamatta- South Creek and Ropes Creek that runs through the site. NRAR should be consulted on design of this corridor.*

In line with the previous DPIE advice, the riparian corridor should be designed (width and vegetation) to ensure there is sufficient are provided to support the requirements of the local ecosystem. A riparian corridor of 40 metres width should be provided and designed in accordance with the principles of the Water Management Act

Response

Refer to **Section 5.6** for detailed discussion on the E2 zone and riparian corridor.

NRAR has been consulted throughout the design development period, with initial meetings held on 3 August 2020 and subsequent email and letter correspondence (refer Costin Roe Consulting Letters 18 August 2020 and 27 October 2020 and Cumberland Ecology letter referenced 19200 – Let6 dated 16 July 2020).

It has been confirmed that the watercourse within the subject land is a first order watercourse (per the Strahler system), and NRAR has confirmed that the watercourse is not considered waterfront land under the definition of the act. The width of the riparian corridor is proposed as 25m allowing for 10m either side of a 5m channel.

Figure 1. The riparian corridor

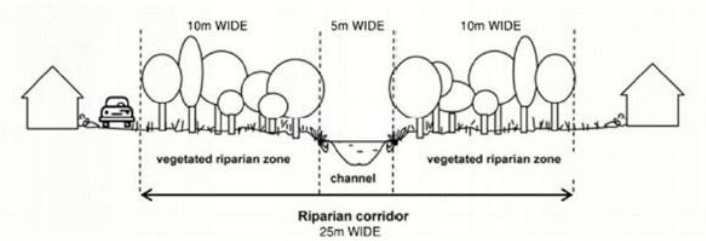

Table 1. Recommended riparian corridor (RC) widths

Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

Demonstration that the proposed geometry changes to the riparian corridor will address adequate flow of the watercourse. A softer geometry angle may be required to improve this issue.

Response

The design of the realigned engineered channel includes integration of naturalised watercourse elements such as a low flow channel, channel meander, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice documents for a naturalised channel.

A 90-degree change in direction, with a prolonged curved radius, is proposed through the lower portion of the channel and at the entry to the culvert. The curved radius is noted to be approximately 55m in length, and the corresponding radius at the entry to the culvert is 25m.

Recommended practice for naturalised creeks has been made using accepted industry methods for naturalised creek design, included in documents such as the *Queensland Urban Drainage Manual 2013,* and Brisbane City Councils *Natural Channel Design Guidelines 2003*. Within these documents recommended minimum radius of bends are recommended, based on the bankfull width of the watercourse. The recommended minimum radius for a constructed bend is 3 times the bankfull width.

For this project, noting the bankfull width of 5m, the minimum acceptable design radius of curvature as such is 15m. The proposed minimum radius is 25m, and where the larger change in direction is proposed (55m radius) the radius is noted to be 3.6 times greater than the minimum recommended curve radius.

Conveyance capacity for the calculated peak flow in the 1% AEP storm event is $4.4m^3/s$. This peak flow is noted to be able to be conveyed within the proposed 5m wide main channel cross section at a depth of approximately 0.8m. Further capacity is available based on overbank flows.

The design treatment of the interface between industrial development and the E2 corridor is important. The design and location of the hardstand areas need to avoid negative impacts on the riparian corridor including addressing noise and vibrations from vehicle movements, stormwater runoff and spillage of pollutants.

Response

The interface with the E2 zone includes additional 5m landscape setback as required of the DRAFT Mamre Precinct DCP. An integrated approach of stepped and landscaped retaining structures, in addition to the vegetation of battered riparian corridors allows for effective separation of the watercourse with the developed areas of the site.

Stormwater runoff from within the developments sites will be contained within each site then treated for pollutants (per objectives set out in **Section 5.1** and demonstrated in **Section 7**) prior to discharge from the site into trunk drainage systems or the noted watercourse.

The SSD will also need to address the riparian corridor alignment and its connections to adjoining properties. It Is noted that the applicant is seeking relocate the zoned E2 area. This will only be considered if the above matters are satisfied and NRAR and the Department's Resilient Planning team agree to the approach.

Response

The design of the realigned engineered channel includes integration of naturalised watercourse elements such as a low flow channel, channel meander, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice documents for a naturalised channel as consulted with NRAR. Refer **Section 5.6**.
The design of proposed retaining walls will need to allow for soft landscape transitions. Response Retaining walls provide landscaped and tiered arrangement, as defined in the DRAFT Mamre Road Precinct DCP.
The layout and connections to the proposed network, including the Intermodal Terminal and Western Sydney freight line. Response Consideration to the freight network has been made as defined in the DRAFT Mamre Road Precinct DCP.
The road design and widths, including application of the indicative precinct wide road network Response Consideration to the road design and network has been made as defined in the DRAFT Mamre Road Precinct DCP. Refer **Section 4** and ASON Group traffic impact assessment.
how bulk earthworks and the road pattern have been prepared to connect to adjoining sites to enable their feasible development for industrial purposes (as proposed in the WSEA SEPP amendment and structure plan.). Response The development responds to the topography by providing development pads which step from progressively from the existing high point on the east of the development site, to the lowest part of the site on the west adjacent to Mamre Road. Consideration to the anticipated development levels and road networks on the adjacent sites to the south and west, contemplated by Mirvac and Altis Property Partners, through consultation with the respective developers has also been made. Refer to **Section 3.2** and **3.3,** and drawings included in **Appendix A**.
Bulk earthworks flooding impacts Response Refer **Section 8** for flooding and flood impact assessments.

conservation and protection of areas with heritage and aboriginal heritage significance Response Refer heritage and aboriginal heritage assessments by the relevant consultants.
and the building heights in relation to ridgelines and adjoining rural -residential views Response Refer visual assessment by SBA.
Any Infrastructure, including roads and drainage infrastructure, should be located on industrial land (i.e., not SP2 or E2). Response Infrastructure has not been located in SP2 or E2 corridors. Integration of water attenuation has been made in the watercourse at the junction of the watercourse and the proposed road culvert, as recommended in the DRAFT Mamre Precinct Integrated Water Cycle Management Plan (Sydney Water/ DPIE 2020).
The SSD must consider the draft Mamre Road Precinct DCP. This includes building controls such as setbacks, built form, landscaping and height controls. Should the SSD progress prior to the finalisation of a precinct wide DCP for the Mamre Road Precinct, a site specific DCP will be required to be prepared. The DCP will need to be prepared in accordance with the existing requirements of the WSEA SEPP and the Precinct Structure Plan, in close consultation with the Department. Matters to be addressed are identified in Schedule 4 of WSEA SEPP as well as particular site characteristics such as (but not limited to) landscaping and setback controls, building design. Alternatives to this approach may be considered through ongoing consultation with DPIE. Response Consideration to the *draft Mamre Road Precinct DCP* has been made throughout the civil engineering design and reporting, and within the whole of the estate master planning.

Authority Information Requests	*Response*
Penrith City Council	
The site's topography is undulating and the proposed large and level warehouse building pads will need to be considered in the context of broader drainage requirements and integration with adjoining land which are also likely to be developed for employment land uses. The development must avoid large expanses and/or high retaining walls/batters.	The development responds to the topography by providing development pads which step from progressively from the existing high point on the east of the development site, to the lowest part of the site on the west adjacent to Mamre Road. Consideration to the anticipated development levels on the adjacent sites to the south and west, contemplated by Mirvac and Altis Property Partners, through consultation with the respective developers has also been made. Overall, it can be anticipated that, on a development site which has a level differences of approximately 44m, and proposed large format industrial warehouse (as zoned) that level changes and retaining structures will be required to facilitate flat building pads and benching suitable for logistics and distribution. This is a fundamental requirement for the effective development over the entire Mamre Road Precinct and a point that has been discussed with DPIE. Refer to **Section 3.2** and **3.3,** and drawings included in **Appendix A**..
The stormwater drainage for the site must be in accordance with the council's Development Control Plan, as well as the Stormwater Drainage Specification for Building Development policy, and the Water Sensitive Urban Design Policy and Technical Guidelines.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met.

Authority Information Requests	*Response*
	Section 7 provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
A stormwater concept plan, accompanied by a supporting report and calculations, shall be submitted with the application.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
The application shall demonstrate that downstream stormwater systems have adequate capacity to accommodate stormwater flows generated from the development. This may require the provision of on-site detention to reduce stormwater flows or upgrade of stormwater infrastructure to increase capacity.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling.

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	Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
Any on-site detention system must be within common property and accessible from the street.	Detention systems are noted to be accessible and within common property of the estate. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
A water sensitive urban design strategy prepared by a suitably qualified person is to be provided for the site. The strategy shall address water conservation, water quality, water quantity, as well as operation and maintenance.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The stormwater strategy has been completed by Costin Roe Consulting, being professional engineers with demonstrated experience in similar industrial projects within Kemps Creek and Penrith City Council LGA. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
The application shall include MUSIC modelling (.sqz file) demonstrating compliance with councils adopted water urban design policy and technical guidelines.*	Refer **Section 6** and **Appendix B** for MUSIC modelling and demonstration of meeting the nominated objectives.

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On lot treatment is to be provided to meet all water quality and water quantity targets. Full details are to be submitted with the application. Penrith City Council will not maintain any estate basins nor accept the dedication of any land for the provision of estate basins.	Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**. Management of basins will be completed by the proponent.
The flood impact assessment report submitted with the application, shall address the site is categorised as being flood affected by local overland flow flooding. *Furthermore, the application must demonstrate that the development proposal is consistent with Councils Development Control Plan for Flood Liable Land.*	Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the

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	Exhibition Draft South Creek Floodplain Management Plan 2020.
Overland flows shall be managed safely through the site and not diverted onto adjoining properties. The development shall not have any adverse impact upon adjoining properties through the damming, concentration or diversion of overland flows. All habitable floor levels shall be a minimum of 0.5m above the 1% AEP water surface level.	Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the E2 corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.

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The Civil plans shall address that no retaining walls or filling is permitted for this development which will impede, divert or concentrate stormwater runoff passing through the site. Furthermore, Earthworks and retaining walls must comply with Council's Development Control Plan.	The civil engineering design allows for conveyance of all upstream flows as demonstrated through the overland flow assessment in **Section 8** and Civil Engineering drawings in **Appendix A**. Earthworks and wall designs have been completed based on the arrangements proposed in the Draft Mamre Road Precinct DCP.
The application is to be supported by a geotechnical report prepared by a suitably qualified person for the site and shall address, but not be limited to ground water movement, salinity, and contamination.	Geotechnical investigations have been completed by PSM. Refer to separate reports by PSM and **Section 3** of this report.
Regarding Traffic considerations, the Council require adjusted road cross sections including verge widths in the draft Mamre Precinct DCP. *The council also considers that there should be no driveway access along Mamre Road or along major internal precinct link roads, however this SSD has driveway access and a temporary road access here.*	Consideration to the road design and network has been made as defined in the DRAFT Mamre Road Precinct DCP. Refer **Section 4** and ASON Group traffic impact assessment. Temporary access (left in and left out) is proposed from Mamre Road until such time that internal precinct roads are constructed. Separate discussions with TfNSW has been undertaken in this regard.
A Stormwater management Strategy will need to be prepared by suitably qualified professional in support of the development. The strategy shall outline how Water Sensitive Urban Design is being incorporated into the design of the development as well as outline how the receiving waters and environment will be safeguarded from the proposed works. The strategy should address the entire site. This should include details into proposed sedimentation and erosion controls as well as the management of stormwater more generally including, as to how increased volumes, peak flows and pollutants in the increased runoff	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The stormwater strategy has been completed by Costin Roe Consulting, being professional engineers with demonstrated experience in similar industrial projects within Kemps Creek and Penrith City Council LGA. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have

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that is likely to increase as a result of the development, will be managed. *The water and Soil Management Strategy needs to demonstrate and outline how both surface and groundwater resources as well as dependent ecosystems will be safeguarded for both the construction stages and for the operational stages of the development. The strategy should also outline what is proposed in relation to the dams located on the site.* *In developing the strategy, consideration Council's WSUD Policy, WSEA SEPP and the liveability and water management principles, that have been identified in the Western City District Plan including the planning priority to* ***protect and improve the health and enjoyment of the District's waterways*** *should be considered.*	been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
With regards to the riparian corridors, any changes to existing drainage lines and streams on the site will need to be in accordance with the requirements of the NSW Natural Resources Assess Regulator. However, a focus on the retention of existing drainage lines including any dams is preferred. Further to this, a vegetation management plan which meets the Department's guidelines should be prepared which provides detailed guidance on the management requirements for these areas.	The design of the realigned engineered channel includes integration of naturalised watercourse elements such as a low flow channel, channel meander, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice documents for a naturalised channel as consulted with NRAR. Refer **Section 5.6**.
Any Impacts to existing creeks should be minimised and where possible the preference should be to retain the natural creek lines and dams as well as restore them to the standards recommended by the Natural Resources Assess Regulator.	The design of the realigned engineered channel includes integration of naturalised watercourse elements such as a low flow channel, channel meander, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice documents for a naturalised channel as consulted with NRAR. Refer **Section 5.6**.

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Sydney Water	
The proponent of development should determine service demands following servicing investigations and demonstrate that satisfactory arrangements for drinking water, wastewater, and recycled water (where required) services have been made.	Refer to separate water and wastewater servicing report.
The proponent must obtain endorsement and/or approval from Sydney Water to ensure that the proposed development does not adversely impact on any existing water, wastewater, or stormwater main, or other Sydney Water asset, including any easement or property. When determining landscaping options, the proponent should take into account that certain tree species can cause cracking or blockage of Sydney water pipes and therefore should be avoided.	Refer to separate water and wastewater servicing report.
Strict requirements for Sydney Water's stormwater assets (for certain types of development) may apply to this site. The proponent should ensure that satisfactory steps/measures have been taken to protect existing stormwater assets, such as avoiding building over and/or adjacent to stormwater assets and building bridges over stormwater assets. The proponent should consider taking measures to minimise or eliminate potential flooding, degradation of water quality, and avoid adverse impacts on any heritage items, and create pipeline easements where required.	There are no existing Sydney Water (or any other asset owner) stormwater systems within the property. As discussed in **Section 2** and **5.2** there are no existing formal drainage systems or infrastructure on the property. The property currently comprises rural residential use.
Lastly, the proponent should outline any sustainability initiatives that will minimise/ reduce the demand for drinking water, including any alternative water supply and end uses of drinking and non-drinking water that may be proposed, and demonstrate water sensitive urban design (principles are used), and any water conservation measures that are likely to be proposed. This will allow Sydney Water to determine ethe impact of the	It is intended to reduce demand on non-potable applications by 80% through rainwater reuse. Refer **Section 5.1** and **7.4**.

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proposed development on our existing services and required system capacity to service the development.	
NSW EPA	
Regarding water quality, the concept plan should include strategies to protect and improve the health of the south Creek catchment to support the vision and aspirations being sought for the Parkland City, In this regard, the planning proposal should provide supporting information that can demonstrate that the proposal contributes to the achievement or protection of the NSW Water Quality Objectives (WQO)for the South Creek catchment. These WQOs underpin the South Creek corridor strategy that is informing the planning of the WS Aerotropolis. These WQOs provide a framework and benchmarks for the community uses and values of the waterways and the water quality that is needed to support these.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
The Western City District Plan include actions to improve health of catchments and waterways through a risk-based approach to managing the cumulative impacts of development. Implementation of this action is supported through application of the OEH/EPA Risk based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions (Risk-based Framework). This Risk-based framework is helping to inform the planning of the Western Sydney Aerotropolis. To compliment this work, the planning proposal should include information that includes but is not limited to the following:	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown

Authority Information Requests	*Response*
	on the Civil Design Drawings included in **Appendix A**.
Provide an assessment of any potential impacts of the proposal on local hydrology and hydrogeology with a particular focus on water quality using the risk- based framework to help inform the design of water management and associated infrastructure needs and identify practical, cost effective management for supporting waterway health outcomes that reflect the community values and uses of the waterways.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
Provide a concept Stormwater Management plan outlining the general stormwater management measures for the proposal, including the use of sustainability measures such as water sensitive Urban Design to create more resilient adaptable urban environments supported by green infrastructure. This should also include approaches to reduce impervious areas to provide greater infiltration taking into account any land capability issues such as salinity and land contamination issues if present. This should also include measures for ongoing maintenance including any associated funding approaches for ongoing management for any water management measures.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.

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Outline opportunities that help deliver integrated water cycle management that includes sustainable water supply, wastewater and stormwater management and reuse and recycling initiatives where it is safe and practicable to do so and provides the best environmental outcome. The proponent may wish to undertake discussions with Sydney Water on current planning occurring in relation to the South Creek Water Factory in servicing the site with treated recycled wastewater.	It is intended to reduce demand on non-potable applications by 80% through rainwater reuse. Refer **Section 5.1** and **7.4**. Refer to separate water and wastewater supply report pertaining to water supply and wastewater.
Explore opportunities for the stormwater management system to include measures (including retention and capacity) to help respond to any pollution incidents (including fire water) due to the sensitivity of the receiving environment.	Specific requirements for containment of firewater, or other pollution incidents, would form part of separate future building specific stormwater management plans.
Drive improved sustainability outcomes through design excellence or incentives which incorporates WSUD and sustainable built form (for example, deliver green roofs and walls). This could include promoting the use of green building ratings tools, for example NABERS, Green Star Communities and programs such as Sustainability Advantage etc.	Greenstar will be considered by the applicant as part of future separate building application submissions. WSUD measures have been incorporated into the design as per the objectives set out in **Section 5.1** and demonstrated in **Sections 6** and **7**.
Written advice should be sought from Sydney Water confirming whether there is adequate capacity in the existing sewerage system to cater for additional loads and the systems environmental performance will not be compromised. This includes sewage overflows from any sewage pumping stations and discharges from any associated sewage treatment plant. The EPA's policy is that for new systems, there should be no pollution of waters as a result of overflows during dry weather and that overflows during wet weather should be avoided.	Refer to separate water and wastewater supply report pertaining to water supply and wastewater.

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A Soil and Water Management Plan should be developed and implemented prior to construction in accordance with the managing Urban Stormwater: soils and construction, vol. 1(Landcom 2004) and vol. 2 (A. Installation of services; B. waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC 2008).	Refer to **Section 9** for soil and water management measures during construction, drawings in **appendix A** for associated erosion and sediment control drawings, and **Appendix C** for a Draft Soil and Water Management Plan. These sections show proposed measures, based on the Landcom document *Managing Urban Stormwater – Soils & Construction Volume 1 ('Blue Book')(Landcom, 2004)*, are proposed during the construction of the development. Measures proposed will limit potential for offsite impact associated with water runoff and soils during construction. Consideration to management of salinity and acid sulphate has been made based on the recommendations of the geotechnical investigations and noted Landcom document.

11 CONCLUSION

This Civil Engineering Report has been prepared to support the State Significant Development Application for a Proposed Development at Lots 59 & 60 DP 259135, Mamre Road, Kemps Creek, NSW.

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 and with consideration to the DPIE Draft Mamre Road Precinct DCP 2020.

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.

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 proprietary filtration 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.

It is proposed that a Stream Erosion Index (SEI) of 2.0 be adopted for stormwater discharge from the development and stream health metric. Noting that Penrith City Council's current DCP requires that the post development duration of stream forming flows shall be no greater than 3.5 times the pre-development duration of stream forming flows.

The SEI target of 2.0 has been adopted in response to the alternate MARV control of 1.9ML/Ha/Yr included in the *DRAFT Mamre Road Precinct DCP Section 2.6*. The adoption of the SEI over the MARV is considered a good balance between the desire from the DPIE to achieve acceptable waterway impact to South Creek with the ability to provide practical and economic measures to achieve the similar waterway health outcomes.

Detailed responses to the SEARS and associated agency requirements has been included in **Section 10** of this report, demonstrating how each requirement has been met.

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

REFERENCES

- NSW Government (2005). *Floodplain Development Manual.*
- 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);
- Landcom (2004). *Managing Urban Stormwater – Soils and Construction* – 4th Edition.
- Penrith City Council – DCP 2013 (Part C3); and
- Water Sensitive Urban Design – "Technical Guidelines for Western Sydney" by URS Australia Pty Ltd, May 2004