Nepean Business Park Development Application

Civil Engineering Report

Prepared for Great River NSW Pty Ltd

06 November 2021

Document Information

Prepared by
Enspire Solutions Pty Ltd
205 / 275 Alfred Street North
North Sydney NSW 2060
ABN 71 624 801 690

Document Title	**Nepean Business Park Development Application**
Document Subject	Civil Engineering Report
Prepared For	Great River NSW Pty Ltd
Project Name	Nepean Business Park
Project Number	200044
File Name	rept001-200044-01-enspire-r03-211106-nepeanbusinessparkdaengineeringreport.docx

Transmittal

Revision	Date	Prepared by	Checked by	Approved by
1	21/12/2020	M.Lester	M.Hodges	M.Hodges
		Issued for Development Application		
2	22/12/2020	M.Lester	M.Hodges	M.Hodges
		Issued for Development Application		
3	6/11/2021	A.Dawes	A.Dawes	M.Hodges
		Additional Appendices included		

Contents

List of Tables

List of Figures

List of Appendices

1 Introduction

Enspire Solutions (**Enspire**) have been engaged by Great River NSW Pty Ltd (**Client**) to prepare the civil engineering and stormwater management design and documentation in support of a State Significant Development Application (**DA**) submission to the NSW Department of Planning for the proposed construction of roads, stormwater drainage infrastructure and lot formation associated with Nepean Business Park as depicted in **Figure 1**.

Works associated with this Development Application include:

- Sediment and erosion controls
- Roads and stormwater drainage infrastructure
- Lot formation
- Construction of footpaths and shared ways

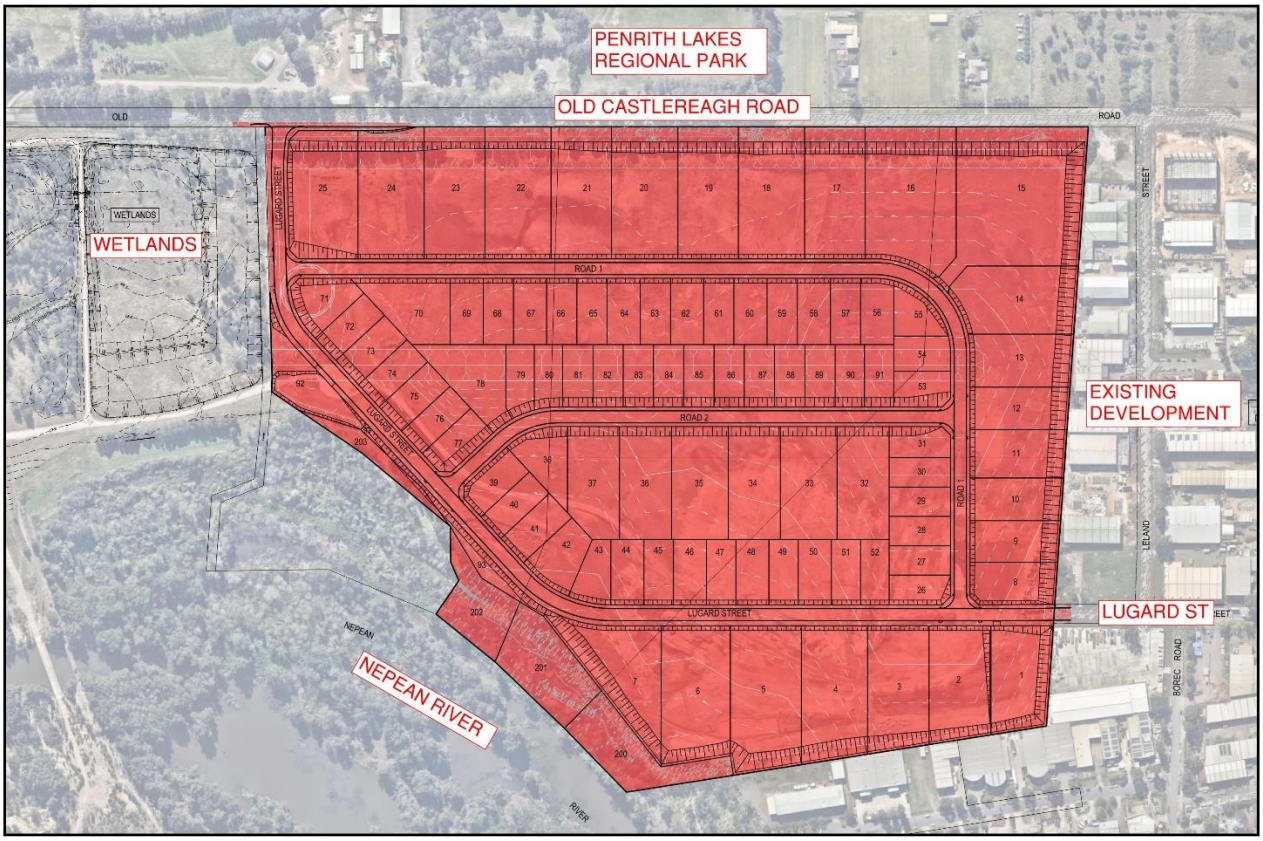


Figure 1 - Site Plan

2 Related Reports and Documents

This report is to be read in conjunction with the following reports and documents.

1) Development Application documentation prepared by Enspire Solutions

Table 1 – Drawing Reference

Drawing Number	Drawing Title
200044-DA-C1.01	COVER SHEET AND DRAWING SCHEDULE
200044-DA-C1.21	GENERAL NOTES AND LEGENDS – SHEET 01
200044-DA-C1.22	GENERAL NOTES AND LEGENDS – SHEET 02
200044-DA-C1.31	STAGING PLAN
200044-DA-C1.41	GENERAL ARRANGEMENT
200044-DA-C2.01	ALIGNMENT CONTROL PLAN
200044-DA-C3.01	EROSION AND SEDIMENTATION CONTROL PLAN – SHEET 01
200044-DA-C3.02	EROSION AND SEDIMENTATION CONTROL PLAN – SHEET 02
200044-DA-C3.03	EROSION AND SEDIMENTATION CONTROL PLAN – SHEET 03
200044-DA-C3.05	SOIL AND WATER MANAGEMENT NOTES
200044-DA-C3.21	EROSION AND SEDIMENTATION CONTROL DETAILS
200044-DA-C3.31	SEDIMENT BASIN PLAN AND SECTION
200044-DA-C4.01	BULK EARTHWORKS CUT AND FILL PLAN
200044-DA-C4.21	BULK EARTHWORKS CUT AND FILL SECTIONS – SHEET 01
200044-DA-C4.22	BULK EARTHWORKS CUT AND FILL SECTIONS – SHEET 02
200044-DA-C4.23	BULK EARTHWORKS CUT AND FILL SECTIONS – SHEET 03
200044-DA-C5.01	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 01
200044-DA-C5.02	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 02
200044-DA-C5.03	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 03
200044-DA-C5.04	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 04
200044-DA-C5.05	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 05
200044-DA-C5.06	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 06
200044-DA-C5.07	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 07
200044-DA-C5.08	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 08
200044-DA-C6.01	ROAD TYPICAL CROSS SECTIONS
200044-DA-C7.01	ROAD LONGITUDINAL SECTIONS – SHEET 01
200044-DA-C7.02	ROAD LONGITUDINAL SECTIONS – SHEET 02
200044-DA-C11.01	PAVEMENT, SIGNAGE AND LINEMARKING PLAN – SHEET 01

200044-DA-C11.02	PAVEMENT, SIGNAGE AND LINEMARKING PLAN – SHEET 02
200044-DA-C11.03	PAVEMENT, SIGNAGE AND LINEMARKING PLAN – SHEET 03
200044-DA-C11.04	PAVEMENT, SIGNAGE AND LINEMARKING PLAN – SHEET 04
200044-DA-C11.05	PAVEMENT, SIGNAGE AND LINEMARKING PLAN – SHEET 05
200044-DA-C11.06	PAVEMENT, SIGNAGE AND LINEMARKING PLAN – SHEET 06
200044-DA-C11.07	PAVEMENT, SIGNAGE AND LINEMARKING PLAN – SHEET 07
200044-DA-C11.08	PAVEMENT, SIGNAGE AND LINEMARKING PLAN – SHEET 08
200044-DA-C13.01	STORMWATER LONGITUDINAL SECTIONS – SHEET 01
200044-DA-C13.02	STORMWATER LONGITUDINAL SECTIONS – SHEET 02
200044-DA-C13.03	STORMWATER LONGITUDINAL SECTIONS – SHEET 03
200044-DA-C13.04	STORMWATER LONGITUDINAL SECTIONS – SHEET 04
200044-DA-C13.05	STORMWATER LONGITUDINAL SECTIONS – SHEET 05
200044-DA-C13.06	STORMWATER LONGITUDINAL SECTIONS – SHEET 06
200044-DA-C13.07	STORMWATER LONGITUDINAL SECTIONS – SHEET 07
200044-DA-C13.08	STORMWATER LONGITUDINAL SECTIONS – SHEET 08
200044-DA-C14.01	SITEWORKS DETAILS – SHEET 01
200044-DA-C14.02	SITEWORKS DETAILS – SHEET 02
200044-DA-C14.11	COUNCIL STANDARD DETAILS – SHEET 01
200044-DA-C14.12	COUNCIL STANDARD DETAILS – SHEET 02
200044-DA-C14.13	COUNCIL STANDARD DETAILS – SHEET 03
200044-DA-C14.14	COUNCIL STANDARD DETAILS – SHEET 04
200044-DA-C18.01	STORMWATER DETAILS – SHEET 01
200044-DA-C18.02	STORMWATER DETAILS – SHEET 02
200044-DA-C18.03	STORMWATER DETAILS – SHEET 03
200044-DA-C22.01	CATCHMENT PLAN
200044-DA-C25.01	TURNING PATH PLANS – SHEET 01
200044-DA-C25.02	TURNING PATH PLANS – SHEET 02
200044-DA-C25.03	TURNING PATH PLANS – SHEET 03
200044-DA-C25.04	TURNING PATH PLANS – SHEET 04
200044-DA-C25.05	TURNING PATH PLANS – SHEET 05

1) Water Management Plan: Stage 2, prepared by Penrith Lakes Development Corporation, May 2020
2) Penrith Lakes Engineering Design for Southern Wetlands Infrastructure: Cell A Detention Basin, drawings prepared by J.Wyndham Prince, August 2019

3) PLDC Southern Wetland, On-site Stormwater Detention and Stormwater Quality Assessment, prepared by J Wyndham Prince (ref: 110088-8-OSD), July 2020
4) Penrith Lakes Employment Land 2-Year Plan Levels, drawings prepared by GCA Engineering Solutions, May 2020
5) Penrith City Council Development Control Plan, 2014
6) Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Developments, 2013
7) Penrith City Council Stormwater Drainage Specification for Building Developments, 2018
8) Penrith City Council Water Sensitive Urban Design (WSUD) Policy, 2013.

3 The Development

3.1 Proposed Development Works

The development site is located within the Penrith City Council Local Government Area (LGA) and occupies a total area of approximately 49ha. The site is located at 14-278 Old Castlereagh Road, Penrith, and is formally known at Lots 1, 2 and 3 of DP1263486.

The site is subject to zoning under the State Environmental Planning Policy (Penrith Lakes Scheme) 1989 (Penrith Lakes SEPP) and the relevant planning authority is the Planning Secretary of the NSW Department of Planning, Industry and Environment (DPIE).

The site is also known as the 'Employment Lands', as referenced in the Penrith Lakes Water Management Plan and Draft Penrith Lakes Development Control Plan.

The development is generally bound by the following:

- Old Castlereagh Road and Penrith Lakes Regional Park to the north
- Existing industrial development to south and east
- The Nepean River to the south west
- Penrith Lakes land (Southern Wetlands site) to the west

The development subject to this development application includes:

- Establishment of roads, pavements, lot formation and stormwater drainage infrastructure for:
  - 93 industrial lots
  - 4 residual lots
- Construction of footpaths and shared paths
- Construction and commissioning of essential utilities.

3.2 Existing Site Conditions

The development site was formally a tailings disposal area utilised under the original Penrith Lakes quarry scheme. Since the ceasing of tailings deposits, the site has been significantly remediated over a period of approximately 30 years.

The site generally consisted of grassy vegetation, minimal trees and generally falls from south to north, where a swampy area exists along the northern frontage of the site. The site survey plan is presented in Figure 2.

The site is currently being rehabilitated and filled as part of the '2-Year Plan" approval (refer GCA Engineering Solutions drawings 18255 C2400, in **Appendix A**) which includes the installation of wick drains across the site and import of consolidation material to improve the ground conditions in preparation for subdivision works.

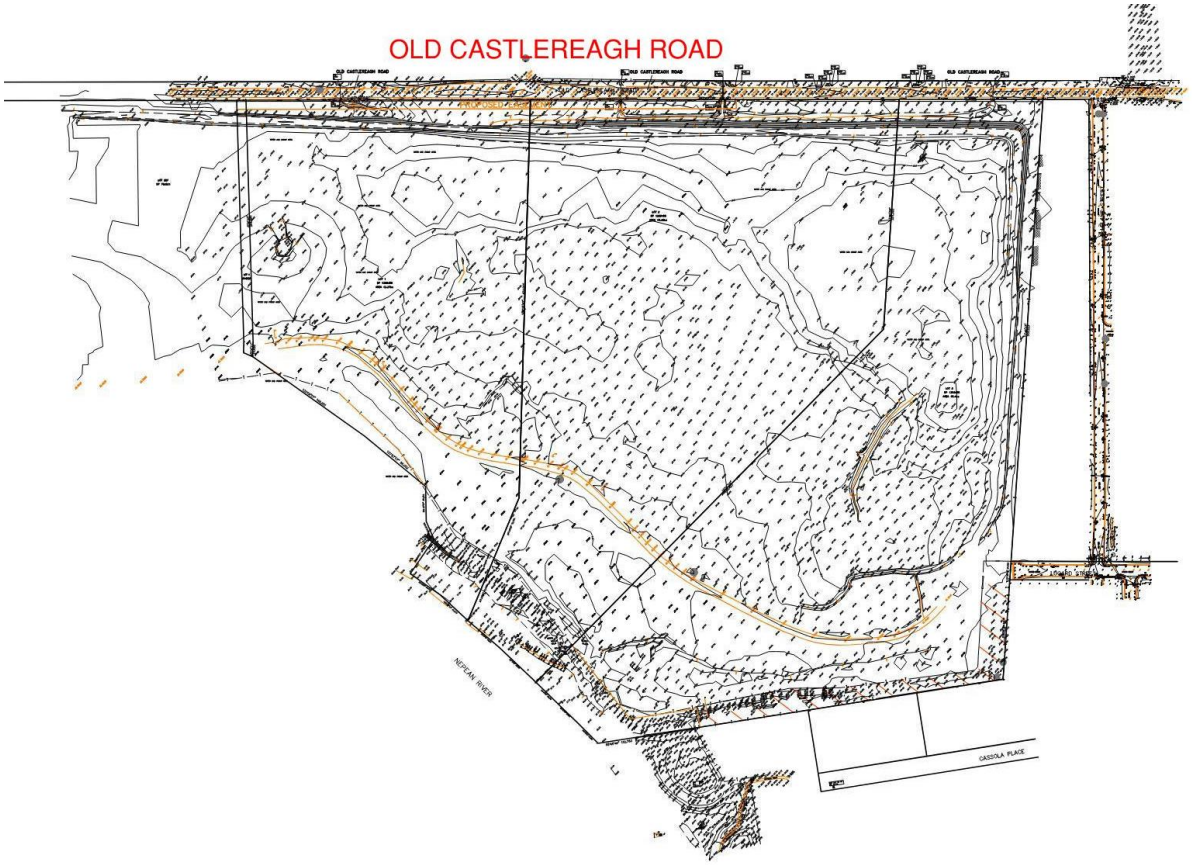


Figure 2 - Site Survey Plan

4 Erosion and Sediment Control

The objectives of the erosion and sediment control for the development site are to ensure:

- Adequate erosion and sediment control measures are applied prior to the commencement of construction and are maintained throughout construction; and
- Construction site runoff is appropriately treated in accordance with Penrith Council requirements.

As part of the works, the erosion and sedimentation control will be constructed in accordance with Council requirements and the NSW Department of Housing Manual, "Managing Urban Stormwater Soil & Construction" 2004 (Blue Book) prior to any earthworks commencing on site.

4.1 Sediment Basin

Three (3) temporary sediment basins are proposed to be constructed as part of this subdivision development application and maintained through the construction of the subdivision. The sediment basins have been designed to capture site runoff during construction and has been located to coincide with the ultimate discharge locations for the site. Sediment basin A is to be located on Lot 1 and caters for site runoff that will be directed to Lugard Street. Sediment Basins B and C are to be located generally along the alignment of the future trunk drainage network and the trunk drainage excavation alignment is to be utilised to direct surface runoff to the proposed sediment basins. Figure 3 below nominates the approximate location of proposed sediment basins and their associated catchments.

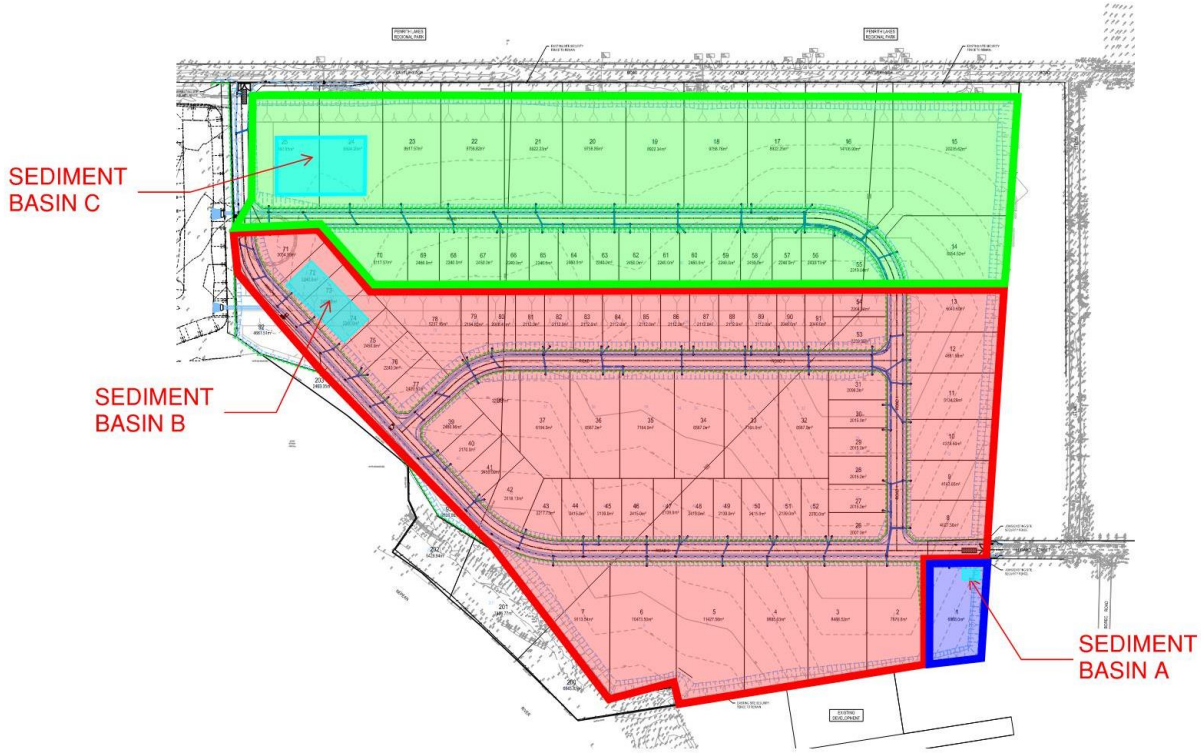


Figure 3 - Sediment Basin Locations

As per Appendix C of the Blue Book, the expected soil texture group for the proposed development is Type D. The proposed sediment basins are designed and sized to represent this soil texture classification.

To ensure the sediment basins are working effectively they will be maintained throughout the construction works. Maintenance includes ensuring adequate settlement times or flocculation and pumping of clean water to reach the minimum storage volume at the lower level of the settling zone. The settling zone will be identified by pegs to clearly show the level at which design storage capacity is available.

The pumped water from the sediment basins can be reused for dust control during construction.

An overflow weir is provided to control overflows for rainfall events in excess of the design criteria.

4.2 Sediment and Erosion Control Measures

Prior to any earthworks commencing on site, sediment and erosion control measure shall be implemented generally in accordance with the Development Application drawings and the “Blue Book”. The measures shown on the drawings are intended to be a minimum treatment only as the contractor will be required to modify and stage the erosion and sedimentation control measures to suit the construction program, sequencing and techniques. These measures will include:

- A temporary site security/safety fence is to be constructed around the site
- Sediment fencing provided downstream of disturbed areas
- Dust control measures including covering stockpiles, installing fence hessian and watering exposed areas
- Placement of straw bales or mesh and gravel inlet filters around and along proposed catch drains and around stormwater inlets pits
- The construction of a temporary sediment basins
- Stabilised site access at the construction vehicle entry/exits

Any stockpiled material, shall be located as far away as possible from any associated natural watercourses or temporary overland flow paths. Sediment fences shall be installed to the downstream side of stockpiles and any embankment formation. All stockpiles and embankment formations shall be stabilised by hydroseeding or hydro mulching on formation.

5 Bulk Earthworks

5.1 Cut and Fill Operations

As part of subdivision works, earthworks on the site will generally consist of cut and fill operations to establish proposed road formations and site levels. The ultimate design levels have been designed in line with proposed stormwater management strategy and coordinated with the proposed trunk drainage grading.

The earthworks proposed as part of the current application are in addition to the earthworks associated with filling the site to the "2-Year Plan" levels (refer GCA Engineering Solutions drawings 18255 C2400). The "2-Year Plan" levels have been adopted as the 'existing' surface in the bulk earthworks analysis associated with the current application.

Approximate cut to fill earthworks operations for the works subject to this development application are summarised in **Table 2**.

Table 2 - Approximate Cut / Fill Quantities

Earthworks	Volume (m^3)
Cut	32,877
Fill	833,414
Balance	800,536 (Import)

The cut and fill earthworks volumes provided are concept only and are subject to change pending final coordination and detailed civil design. It should be noted the cut and fill operations for this development are based on the following assumptions:

- No allowance for earthworks bulking factors
- No allowance for spoil generated from utility service and stormwater drainage trenching
- No allowance for any future warehouse slabs

6 Stormwater Management Strategy

6.1 Proposed Stormwater Management Strategy

The stormwater management strategy has been designed to ensure site stormwater runoff is managed in the following key areas:

- Site catchments (internal and external)
- Stormwater Quantity
- Stormwater Quality
- Flooding

The proposed civil engineering subdivision package documents site levels, grading, minor and major stormwater drainage components, and catchments for the site.

The development site (Employment Land) forms part of the Penrith Lakes Development Corporation Water Management Plan (Part 2, May 2020) as shown in **Appendix B**, and is an integral part of the water supply and treatment system in the Southern Wetlands network. The site is proposed to drain to Cell A of the Southern Wetlands system, directly to the west of the proposed site.

Figure 4 - Penrith Lakes Scheme (Excerpt from Penrith Lakes Water Management Plan 2020)

6.2 Trunk Drainage Network

The overall stormwater strategy has been developed through discussion with Penrith City Council and utilises trunk stormwater drainage culverts to convey the site runoff to the Penrith Lakes Southern Wetlands network to the west of the development site.

The proposed strategy incorporates stormwater culverts graded at 0.35% and 0.5% in conjunction with a saw-tooth road grading alignment along sections of proposed roads. Inlet pits are proposed to drop directly into the top of the culvert removing the need for vertical fall in pits. This strategy aims to minimise fill at the eastern end of the site, particularly along the eastern boundary where the proposed development is directly adjacent existing industrial properties.

An alternative design for those areas with longitudinal falls on 0.5% is to provide for the installation of a traditional pit and reinforced concrete pipe network including installing inlet and junction pits.

The development application seeks approval for the installation of an in-ground drainage network, either by construction of a reinforced box culvert system and/or a pit and reinforced concrete pipe network, with final details to be resolved at the subdivision works construction certificate.

Figure 5 below shows the extent of the proposed trunk drainage network, the proposed grade of culvert and extent of saw-tooth grading in the road network.

The proposed trunk drainage strategy was developed in consultation with by Penrith City Council and was endorsed via email. Refer **Appendix C** for email correspondence with Penrith City Council confirming the trunk drainage grading strategy.

Figure 5 - Proposed Trunk Drainage Network

6.3 Proposed Pit and Pipe Network

The proposed pit, pipe and overland flow network has been designed in accordance with Penrith City Councils Design Guidelines for Engineering Works for Subdivisions and Developments. The following key criteria as noted in Table 3 have been considered and applied in the stormwater drainage design.

Table 3 - Adopted Design Criteria

Design Condition	Design Criteria
General	Major Storm Event – 1% AEP Minor Storm Event – 5% AEP
	Blockage factor - Sag pits 50%
	Maximum 150mm freeboard to grate level (minor event)
	Maximum 200mm ponding (major event)
	Flow width in roadway <2m or clear vehicle passage >3.5m
	Velocity x depth in roadway gutter < 0.4
Overland Flow	Reverse cross fall at road sag locations

The proposed subdivision will be drained by an in-ground pit and pipe network designed to convey the 5% AEP (minor) storm event. The surface drainage has been designed to convey flows in excess of the minor event up to and including the 1% AEP (major) storm event.

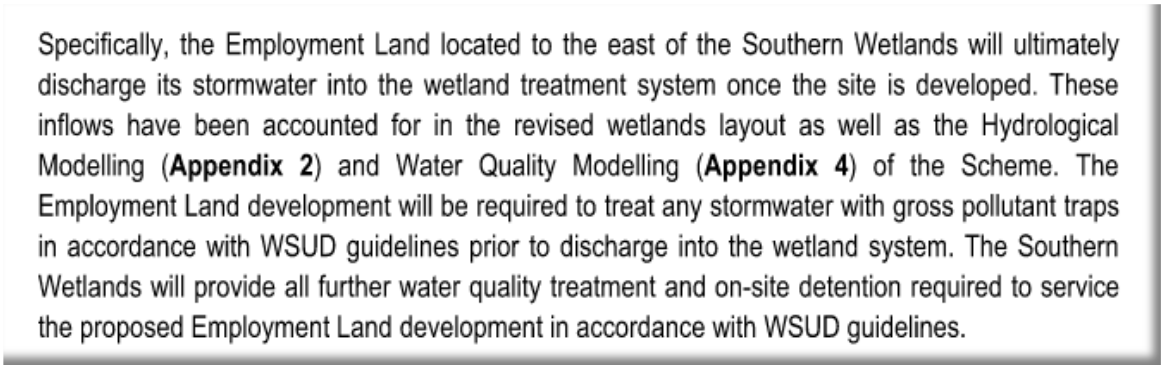
DRAINS software (ARR 2019 procedures) has been used to develop a hydrological rainfall-runoff catchment model to determine post development site discharges. The pit and pipe network has been designed and modelled using DRAINS (standard hydraulic model). The hydraulic parameters that have been adopted are as follows:

- Post development impervious fraction (roads and lots) 90%
- Depression storage:
    - 1mm for paved area
    - 5mm for grassed area
- Antecedence moisture condition 3
- Time of concentration 5 mins for impervious areas, 10mins for pervious areas

6.4 Stormwater Quantity

In accordance with the Penrith Lakes Water Management Strategy, May 2020, the site discharges to the west into the Southern Wetlands network. The design of the Southern Wetlands provides on-site stormwater detention facilities with the capacity for and benefit of the Employment Lands in the fully developed case, for all storms up to and including the 1% AEP storm event.

Refer Figure 6 for an except from the Penrith Lakes Water Management Plan, May 2020 outlining that the on-site stormwater detention provisions for the Employment Lands site has been catered for in the Southern Wetlands design.



Specifically, the Employment Land located to the east of the Southern Wetlands will ultimately discharge its stormwater into the wetland treatment system once the site is developed. These inflows have been accounted for in the revised wetlands layout as well as the Hydrological Modelling (**Appendix 2**) and Water Quality Modelling (**Appendix 4**) of the Scheme. The Employment Land development will be required to treat any stormwater with gross pollutant traps in accordance with WSUD guidelines prior to discharge into the wetland system. The Southern Wetlands will provide all further water quality treatment and on-site detention required to service the proposed Employment Land development in accordance with WSUD guidelines.

Figure 6 - Excerpt from Penrith Lakes Water Management Plan, May 2020 (pg 24)

Additionally, the On-site Stormwater Detention and Stormwater Quality Assessment report prepared by J Wyndham Prince, July 2020 (ref: 110088-8-OSD) concludes that OSD is not required for the Employment Lands development, and the site forms part of the Southern Wetlands on-site stormwater detention strategy. Refer **Appendix D** for the JWP Assessment report.

6.5 Stormwater Quality

6.5.1 Stormwater Quality Management Scheme

Stormwater quality treatment requirements for the Employment Lands are outlined in the Penrith Lakes Water Management Plan, May 2020 as shown in Figure 6.

The proposed water quality treatment system will consist of Gross Pollutant Traps (GPTs) and rainwater tanks.

Gross pollutant traps are to be provided at each stormwater outlet as part of the subdivision works, prior to discharge into the Southern Wetlands Cell A basin. These GPTs are to be sized to cater for and treat gross pollutant runoff from the road reserve areas only. Furthermore, each individual lot will be required to provide a GPT in line with the Penrith Lakes Water Management Plan strategy as they are developed.

No additional water quality treatment measures are proposed as part of the proposed works.

Note that the the On-site Stormwater Detention and Stormwater Quality Assessment report prepared by J Wyndham Prince, July 2020 (ref: 110088-8-OSD) concludes only GPTs are required as part of the Employment Lands development, and the site forms part of the Southern Wetlands WSUD strategy.

Refer Figure 7 for location of GPTs that are to be provided as part of the subdivision works.

6.5.2 Gross Pollutant Traps

Gross pollutant traps (GPTs) are primary stormwater treatment measures, typically applied as a first measure in a stormwater treatment train. GPTs come in varying forms from simple trash racks through to more complex devices with continuous deflection screens and hydrodynamic separation. The performance of GPTs varies according to the type of device selected.

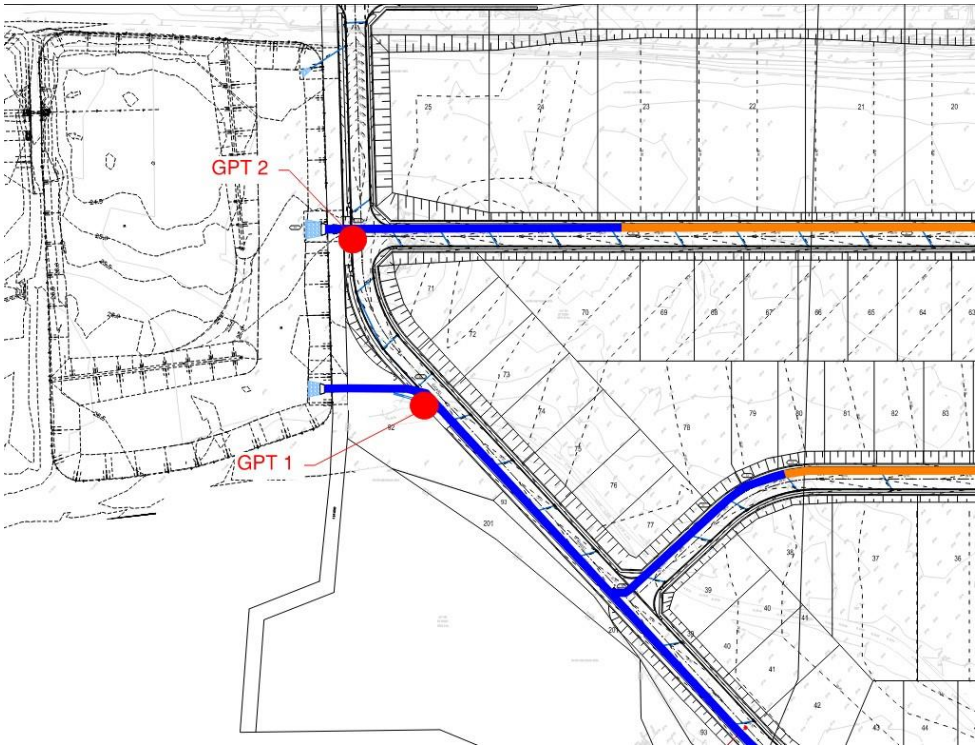


Figure 7 - Subdivision GPT Locations

7 Siteworks

7.1 General

The proposed development works will involve the extension of the Lugard Street to connect to Old Castlereagh Road (Road 3) and the construction of two internal roads (Road 1 and Road 2).

Figure 8 demonstrates the proposed road layout.

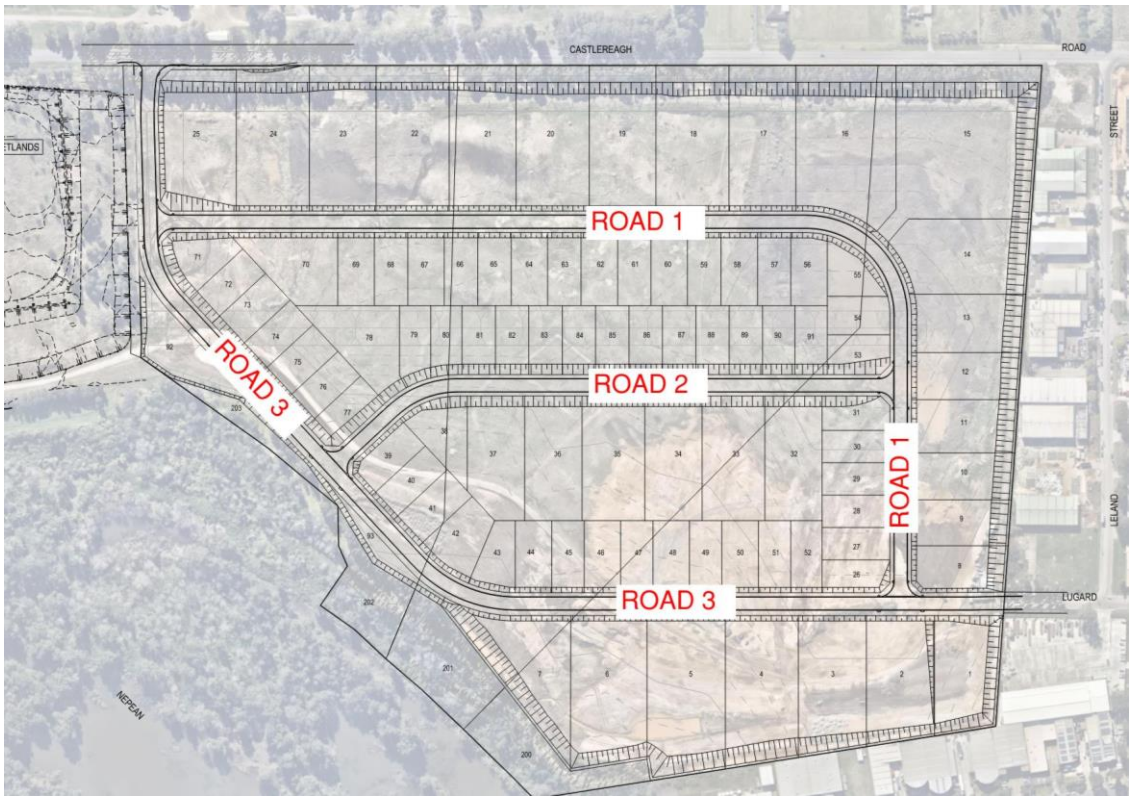


Figure 8 - Proposed Road Layout

7.2 Road Types

It is proposed that the following road hierarchy outlined in Table 4 applies to the development.

Table 4 – Typical Road Sections

Road	Category	Typical Road Reserve	Comments
Road 1 Road 2	Local Access Road	20.60m (13m carriageway + 3.8m verge both sides)	1.5m footpaths both sides
Road 3	Local Access Road	22.0m (13m carriageway + 3.8m verge + 5.2m verge)	1.5m footpath in 3.8m verge 3.0m shared path in 5.2m verge

7.3 Design and Posted Speed

Internal roads of the development have a proposed speed limit of 50km/h.

7.4 Signage

Signage and pavement line markings have been proposed in order to provide appropriate warning to vehicles, traffic calming at key intersections and improve driver awareness in critical locations where sight distance is less than desired.

Reference is to be made to Enspire's engineering drawing package for details of proposed pavement, signage and line marking.

7.5 Vertical and Horizontal Geometry

The road geometry has been designed in accordance with Penrith City Council Design Guides for Engineering Works for Subdivisions and Developments and generally in accordance with AUSTROADS Guide to Road Design Part 3. The vertical and horizontal geometry has considered sight distance in accordance with AUSTROADS Guide to Road Design Part 3.

Horizontal alignments, longitudinal gradients and vertical curves have been designed in accordance with Section 2.2.13 to 2.2.15 in Councils Design Guide for Engineering Works Specification.

7.6 Design Vehicles

Design vehicle for the development is the 26m B-Double articulated vehicle. Swept path analysis has been completed using AutoTURN software and in accordance with AUSTROADS (2006) and Council's Guidelines.

Reference is to be made to Enspire's engineering drawing package for swept paths at critical locations.

8 Conclusion

This Civil Engineering and Stormwater Management Report has been prepared to provide an understanding of the design assumptions, inputs and guide to the civil engineering and stormwater management components and techniques for the proposed Nepean Business Park (Employment Lands) as depicted in Figure 1.

Trunk drainage components are proposed to be constructed to safely convey internal catchments to the Southern Wetlands which form part of the Penrith Lakes Water Management Plan.

In line with the Penrith Lakes Water Management Plan no on-site stormwater detention is proposed for the development. Water quality treatment is proposed to consist of Gross Pollutant Traps (GPTs) at the trunk drainage outlet to the Southern Wetlands which will treat road reserve runoff, as well as on-lot GPTs which will form part of the individual lot developments.

Appendix A GCA 2-Year Plan Civil Engineering

PENRITH LAKES EMPLOYMENT LAND

OLD CASTLEREAGH ROAD, CASTLEREAGH

CIVIL PLANS

DRAWING SCHEDULE

DWG No.	SHEET TITLE	REV
C2000	COVER SHEET	11
C2001	GENERAL ARRANGEMENT PLAN	11
C2002	PLAN SHEET (1 OF 2)	11
C2003	PLAN SHEET (2 OF 2)	11
C2004	SITE SECTIONS (1 OF 3)	11
C2005	SITE SECTIONS (2 OF 3)	11
C2006	SITE SECTIONS (3 OF 3)	11
C2007	DETAILED SITE SECTIONS (1 OF 2)	11
C2008	DETAILED SITE SECTIONS (2 OF 2)	11
C2009	SEDIMENT AND EROSION CONTROL DETAILS	11

GCA
ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

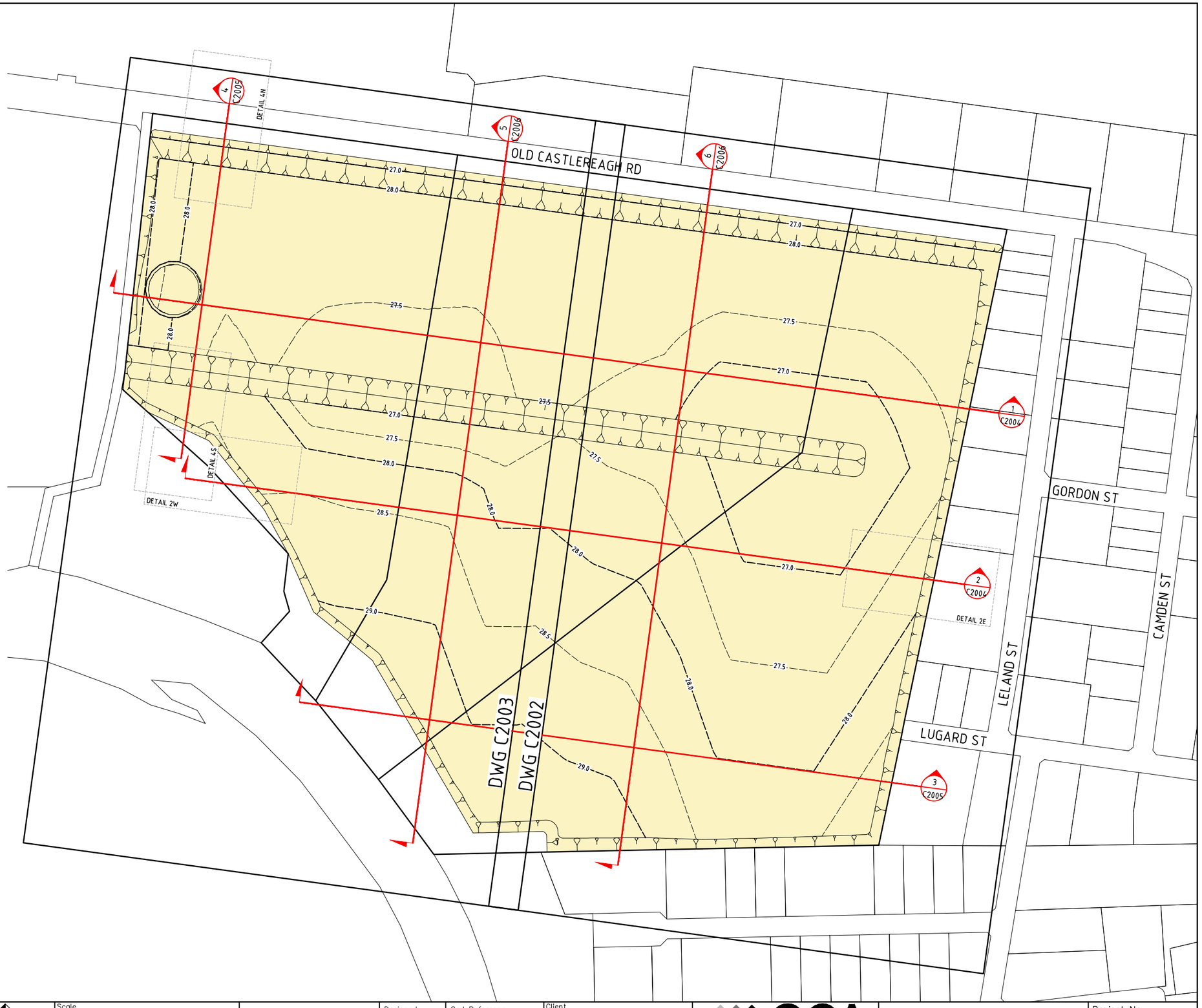
PLOT DATE: 1/06/2020 12:59:44 PM CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2001 r11.dwg

GENERAL NOTES:

1. ALL EXISTING UNDERGROUND SERVICES MUST BE LOCATED AND EXPOSED PRIOR TO EARTHWORKS COMMENCING AND IT IS THE RESPONSIBILITY OF THOSE PERSONS USING THIS PLAN TO CONFIRM BOTH POSITION & LEVEL OF THESE UTILITIES IN CONJUNCTION WITH THE APPROPRIATE AUTHORITY.
2. WORKING HOURS ON SITE SHALL BE IN ACCORDANCE WITH THE CONDITIONS OF CONSENT.
3. SITE ACCESS SHALL BE OBTAINED USING EXISTING ACCESS POINTS.
4. VEHICULAR ACCESS AND ALL SERVICES ARE TO BE MAINTAINED AT ALL TIMES TO ADJOINING PROPERTIES AFFECTED BY CONSTRUCTION WORKS.
5. TRAFFIC CONTROL MEASURES TO BE IN ACCORDANCE WITH AS 1742.3-1996.
6. ALL LEVELS MUST BE OBTAINED FROM ESTABLISHED BENCH MARKS AS DIRECTED BY THE SUPERVISOR.
7. ALL EARTHWORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH:
   - LETTER FROM PELLS SULLIVAN MEYNINK (PSM) TO GREAT RIVER NSW PTY LTD DATED 15 MARCH 2019, TITLED "ADDITIONAL DETAILS REGARDING PROPOSED GEOTECHNICAL REHABILITATION WORKS FOR THE PROPOSED INDUSTRIAL DEVELOPMENT OF SOUTHERN WETLANDS SIDE, PENRITH LAKES"
   - PENRITH LAKES, SOUTHERN WETLANDS GEOTECHNICAL DESIGN, GROUND TREATMENT (PELLS SULLIVAN MEYNINK, 25 MARCH 2019, REF: PSM3688-013R REV 1)
7. THE WORKS AREA IS TO BE REVEGETATED PROGRESSIVELY (TO THE EXTENT PRACTICAL) IN ACCORDANCE WITH THE PLAN(S) PREPARED BY CLOUSTON ASSOCIATES.

EROSION AND SEDIMENT CONTROL

1. SITE EROSION AND SEDIMENT CONTROLS SHALL BE PLANNED AND IMPLEMENTED IN ACCORDANCE WITH THE LAND REHABILITATION MANUAL 1987.
2. CAPACITIES OF DRAINAGE AND EROSION CONTROL WORKS ARE TO BE DETERMINED IN ACCORDANCE WITH THE AUSTRALIAN RAINFALL AND RUNOFF MANUAL
3. MINIMUM STORM RETURN PERIODS ARE TO BE:
   - LATERAL DRAINS - 5 YEARS
   - WATERWAYS - 20 YEARS



Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	REVISED DESIGN	KS	AS	26.05.20
9	REVISED CONTOUR INTERVAL	KS	AS	15.05.20
8	REVISED DESIGN	KS	AS	08.05.20

North

Scale
0 40 80 120 160m
1:2000 (A1) 1:4000 (A3)

Designed	Cad Reference
KS	18255 C2001 r11
Scale	A1 SHEET
1:2000	

Project Approval
IAN HILL (B.E)
Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

PENRITH LAKES EMPLOYMENT LAND

CIVIL PLANS

GENERAL ARRANGEMENT PLAN

Project No	
18255C	
Drawing No	Revision
C2001	11

PLOT DATE: 1/06/2020 12:59:45 PM CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2001 r11.dwg

DWG C2002

LOT 2 DP808684

LOT 1 DP812619

LOT 2829 DP1083212

LOT 30 DP794370

LOT 31 DP794370

LOT 1 DP1050105

SP68321

LOT 10 DP788072

LOT 11 DP788072

LOT 12 DP788072

LOT 319 DP752021

LOT 318 DP752021

LOT 309 DP752021

LOT 310 DP752021

LOT 3 SEC C DP979378

LOT 2 SEC C DP979378

LOT 1 SEC C DP979378

LOT 50 DP789116

LOT 7 SEC C DP979378

LOT 8 DP718139

LOT 9 DP806836

LOT 10 DP800843

LOT 11 SEC C DP979378

LOT 123 DP1038183

LOT 14 SEC C DP979378

LOT 15 SEC C DP979378

LOT 16 SEC C DP979378

LOT 19 DP1013504

LOT 16 DP793163

LOT 14 DP793163

LOT 12 DP793163

LOT 10 DP793163

LOT 8 DP793163

LUGARD ST

LELAND ST

C2005 3

C2004 2

C2004 1

6 C2006

Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	REVISED DESIGN	KS	AS	26.05.20
9	REVISED CONTOUR INTERVAL	KS	AS	15.05.20
8	REVISED DESIGN	KS	AS	08.05.20

North

Scale
0 20 40 60 80m
1:1000 (A1) 1:2000 (A3)

Designed KS
Cad Reference 18255 C2001 r11
Scale 1:1000
A1 SHEET
Project Approval
IAN HILL (B.E)
Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

PENRITH LAKES EMPLOYMENT LAND

CIVIL PLANS

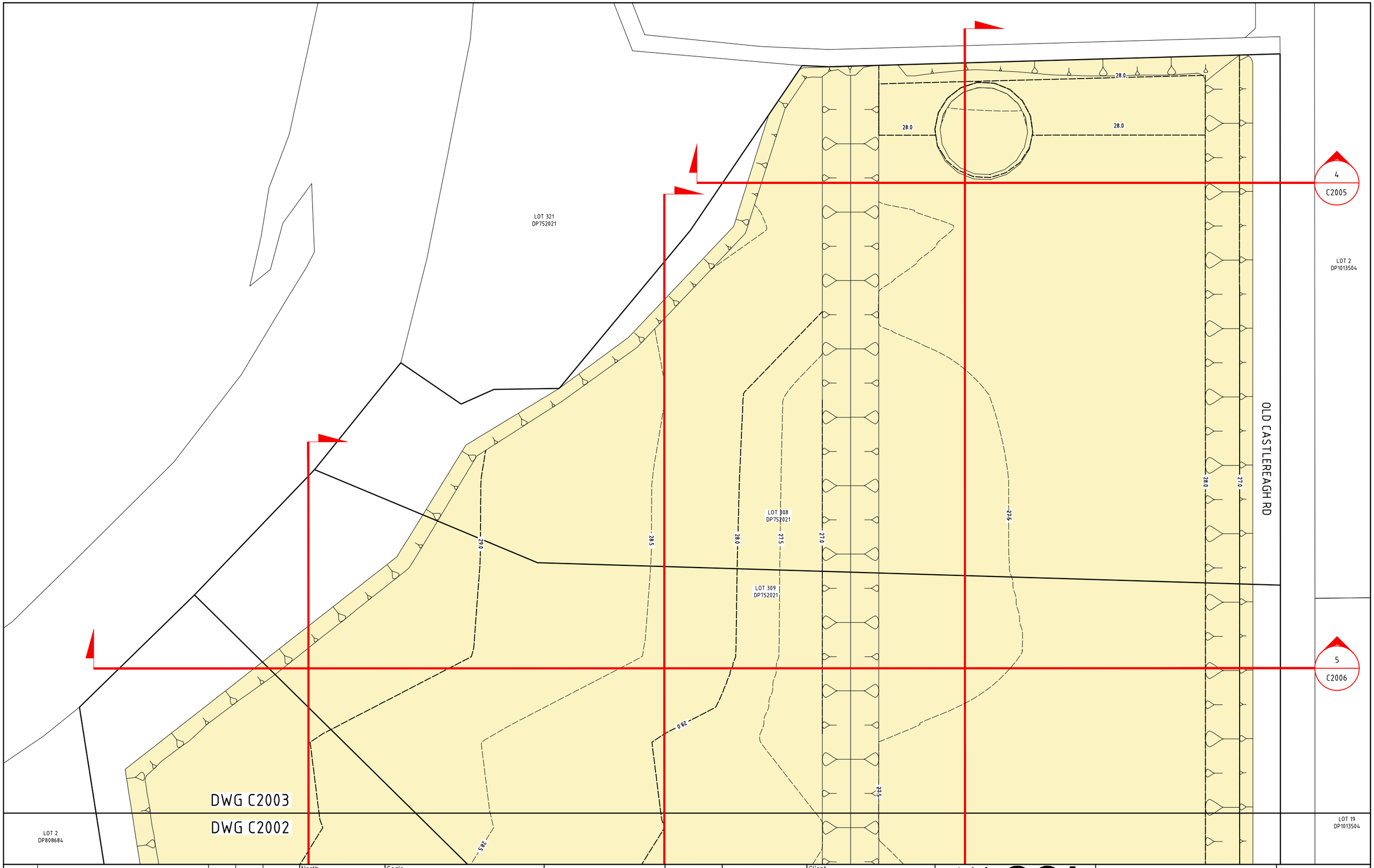
SITE PLAN - SHEET 1 OF 2

Project No 18255C

Drawing No C2002

Revision 11

PLOT DATE: 1/06/2020 12:59:46 PM
CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2001 r11.dwg



Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	REVISED DESIGN	KS	AS	26.05.20
9	REVISED CONTOUR INTERVAL	KS	AS	15.05.20
8	REVISED DESIGN	KS	AS	08.05.20

North

Scale
0 20 40 60 80m
1:1000 (A1) 1:2000 (A3)

Designed: KS
Cad Reference: 18255 C2001 r11
Scale: 1:1000
A1 SHEET
Project Approval
IAN HILL (B.E)
Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

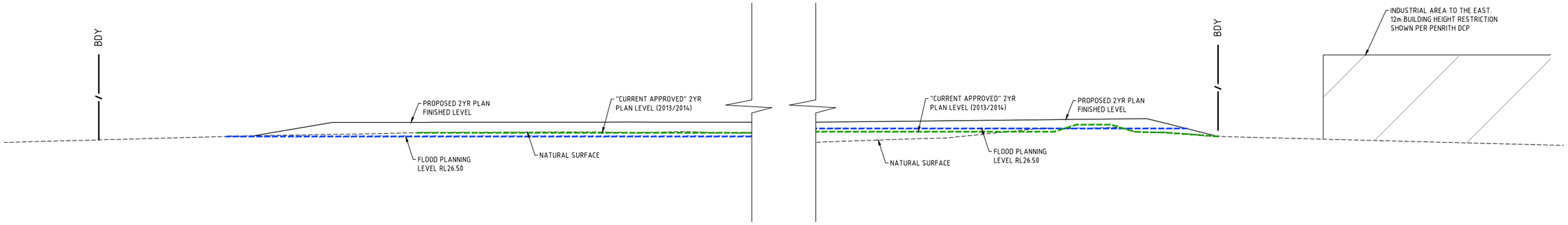
PENRITH LAKES EMPLOYMENT LAND

CIVIL PLANS

SITE PLAN - SHEET 2 OF 2

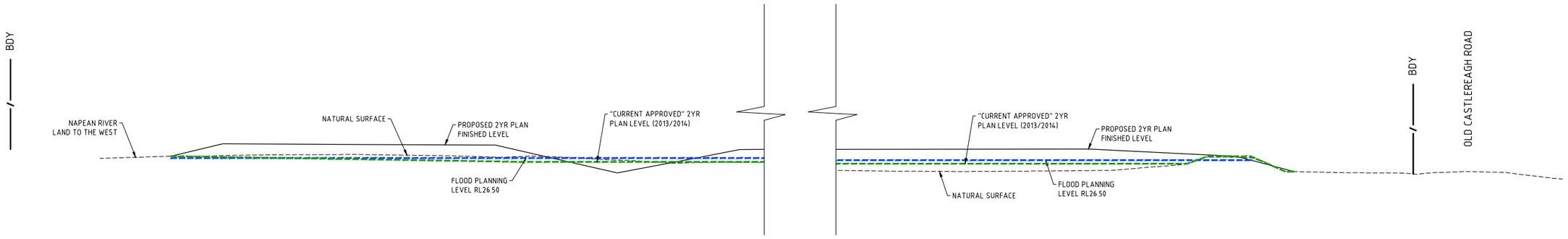
Project No: 18255C
Drawing No: C2003
Revision: 11

PLOT DATE: 1/06/2020 12:59:46 PM
CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2001 r11.dwg



DETAIL 2W (SITE SECTION 2)

DETAIL 2E (SITE SECTION 2)



DETAIL 4S (SITE SECTION 4)

DETAIL 4N (SITE SECTION 4)

NOTE:
SITE SECTION VERTICAL SCALE IS THE SAME AS THE HORIZONTAL SCALE.

Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	ORIGINAL ISSUE	KS	AS	26.05.20

North

Scale

Designed: KS
Cad Reference: 18255 C2007 r11
Scale: 1:2000
A1 SHEET
Project Approval
IAN HILL (B.E)
Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

PENRITH LAKES EMPLOYMENT LAND

CIVIL PLANS

DETAILED SITE SECTIONS (1 OF 2)

Project No: 18255C
Drawing No: C2007
Revision: 11

PLOT DATE: 1/06/2020 12:59:53 PM
CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2007 r11.dwg

DATUM RL = -45.00

CHAINAGE	FINISHED SURFACE	NATURAL SURFACE
0.000		
10.000		
20.000		
30.000		
40.000		
50.000		
60.000		
70.000	28.082	26.717
80.000	28.473	26.897
90.000	28.482	27.040
100.000	28.491	27.075
110.000	28.501	27.089
120.000	28.502	27.100
130.000	28.494	26.970
140.000	28.486	26.930
150.000	28.477	26.900
160.000	28.469	27.024
170.000	28.463	27.308
180.000	28.463	27.276
190.000	28.462	27.236
200.000	28.462	27.165
210.000	28.462	27.122
220.000	28.459	27.133
230.000	28.456	27.137
240.000	28.452	26.867
250.000	28.448	26.631
260.000	28.444	26.468
270.000	28.436	26.355
280.000	28.344	26.024
290.000	28.247	26.030
300.000	28.151	25.932
310.000	28.054	25.903
320.000	27.967	26.000
330.000	27.970	26.025
340.000	27.976	25.994
350.000	27.982	25.905
360.000	27.988	25.822
370.000	28.000	25.773
380.000	27.971	25.715
390.000	27.940	25.638
400.000	27.909	25.576
410.000	27.878	25.576
420.000	27.850	25.620
430.000	27.837	25.629
440.000	27.825	25.630
450.000	27.813	25.667
460.000	27.801	25.658
470.000	27.780	25.636
480.000	27.715	25.577
490.000	27.648	25.575
500.000	27.581	25.594
510.000	27.513	25.653
520.000	27.441	25.638
530.000	27.344	25.573
540.000	27.245	25.568
550.000	27.147	25.520
560.000	27.048	25.432
570.000	26.966	25.337
580.000	26.962	25.259
590.000	26.962	25.297
600.000	26.962	25.471
610.000	26.962	24.206
620.000	26.962	25.381
630.000	26.962	25.368
640.000	26.962	25.131
650.000	26.962	24.611
660.000	26.962	24.227
670.000	26.977	24.115
680.000	27.083	24.010
690.000	27.189	24.035
700.000	27.296	24.270
710.000	27.402	24.656
720.000	27.508	24.985
730.000	27.615	25.690
740.000	27.721	26.469
750.000	27.827	26.345
760.000	26.068	25.546
770.000		
780.000		
790.000		
794.274		

A1 SCALE: HORIZONTAL 1:1500, VERTICAL 1:1500

DETAIL 5 (SITE SECTION 2)

NOTE:
SITE SECTION VERTICAL SCALE IS THE SAME AS THE HORIZONTAL SCALE.

Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	ORIGINAL ISSUE	KS	AS	26.05.20

North

Scale

Designed: KS
Cad Reference: 18255 C2008 r11
Scale: A1 SHEET
Project Approval: IAN HILL (B.E) Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

PENRITH LAKES EMPLOYMENT LAND

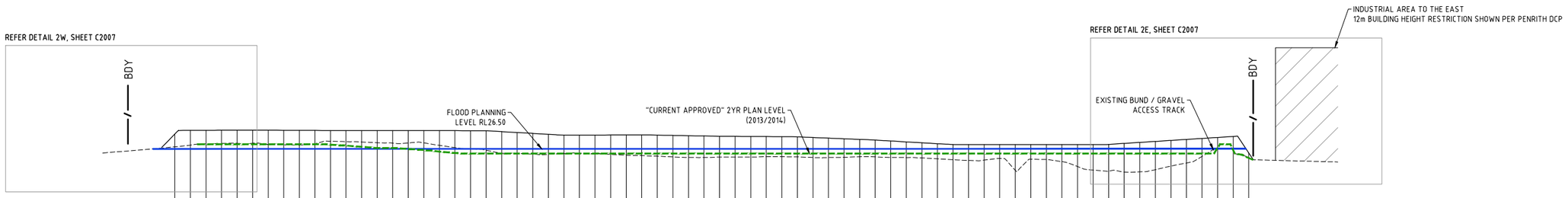
CIVIL PLANS

DETAILED SITE SECTIONS (2 OF 2)

Project No: 18255C
Drawing No: C2008
Revision: 11

PLOT DATE: 1/06/2020 12:59:55 PM
CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2008 r11.dwg

NOTE:
SITE SECTIONS 1-6 ARE SHOWN AT 6x EXAGGERATION FOR CLARITY



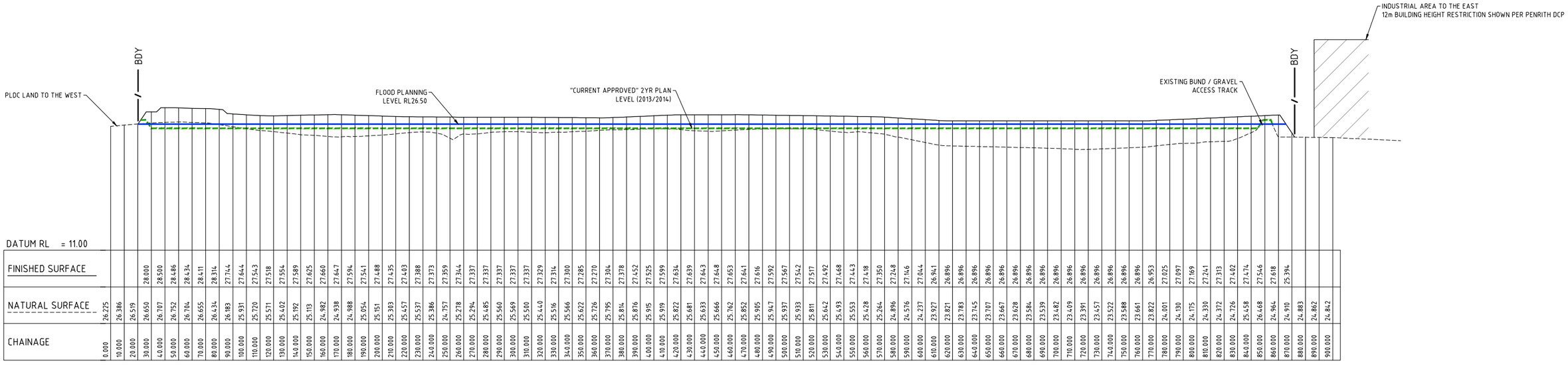
DATUM RL = 11.00

CHAINAGE	FINISHED SURFACE	NATURAL SURFACE
0.000		26.717
10.000		26.897
20.000		27.049
30.000		27.075
40.000		27.089
50.000		27.100
60.000		26.970
70.000	28.082	26.930
80.000	28.473	26.900
90.000	28.482	27.024
100.000	28.491	27.308
110.000	28.501	27.276
120.000	28.502	27.236
130.000	28.494	27.165
140.000	28.486	27.122
150.000	28.477	27.133
160.000	28.469	27.137
170.000	28.463	26.867
180.000	28.463	26.631
190.000	28.462	26.468
200.000	28.462	26.355
210.000	28.462	26.024
220.000	28.459	26.030
230.000	28.456	25.932
240.000	28.452	25.903
250.000	28.448	26.000
260.000	28.444	26.025
270.000	28.436	25.994
280.000	28.344	25.905
290.000	28.247	25.822
300.000	28.151	25.773
310.000	28.054	25.715
320.000	27.967	25.638
330.000	27.970	25.576
340.000	27.976	25.620
350.000	27.982	25.629
360.000	27.988	25.630
370.000	28.000	25.667
380.000	27.971	25.658
390.000	27.940	25.636
400.000	27.909	25.577
410.000	27.878	25.575
420.000	27.850	25.594
430.000	27.837	25.653
440.000	27.825	25.638
450.000	27.813	25.573
460.000	27.801	25.568
470.000	27.780	25.520
480.000	27.715	25.432
490.000	27.648	25.337
500.000	27.581	25.259
510.000	27.513	25.297
520.000	27.441	25.471
530.000	27.344	24.206
540.000	27.245	25.381
550.000	27.147	25.368
560.000	27.048	25.131
570.000	26.966	24.611
580.000	26.962	24.227
590.000	26.962	24.115
600.000	26.962	24.010
610.000	26.962	24.035
620.000	26.962	24.270
630.000	26.962	24.656
640.000	26.962	24.985
650.000	26.962	25.690
660.000	26.962	26.469
670.000	26.977	26.345
680.000	27.083	25.546
690.000	27.189	26.068
700.000	27.296	
710.000	27.402	
720.000	27.508	
730.000	27.615	
740.000	27.721	
750.000	27.827	
760.000	26.068	
770.000		
780.000		
790.000		
794.274		

A1 SCALE: HORIZONTAL 1:1500, VERTICAL 1:250

SITE SECTION 2

(ALSO REFER TO DETAIL 5, SHEET C2008)



DATUM RL = 11.00

CHAINAGE	FINISHED SURFACE	NATURAL SURFACE
0.000		26.225
10.000		26.386
20.000		26.519
30.000	28.000	26.650
40.000	28.500	26.707
50.000	28.486	26.752
60.000	28.434	26.704
70.000	28.411	26.655
80.000	28.314	26.434
90.000	27.744	26.183
100.000	27.644	25.931
110.000	27.543	25.720
120.000	27.518	25.571
130.000	27.554	25.402
140.000	27.589	25.192
150.000	27.625	25.113
160.000	27.660	24.982
170.000	27.647	24.938
180.000	27.594	24.988
190.000	27.541	25.054
200.000	27.488	25.151
210.000	27.435	25.303
220.000	27.403	25.457
230.000	27.388	25.537
240.000	27.373	25.386
250.000	27.359	24.757
260.000	27.344	25.278
270.000	27.337	25.294
280.000	27.337	25.485
290.000	27.337	25.560
300.000	27.337	25.569
310.000	27.337	25.500
320.000	27.329	25.440
330.000	27.314	25.516
340.000	27.300	25.566
350.000	27.285	25.622
360.000	27.270	25.726
370.000	27.304	25.795
380.000	27.378	25.814
390.000	27.452	25.876
400.000	27.525	25.915
410.000	27.599	25.919
420.000	27.634	25.822
430.000	27.639	25.681
440.000	27.643	25.633
450.000	27.648	25.666
460.000	27.653	25.762
470.000	27.641	25.852
480.000	27.616	25.905
490.000	27.592	25.947
500.000	27.567	25.937
510.000	27.542	25.933
520.000	27.517	25.811
530.000	27.492	25.642
540.000	27.468	25.493
550.000	27.443	25.553
560.000	27.418	25.428
570.000	27.350	25.264
580.000	27.248	24.896
590.000	27.146	24.576
600.000	27.044	24.237
610.000	26.941	23.927
620.000	26.896	23.821
630.000	26.896	23.783
640.000	26.896	23.745
650.000	26.896	23.707
660.000	26.896	23.667
670.000	26.896	23.628
680.000	26.896	23.584
690.000	26.896	23.539
700.000	26.896	23.482
710.000	26.896	23.409
720.000	26.896	23.391
730.000	26.896	23.457
740.000	26.896	23.522
750.000	26.896	23.588
760.000	26.896	23.661
770.000	26.896	23.822
780.000	26.896	24.001
790.000	26.896	24.130
800.000	26.896	24.175
810.000	26.896	24.330
820.000	26.896	24.372
830.000	26.896	24.726
840.000	26.896	25.458
850.000	26.896	26.468
860.000	26.896	24.964
870.000	26.896	24.510
880.000	26.896	24.883
890.000	26.896	24.862
900.000	26.896	24.842

A1 SCALE: HORIZONTAL 1:1500, VERTICAL 1:250

SITE SECTION 1

Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	REVISED DESIGN	KS	AS	26.05.20
9	NOT ISSUED			
8	REVISED DESIGN	KS	AS	08.05.20

North

Scale

Designed: KS
Cad Reference: 18255 C2004 r11
Scale: 1:2000
A1 SHEET
Project Approval: IAN HILL (B.E) Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

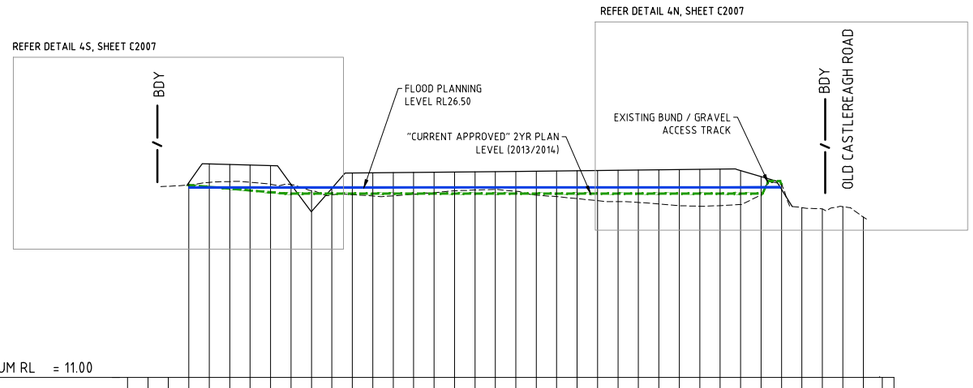
PENRITH LAKES EMPLOYMENT LAND

CIVIL PLANS

SITE SECTIONS - SHEET 1 OF 3

Project No: 18255C
Drawing No: C2004
Revision: 11

PLOT DATE: 1/06/2020 12:59:48 PM
CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2004 r11.dwg

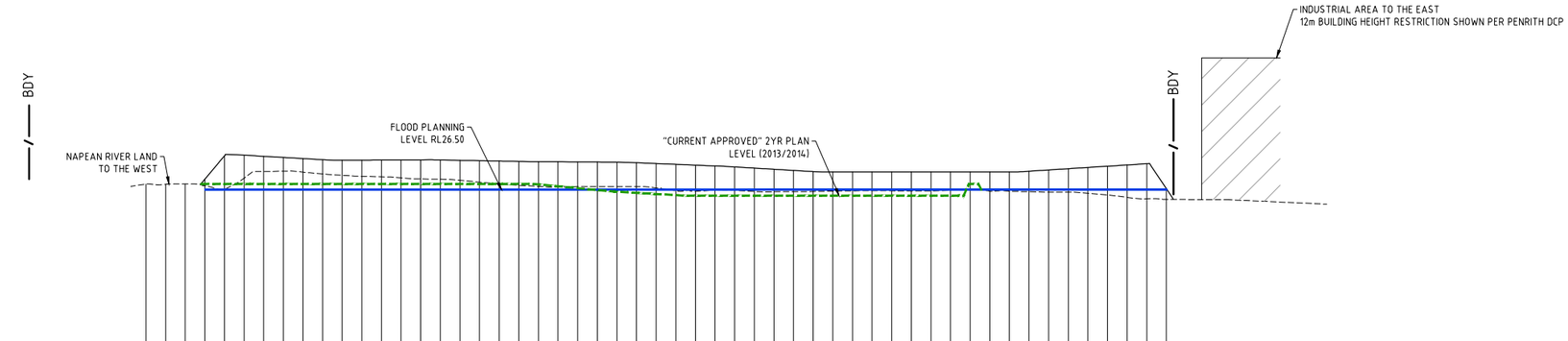


DATUM RL = 11.00

CHAINAGE	FINISHED SURFACE	NATURAL SURFACE
0.000		
10.000		
20.000		
30.000	26.873	26.680
40.000	28.416	26.904
50.000	28.366	26.970
60.000	28.316	26.911
70.000	28.266	26.740
80.000	26.741	26.724
90.000	24.523	26.223
100.000	26.426	25.881
110.000	27.670	25.905
120.000	27.685	25.802
130.000	27.701	25.804
140.000	27.716	25.932
150.000	27.732	26.059
160.000	27.747	26.219
170.000	27.763	26.276
180.000	27.778	26.334
190.000	27.795	26.184
200.000	27.814	25.869
210.000	27.833	25.741
220.000	27.852	25.580
230.000	27.871	25.413
240.000	27.890	25.336
250.000	27.909	25.273
260.000	27.928	25.144
270.000	27.947	25.012
280.000	27.967	24.951
290.000	27.986	25.012
300.000	27.874	25.098
310.000	27.374	25.877
320.000	26.336	26.742
330.000		24.844
340.000		24.747
350.000		24.924
360.000		24.077
368.004		

A1 SCALE: HORIZONTAL 1:1500, VERTICAL 1:250

SITE SECTION 4



DATUM RL = 13.00

CHAINAGE	FINISHED SURFACE	NATURAL SURFACE
0.000		
10.000		
20.000		
30.000		
40.000		
50.000		
60.000		
70.000		
80.000		26.977
90.000		26.959
100.000		26.997
110.000	27.393	26.841
120.000	29.369	26.530
130.000	29.435	27.475
140.000	29.339	28.048
150.000	29.242	28.076
160.000	29.146	27.995
170.000	29.049	27.837
180.000	29.008	27.721
190.000	29.014	27.638
200.000	29.020	27.604
210.000	29.027	27.517
220.000	29.033	27.412
230.000	29.029	27.392
240.000	28.997	27.301
250.000	28.966	27.143
260.000	28.935	26.987
270.000	28.904	26.883
280.000	28.885	26.783
290.000	28.873	26.736
300.000	28.861	26.757
310.000	28.849	26.759
320.000	28.837	26.762
330.000	28.791	26.763
340.000	28.724	26.643
350.000	28.657	26.404
360.000	28.589	26.367
370.000	28.522	26.468
380.000	28.436	26.442
390.000	28.337	26.359
400.000	28.239	26.330
410.000	28.140	26.343
420.000	28.042	26.350
430.000	28.004	26.384
440.000	28.004	26.409
450.000	28.004	26.427
460.000	28.004	26.412
470.000	28.004	26.403
480.000	28.004	26.411
490.000	28.004	26.453
500.000	28.004	26.498
510.000	28.004	26.371
520.000	28.004	26.374
530.000	28.069	26.338
540.000	28.175	26.299
550.000	28.282	26.295
560.000	28.388	26.195
570.000	28.494	26.047
580.000	28.600	25.853
590.000	28.707	25.735
600.000	26.584	25.625
610.000		
620.000		
630.000		
633.501		

A1 SCALE: HORIZONTAL 1:1500, VERTICAL 1:250

SITE SECTION 3

NOTE:
SITE SECTIONS 1-6 ARE SHOWN AT 6x EXAGGERATION FOR CLARITY

Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	REVISED DESIGN	KS	AS	26.05.20
9	NOT ISSUED			
8	REVISED DESIGN	KS	AS	08.05.20

North

Scale

Designed: KS
Cad Reference: 18255 C2005 r11
Scale: 1:2000
A1 SHEET
Project Approval
IAN HILL (B.E)
Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

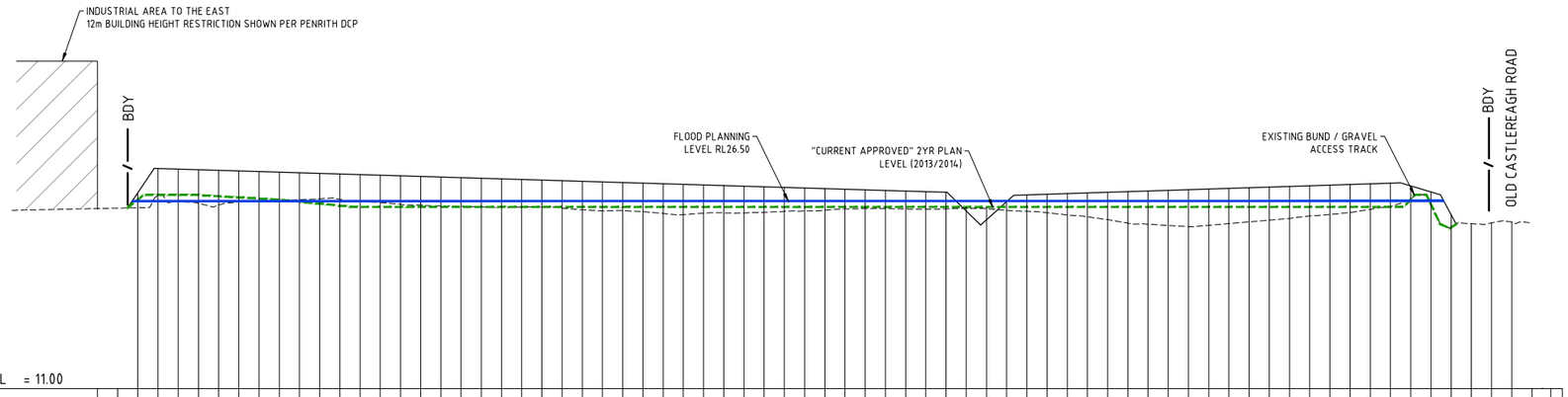
PENRITH LAKES EMPLOYMENT LAND

CIVIL PLANS

SITE SECTIONS - SHEET 2 OF 3

Project No: 18255C
Drawing No: C2005
Revision: 11

PLOT DATE: 1/06/2020 12:59:50 PM
CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2005 r11.dwg

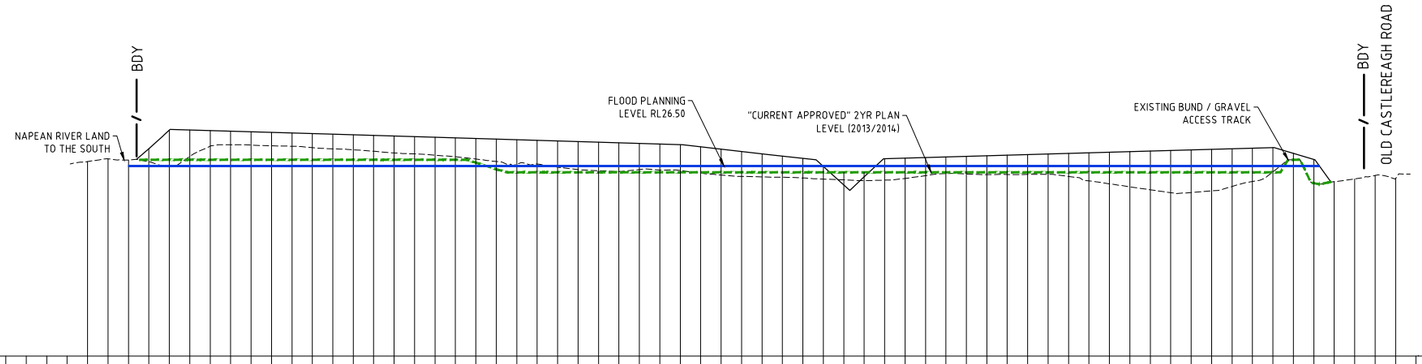


DATUM RL = 11.00

CHAINAGE	FINISHED SURFACE	NATURAL SURFACE
0.000		
10.000		
20.000	27.174	
30.000	29.168	26.872
40.000	29.118	26.412
50.000	29.068	26.299
60.000	29.018	26.145
70.000	28.968	26.420
80.000	28.918	26.466
90.000	28.868	26.531
100.000	28.818	26.591
110.000	28.768	26.673
120.000	28.718	26.624
130.000	28.668	26.494
140.000	28.618	26.376
150.000	28.568	26.207
160.000	28.518	26.139
170.000	28.468	26.085
180.000	28.418	26.045
190.000	28.368	26.001
200.000	28.318	25.976
210.000	28.268	25.990
220.000	28.218	26.021
230.000	28.168	25.906
240.000	28.118	25.773
250.000	28.068	25.684
260.000	28.018	25.696
270.000	27.968	25.607
280.000	27.918	25.462
290.000	27.868	25.373
300.000	27.818	25.485
310.000	27.768	25.510
320.000	27.718	25.515
330.000	27.668	25.558
340.000	27.618	25.636
350.000	27.568	25.662
360.000	27.518	25.735
370.000	27.468	25.843
380.000	27.418	25.854
390.000	27.368	25.858
400.000	27.318	25.833
410.000	27.268	25.820
420.000	27.218	25.842
430.000	25.665	25.874
440.000	24.935	25.860
450.000	26.427	25.723
460.000	26.995	25.647
470.000	27.049	25.528
480.000	27.104	25.340
490.000	27.158	25.190
500.000	27.212	24.946
510.000	27.267	24.662
520.000	27.321	24.580
530.000	27.375	24.477
540.000	27.430	24.374
550.000	27.484	24.485
560.000	27.538	24.627
570.000	27.593	24.769
580.000	27.647	24.911
590.000	27.702	25.052
600.000	27.756	25.252
610.000	27.810	25.319
620.000	27.865	25.542
630.000	27.919	25.806
640.000	27.973	26.072
650.000	27.739	26.588
660.000	27.239	26.190
670.000	25.370	24.324
680.000		24.625
690.000		24.690
700.000		24.763
710.000		
715.173		

A1 SCALE: HORIZONTAL 1:1500, VERTICAL 1:250

SITE SECTION 6



DATUM RL = 11.00

CHAINAGE	FINISHED SURFACE	NATURAL SURFACE
0.000		
10.000		
20.000		
30.000		
40.000		
50.000		
60.000		
70.000		26.868
80.000		27.082
90.000		26.993
100.000	27.911	26.841
110.000	29.425	26.482
120.000	29.440	27.276
130.000	29.390	28.120
140.000	29.340	28.232
150.000	29.290	28.208
160.000	29.240	28.140
170.000	29.190	28.112
180.000	29.140	28.001
190.000	29.090	27.905
200.000	29.040	27.826
210.000	28.990	27.701
220.000	28.940	27.568
230.000	28.890	27.497
240.000	28.840	27.385
250.000	28.790	27.250
260.000	28.740	27.068
270.000	28.690	26.870
280.000	28.640	26.641
290.000	28.590	26.658
300.000	28.540	26.406
310.000	28.490	26.216
320.000	28.440	26.113
330.000	28.390	26.052
340.000	28.340	26.210
350.000	28.290	26.161
360.000	28.240	26.134
370.000	28.065	25.519
380.000	27.874	25.764
390.000	27.683	25.653
400.000	27.492	25.609
410.000	27.305	25.583
420.000	27.120	25.524
430.000	26.463	25.440
440.000	24.948	25.370
450.000	25.614	25.315
460.000	27.089	25.351
470.000	27.137	25.493
480.000	27.186	25.113
490.000	27.235	25.880
500.000	27.284	25.853
510.000	27.332	25.804
520.000	27.381	25.811
530.000	27.430	25.811
540.000	27.479	25.818
550.000	27.527	25.654
560.000	27.576	25.284
570.000	27.625	25.050
580.000	27.674	24.807
590.000	27.720	24.563
600.000	27.767	24.320
610.000	27.813	24.343
620.000	27.859	24.473
630.000	27.905	24.831
640.000	27.951	25.232
650.000	27.997	26.022
660.000	27.531	27.002
670.000	27.031	25.112
680.000		25.226
690.000		25.449
700.000		25.734
710.000		25.488
720.000		
721.067		

A1 SCALE: HORIZONTAL 1:1500, VERTICAL 1:250

SITE SECTION 5

NOTE:
SITE SECTIONS 1-6 ARE SHOWN AT 6x EXAGGERATION FOR CLARITY

Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	ORIGINAL ISSUE	KS	AS	26.05.20

North

Scale

Designed: KS
Cad Reference: 18255 C2006 r11
Scale: 1:2000
A1 SHEET
Project Approval
IAN HILL (B.E)
Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

PENRITH LAKES EMPLOYMENT LAND

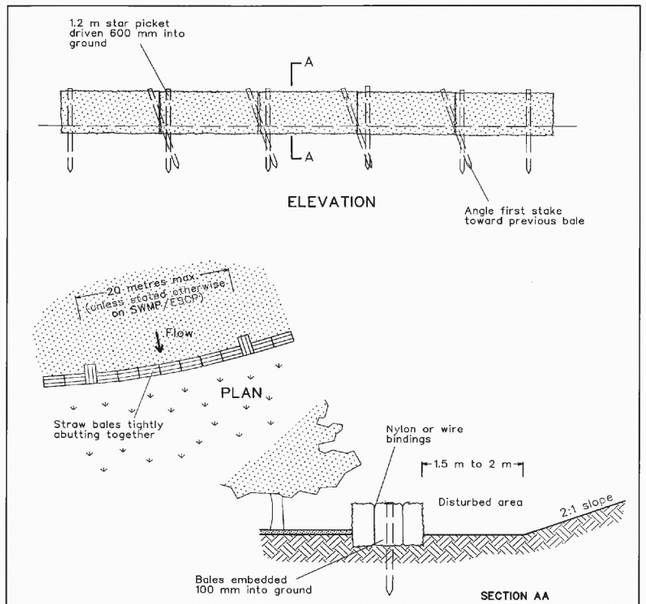
CIVIL PLANS

SITE SECTIONS - SHEET 3 OF 3

Project No: 18255C
Drawing No: C2006
Revision: 11

PLOT DATE: 1/06/2020 12:59:51 PM
CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2006 r11.dwg

NOTE:
1. ALL SEDIMENT AND EROSION CONTROL WORKS ARE TO BE MAINTAINED IN ACCORDANCE WITH SECTION 6 OF THE PENRITH LAKES LAND REHABILITATION MANUAL (1987).
2. ALL WORKS SHOULD BE COMPLETED IN ACCORDANCE WITH "SOILS AND CONSTRUCTION" VOLUME 1, 4TH EDITION, MARCH 2004"

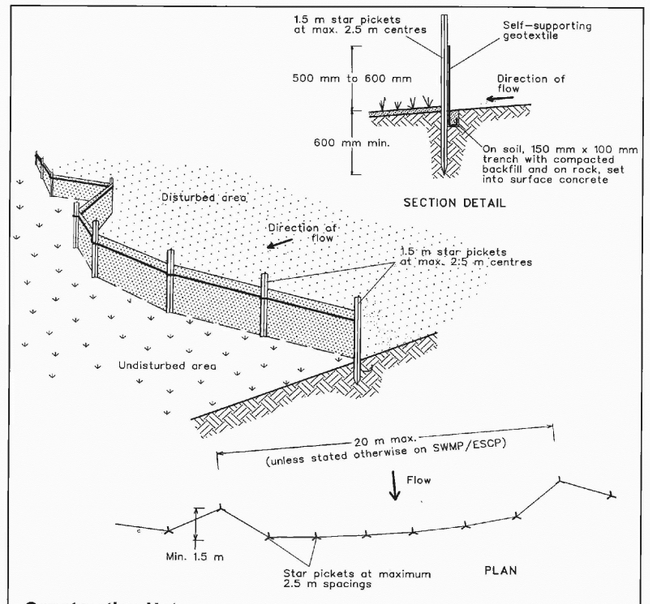


Construction Notes

1. Construct the straw bale filter as close as possible to being parallel to the contours of the site.
2. Place bales lengthwise in a row with ends tightly abutting. Use straw to fill any gaps between bales. Straws are to be placed parallel to ground.
3. Ensure that the maximum height of the filter is one bale.
4. Embed each bale in the ground 75 mm to 100 mm and anchor with two 1.2 metre star pickets or stakes. Angle the first star picket or stake in each bale towards the previously laid bale. Drive them 600 mm into the ground and, if possible, flush with the top of the bales. Where star pickets are used and they protrude above the bales, ensure they are fitted with safety caps.
5. Where a straw bale filter is constructed downslope from a disturbed batter, ensure the bales are placed 1 to 2 metres downslope from the toe.
6. Establish a maintenance program that ensures the integrity of the bales is retained - they could require replacement each two to four months.

STRAW BALE FILTER **SD 6-7**

6-35



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE **SD 6-8**

6-36

Amendment	Description	Drawn	App'd	Date
11	DETAILED SITE SECTIONS ADDED	KS	AS	29.05.20
10	REVISED DESIGN	KS	AS	26.05.20
9	NOT ISSUED			
8	REVISED DESIGN	KS	AS	08.05.20
7	ORIGINAL ISSUE	KS	AS	03.04.20

North

Scale

Designed: KS
Cad Reference: 18255 C2009 r11
Scale: 1:2000
A1 SHEET
Project Approval: IAN HILL (B.E) Consulting Civil Engineer

Client

GCA ENGINEERING SOLUTIONS
A.B.N. 92 086 017 745
1 HARTLEY DRIVE, THORNTON NSW 2322
PO BOX 3337, THORNTON NSW 2322
PHONE: (02) 4964 1811

PENRITH LAKES EMPLOYMENT LAND
CIVIL PLANS
SEDIMENT AND EROSION CONTROL DETAILS

Project No: 18255C
Drawing No: C2009
Revision: 11

PLOT DATE: 1/06/2020 12:59:56 PM
CAD FILE: Q:\18\18255 Penrith Lakes Industrial\02_CAD\AutoCAD\Civil\C2000 Civil Plan EW\C2000 Series\18255 C2009 r11.dwg

Appendix B Penrith Lakes Water Management Plan

PENRITH LAKES DEVELOPMENT CORPORATION

WATER MANAGEMENT PLAN: STAGE 2

May 2020

Cover Image: Cranebrook Lake Wetland

WATER MANAGEMENT PLAN: STAGE 2

Prepared by

PENRITH LAKES DEVELOPMENT CORPORATION LTD

89 - 151 Old Castlereagh Road • Castlereagh • NSW 2749
PO Box 457 • Cranebrook NSW 2749
Telephone +61 2 4729 0044 • Facsimile +61 2 4730 1462
Contact: Arthur Ashburn
Email • info@pldc.com.au
Web • http://www.penrithlakes.com.au

Authors	*Qualifications*
Kate Shmidt	MA Environmental Policy and Management (Applied)
Tony Church	PhD (Marine Ecology)
Arthur Ashburn	B Engineering Civil (Hons)

Supporting documents by:

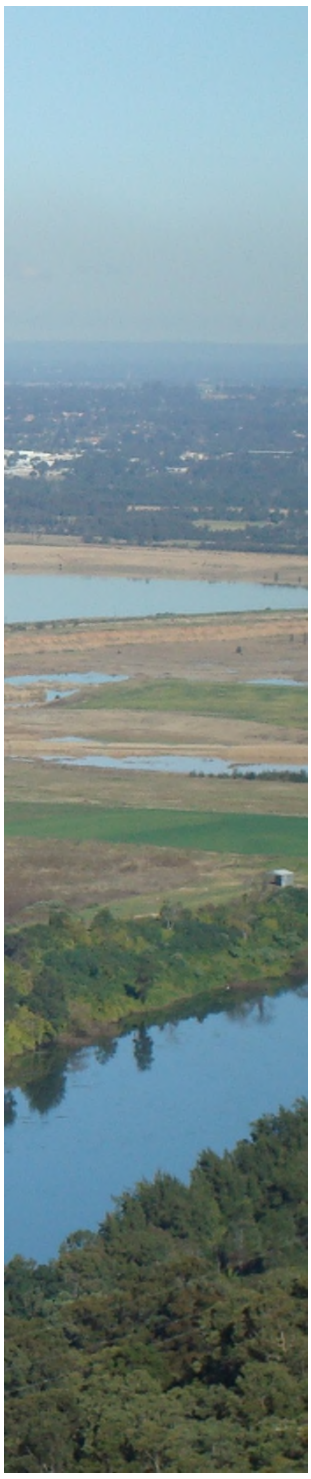
Image: One Tree Lagoon constructed wetland

TABLE OF CONTENTS

This page was left intentionally blank

1 INTRODUCTION

Penrith Lakes Development Corporation (PLDC), in accordance with the provisions of the 1987 Deed of Agreement (Deed) with the State of New South Wales, is implementing the Penrith Lakes Scheme. A key document described in the Deed and its Schedules is the Water Management Plan, the aim of which was to guide the development and implementation of a unique water based Scheme for western Sydney on completion of extraction activities.



Over the 30 year period, since the inception of the Deed the Water Management Plan has been updated and modified on several occasions, reflecting changes in circumstances, technology, responses to ongoing monitoring results, water management studies and operational experience gained by PLDC through the management of newly formed water bodies.

This Stage 2 Water Management Plan complements the Stage 1 Water Management Plan which was approved in November 2013. Stage 1 of the Water Management Plan investigated the infrastructure required to complete the lakes. Stage 2 details the outcomes of investigations into water quality and water balance and makes recommendations regarding the future operational and water management requirements of the completed Scheme. When approved the combination of these plans will form the final Water Management Plan for delivery of infrastructure and for operating the completed Lakes Scheme over the long term.

1.1 PURPOSE OF THIS REPORT

The delivery of the Water Management Plan has been completed over 2 stages at the request of the Department of Planning, Industry and Environment (DPIE). This document presents the final Stage of the Water Management Plan combining work completed in 2014 (original Stage 2 submission) and the outcomes of the “In-Principle Agreement” between PLDC and DPIE agreed February 2019. The Stage 2 Water Management plan addresses the following:

- Water Quality Criteria
- Groundwater Management
- Stormwater Management
- Ecosystem Development
- Fisheries Management
- Southern Wetlands Design
- Lakes Operations Plan

To adequately address management and water quality performance of the Scheme, PLDC and DPIE have agreed to introduce additional water management infrastructure and have carried out complementary research, including additional water quality and quantity modelling as well as assessment of performance of the redesigned wetlands system in the south of the Scheme.

1.2 FINAL WATER MANAGEMENT PLAN (STAGES 1 & 2)

The 2012 Water Management Plan Stage 1 was conditionally approved on the 5 November 2013

and is included as **Appendix 1** of this document.

This Stage 2 document details recommendations for the final lakes and infrastructure requirements to complete the Penrith Lakes Scheme. This submission complies with conditions 7 to 9 of the above mentioned approval.

1.3 THE PENRITH LAKES SCHEME

The Penrith Lakes Scheme is bound to the north by Smith Road, to the east by The Cranebrook Terrace and Castlereagh Rd and to the west and south by the Hawkesbury-Nepean River. Located 60km west of Sydney and 2km north-west of Penrith, the Scheme covers 1,935 hectares within the Penrith LGA with over 11kms of river frontage. The Scheme's location within the greater Sydney region is shown below in Figure 1.

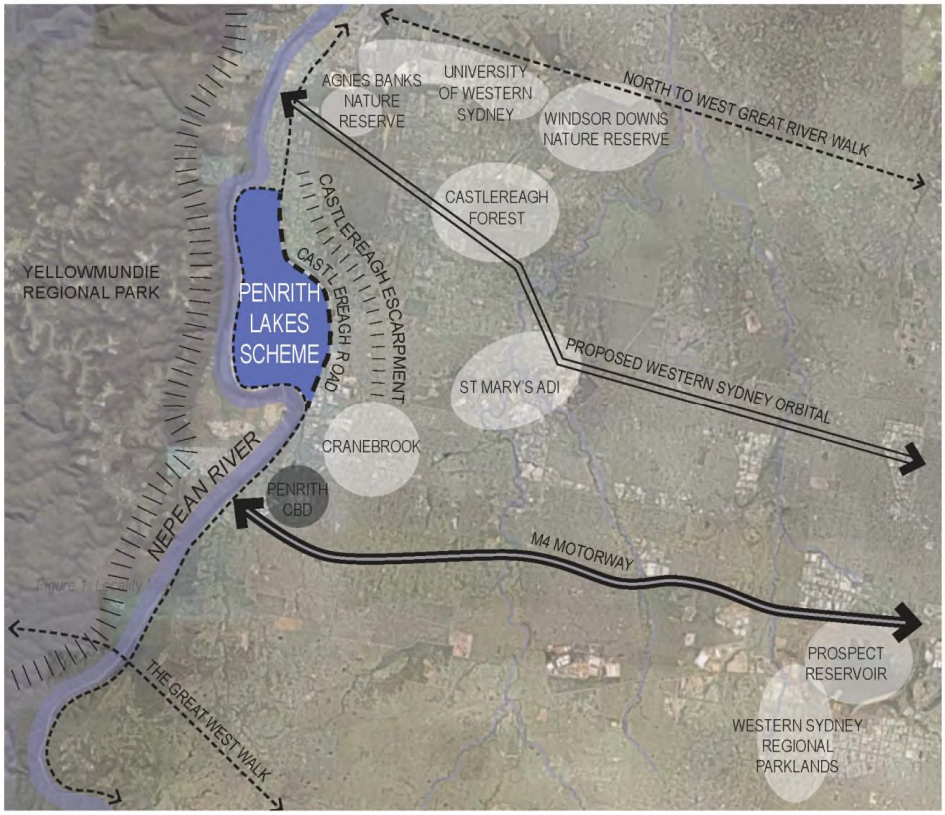


Figure 1: Location of the Penrith Lakes Scheme.

The Penrith Lakes Scheme was envisaged in the 1970's as an innovative rehabilitation project which had its genesis in a joint PLDC and State Government working party. The outcome from the working party was a Regional Environmental Study (RES) completed in 1984 by the Department of Environment and Planning. The key objectives for the RES were:

1) secure the long term orderly extraction of sand and gravel for Sydney's building needs;

and

2) provide significant social, community and environmental benefits for the residents of western Sydney by the creation of a major water-oriented recreation resource.

To give effect to the objectives of both parties as contained in the RES and the 1987 Deed of Agreement (as amended). The Sydney Regional Environmental Plan 11 – The Penrith Lakes Scheme (SREP) was finalised to guide the delivery of the Scheme and establish development objectives for the Scheme's ultimate completion.

The Deed outlines the original intentions for overall water management within the Scheme and is consistent with the preferred Scheme articulated within the RES. The Deed acknowledges that the effect of those intentions were likely to alter over the course of the development and delivery of the Scheme. The Water Management Plan represents the culmination of these changes and establishes the blueprint for completion of the Scheme and achievement of the objectives of both PLDC and Government.

The Stage 1 Water Management Plan, approved in November 2013, details the flood mitigation and reticulation infrastructure to be delivered in the completed Scheme and sets the operating levels for each of the water bodies for the optimum performance of the Scheme during various flood events and normal operating conditions. It also addressed water balance issues in the Cardno Water Balance and Lake Operating Levels Report – August 2012.

The Stage 2 Water Management Plan submission details the water quality and management objectives for the Scheme under its normal operations. It also further refines the water balance investigation carried out by Cardno in Stage 1 and provides information on the final design of the wetlands system and associated infrastructure. Both documents combine to form the completed Water Management Plan for the Scheme.

1.4 DOCUMENT STRUCTURE

The Stage 2 Water Management Plan consists of eleven sections and provides an outline of the Scheme being delivered and further detail on the key approval criteria required to successfully operate the Scheme over the long term.

As a supporting tool for the proposed Scheme, extensive water quality modelling has been undertaken to simulate water quality performance of the Scheme over a 10 year climate sequence from 1985 to 1994. This period is the standard period accepted by Government water agencies for their planning purposes and for consistency has been adopted by PLDC for its modelling and analysis work.

Sections of the Plan are as below:

Section 1 - Introduction

Section 2 - The Scheme

Section 3 - Groundwater Management

Section 4	**-**	**Stormwater Management**
Section 5	**-**	**Ecosystem Management**
Section 6	**-**	**Fisheries Management**
Section 7	**-**	**Water Quality Model**
Section 8	**-**	**Water Quality Model Outcomes**
Section 9	**-**	**Operational Infrastructure**
Section 10	**-**	**Lakes Operations Plan**
Section 11	**-**	**Conclusion and Recommendations**

Appendices attached to the document include:

Appendix 1: Water Management Plan Stage 1

Appendix 2: Hydrological Modelling of Resized NRPP

Appendix 3: Hydrogeological Assessment

Appendix 4: Water Quality Modelling Report

Appendix 5: Water Quality Model Calibration Results

Appendix 6: Southern Wetlands Design Review

Appendix 7: Southern Wetlands Infrastructure Drawings

Appendix 8: Lakes Operations Plan

Appendix 9: Southern Wetlands Permeability

2 THE SCHEME

The completed Penrith Lakes Scheme as programmed to be completed in 2020 / 2021 will include 723ha of lakes, 32ha of wetlands, and at optimal operating capacity, contains 37.5 gigalitres of water. At the core of the Scheme is a series of interconnected lakes and associated water bodies through which water moves by gravity flow networks from south to north before discharging into the Nepean River in the north. Water for the completed Scheme will be sourced from the surrounding catchment as well as drawing from the Nepean River through a pump and pipeline under an approved water access licence.

The Scheme's water management plan seeks to minimise intervention using either mechanical or chemical means to achieve water quality objectives. The management plan is based on the key principles of:

- water quality management at the source;
- use of detention basins and wetlands to enhance water quality prior to water entering the lakes proper;
- introduction of diverse terrestrial ecosystems; and
- introduction and ongoing management of healthy macrophyte dominated aquatic ecosystems.

A hierarchy of lakes has been adopted by PLDC to deliver operational flexibility to accommodate a wide range of climatic conditions likely to prevail over the life of the Scheme and provide opportunities to optimise the potential to achieve the water quality objectives to support the end water uses.

The recommended hierarchy for recreational lake usage is as follows:

1. Regatta and Warm up Lakes
2. Main Lake B
3. Main Lake A
4. Quarantine Lake
5. Duralia Lake

The Wildlife Lake remains primarily a wildlife habitat for scientific and educational purposes with significant aesthetic value.

Indicative flow paths throughout the Scheme are shown below in Figure 2.

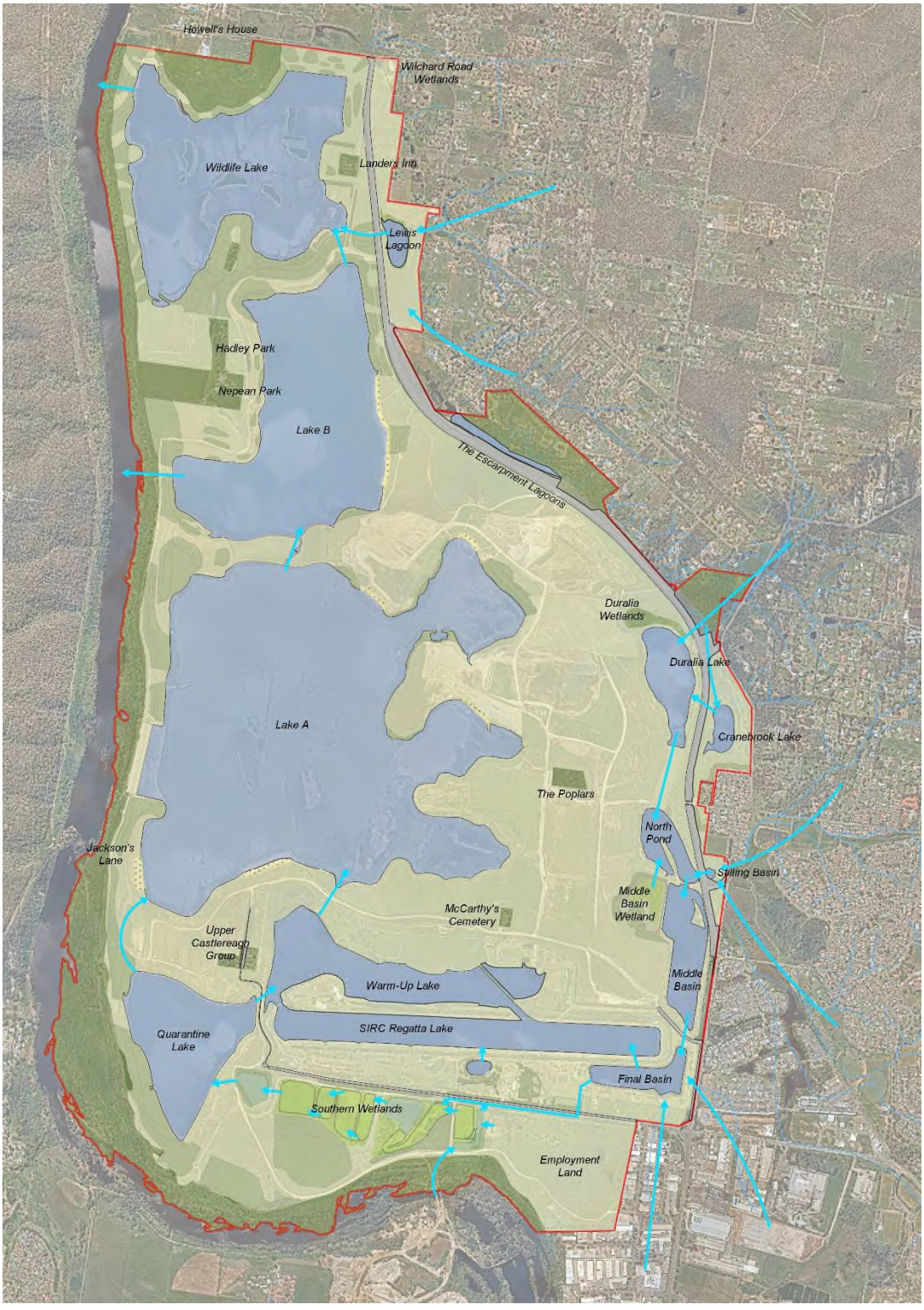


Figure 2: Indicative gravity flow and pumped system across the Scheme.

2.1 SCHEME WATER – DESIGN AND OPERATIONAL OBJECTIVES

The overall objectives for the effective design and long term operation of the completed Scheme are set out below. Over a 30 year period PLDC has investigated and tested the most appropriate system capable of delivering the desired outcomes contained within Schedule 7 of the 1987 Deed of Agreement (Deed) and the 1984 Regional Environmental Study (RES).

The strategic framework set out below includes policies and strategies appropriate to investigating, designing and managing the Scheme's water bodies. The framework has guided the approach PLDC has taken during its tenure as designers, constructors and terrestrial and water managers of the Scheme.

Goal: To achieve as far as practicable the water objectives in Schedule 7 of the Deed.

Key Objectives:

1) **Development of Lakes and Foreshores** - To design and construct the lakes and foreshores to support the proposed end water uses and associated water quality targets, at the least capital and ongoing recurrent operating costs.
2) **Establishment of Ecosystems** - To design and implement the key components required to establish a healthy terrestrial and aquatic ecosystem that does not preclude any of the identified end uses of the water.
3) **Building in Operational Flexibility** - To design processes which maintain adequate depths of water (within the designed operational water level tolerances) for water balance and identified end water use options.
4) **Reducing Impacts on Regional Water Resources** - To minimise any reduction in Nepean-Hawkesbury river system water quality that may be caused by diversions to the Scheme and to minimise any impacts which the lakes may have on local groundwater tables.

To achieve the objectives PLDC has adopted the following principal policies and associated strategies.

Policies which relate to the key objective "Development of Lakes and Foreshores" are detailed in the 2012 Water Management Plan Stage 1 submission and are not repeated here.

Policy: ***To adopt measures whereby the recommended water quality criteria can be met in the lakes.***

Strategies:

Determine appropriate water detention and holding regimes within the Scheme's treatment trains to deliver optimum outcomes.

Consider catchment inflows and encourage local Government to complete stormwater infrastructure works required to protect the Scheme's lakes from deteriorating water quality from external sources.

Consider the impacts of urban growth in the catchment on the Scheme lakes and encourage local Government to apply water sensitive urban design principles to any development in catchments external to the Scheme.

Monitor appropriate water quality components in the lakes. Identify areas where incomplete horizontal mixing may occur.

Monitor component lakes and detention basins.

Review and update the recommended water quality criteria.

Determine the most appropriate physical, chemical and biological indicators to be monitored.

Confirm the processes which will influence the lakes' water quality in the long term.

Develop a water quality model to assess the performance of the Scheme and simulate final conditions.

Stock the lakes with appropriate fish species to reduce vector populations.

Monitor microbiological and toxicant levels in the lakes.

Policy: ***Ensure that water of undesirable quality entering the main lakes is kept to a minimum***.

Strategies:

Investigate the eastern catchment stormwater inflow into to the Scheme and the potential impact on Scheme water quality.

Improve water quality of catchment inflows by selectively pumping excess water from eastern detention lakes into Southern Wetlands for extended detention time.

Selectively pump input water to the lakes from the Nepean River to minimise the risk of undesirable water quality or weed material entering the Lakes.

Establish a program to educate users and neighbours to behave in a manner least likely to impair the lakes' water quality.

Minimise the use of fertilisers and chemicals on areas which drain into the lakes.

Minimise the amount of stormwater entering the lakes from roads and urban areas both within and external to the Scheme area.

Divert stormwater originating from catchment areas outside the Scheme area around the main lakes.

Determine the origins and levels of undesirable water quality components likely to enter the lake system.

Determine relationships between nutrient levels and potential discharge into the Nepean River.

Design building developments within the Scheme area to ensure that the likelihood of discharge of undesirable water quality components is minimised.

Policy: Efficiently manage water through the lake system to minimise operating and recurrent budget.

Strategies:

Adopt a hierarchy of Lakes to ensure optimal safe recreational and public use.

Design outlet pipes to ensure return of water to the Hawkesbury/Nepean River through the gravity system within the Lakes.

Develop an operational plan for the completed lakes.

Model the required maximum amount of water from the Nepean River which would be consistent with maintaining the desired water levels within the lakes.

Determine treatment strategies that have no or minimum impact on the aquatic ecosystem.

Determine the most effective methods for the management of water through the system including use of buffer water storage, series of sluice gates and pumps as designed within the lakes.

Determine and install the most effective means of draining the lakes.

Dispose of material gathered, including weeds, away from the water bodies.

Provide suitable facilities to manage transfer of water through and between lakes.

Policy: ***Divert water into Lakes from the Nepean River.***

Diversions are to be effected in accordance with the approved Water Access Licence conditions.

Design and deliver pumping installation and supply lines having due regard to the staged development of the Scheme, cost-effectiveness and long term operating requirements.

2.2 LAKE STRUCTURE

The lakes have been designed to provide optimal operational flexibility in achieving the desired end water uses and maximise public amenity. The ultimate design included wetlands to assist with improving the overall ecosystem performance and water quality and the capacity for significant water storage buffer above the prescribed operating levels approved in the Stage 1 Water Management Plan. Operational flexibility is also optimised through adopting the hierarchy of lakes as set out above. Physical attributes including the size, capacity and recommended water level tolerances of the lakes are provided below in Table 1 and details on the wetlands in Table 2.

.

Table 1: Surface areas, operating water levels, volumes and recommended water level tolerances in the various Scheme water bodies

LAKE	SIZE (HA)	AVERAGE DEPTH (M)	OPERATING LEVEL (M AHD)	VOLUME AT OPERATING LEVEL (GL)	RECOMENDED WATER LEVEL TOLERANCES
Primary Lakes					
Wildlife Lake	110	4-5	10	3.9	-1.00m / +1.00m
Main Lake B	121	6-7	13.5	7.3	-1.00m / +1.00m
Main Lake A	318	5-6	14	17.8	-1.00m / +0.50m
Quarantine Lake	42	6-7	15	2.4	-0.25m / +0.40m
Regatta Lake	80	5-6	15	4.2	-0.25m / +0.40m
Treatment Lakes					
Duralia Lake	13	10-11	18	0.9	-1.50m / +0.90m
Cranebrook Lake	3	10-11	18	0.13	-1.50m / +0.90m
Detention Basins					
Lewis Lagoon	3	5	14	0.08	-1.50m / +1.00m
North Pond	7	4	16.5	0.17	-1.50m / +1.55m
Stilling Basin	0.6	2.5	17.7	0.01	-1.50m / +0.35m
Middle Basin Wetland	5	1-2	17	0.04	-1.50m / +1.05m
Middle Basin	13	4-5	16.0	0.5	-1.50m / +2.05m
Final Basin	7	3-4	15.5	0.07	-1.50m / +2.55m
Lake Totals	**723**			**37.5**	

Table 2: Surface areas and recommended water level tolerances of the Scheme wetland systems

WETLANDS	SIZE (HA)	RECOMENDED WATER LEVEL TOLERANCES (M AHD)
Southern Wetlands	23	24.4 – 18
Duralia Wetlands	3.7	19 – 18
Cranebrook Wetlands	2.2	24.5 – 18
Eastern Chain of Ponds	3.6	24 – 17

2.3 END WATER USES AND WATER QUALITY INDICATORS

The completed Primary Lakes as listed in Table 1 have end water uses as set out in Schedule 7 of the Deed. These end water uses are set out below in Table 3.

Table 3: End water uses of the Scheme in the Deed.

LAKE	END WATER USE
Main Lakes A & B	Aesthetic value. Water surface sports - primary and secondary contact. Fishing.
Regatta Lake	Lake water management Water surface sports – secondary contact. Aesthetic value.
Treatment Lake (Duralia Lake)	Lake water management Water surface sports - secondary contact. Aesthetic value.
Wildlife Lake	Lake water management Wildlife habitat including aquatic and shoreline habitat. Scientific and educational. Aesthetic value.
Detention Basin	Lake water management Aesthetic value.

The results of the modelling carried out in Stage 2 indicates that all Primary Lakes will achieve water quality to Primary Contact standard well above 90% of the time and as such could safely accommodate other recreational activities including swimming.

The Deed also lists water quality indicators for Main Lake A and Main Lake B as a guide to achieve the proposed end water uses. As recommended by the NSW Public Health Unit and the NSW Regional Algal Coordination Committee PLDC subsequently adopted the National Health and Medical Research Council Guidelines for Managing Risks in Recreational Waters (NHMRC 2008). As the NHMRC 2008 guidelines are accepted as the appropriate Government standard PLDC believes that these should continue to be used and reviewed by the long term operators for managing recreational uses within the lakes.

Table 4 provides a summary of both the Deed indicators as well as the NHMRC (2008) guidelines to measure water quality performance for Main Lakes.

Table 4: Water quality standards for the Main Recreational Lakes as identified by the 1987 Deed compared to Primary and Secondary water contact requirements under the NHMRC 2008 guidelines.

INDICATOR	1987 DEED STANDARD	PRIMARY CONTACT	SECONDARY CONTACT
Dissolved Oxygen	>90%	>80%	>80%
pH	6.00 - 8.50	5.00 - 9.00	5.00 - 9.00
Temperature	Ambient Variation	16 - 340C	16 - 340C
Salinity	0 - 1000mg/L	N/A	N/A
Suspended Solids	<25mg/L	N/A	N/A
Light Penetration	1.5m	N/A	N/A
Total Nitrogen	<0.7mg/L	N/A	N/A
Total Phosphorus	<0.025mg/L*	N/A	N/A
Bacteriological Indicators	<100 CFU in 80% of samples	<40 CFU Enterococci	<200 CFU Enterococci
Cyanobacteria cell/mL	N/A	<5000 cells/mL Microcystis aeruginosa	<50,000 cells/mL Microcystis aeruginos
Cyanobacterial Biovolume	N/A	<4mm^3/L potentially toxic cyanobacterial biovolume	<10mm^3/L total cyanobacterial biovolume
Cyanobacterial toxins	N/A	<10ug/L Cylindrospermopsis** or Microcystis <20ug/L Saxitoxins**	
Aesthetic quality	No objectionable taints, odours or colours. No visible floating oil, grease scum or other objectionable matter.		

**Based on ratio of total nitrogen to total phosphorus of 14:1. This may vary in accordance with findings of studies detailed in Water Plan*

***PLDC Specific Guideline provided by the NSW Public Health Unit.*

2.4 CONCEPT DESIGN

When complete the SIRC Lakes, Main Lakes A and B, Duralia Lake (treatment lake),Quarantine Lake and the detention basins (Eastern Lakes, Southern Wetlands) can be characterised by the following:

- a fit-for-purpose landscape, suitable for public recreation and urban uses in accordance with the Construction Principles as defined in the Deed;
- maximum substrate and soil health, conservation and landform stability;
- efficient use of on-site resources;
- minimal ongoing maintenance costs including for the water treatment basins and Wildlife Lake; and
- enhanced biodiversity through the fabrication of foundations of former natural vegetation communities, maximising ecosystem services, landscape function and resilience.

Table 5 summarises the purpose and the character of the main lakes to be used for recreational purposes. The terrestrial recreational activities and water-based activities that could be provided in the longer term are shown in Table 6.

The overall aim for recreational use is to provide a water-based recreational resource for local Western Sydney residents and visitors to enjoy within a pleasant parkland setting and to encourage discovery and appreciation of the area's natural and cultural heritage.

Table 5: Purpose and design character of the main recreation lakes.

SITE	PURPOSE	DESIGN CHARACTER
SIRC Lakes	To optimise public recreation whilst also supporting flood management, ecological water quality improvement and maintenance. To include an International standard Regatta facility.	Reflects a natural open water form. The Warm Up Lake foreshore profiles generally appear natural in gradient. A standard international course, straight with at least 6 operational racing lanes, and at least 3 metres deep at the shallowest point. The course is sheltered from wind as far as possible and has no natural or artificial obstacles (such as woods, buildings, structures) in the immediate neighbourhood of the course that might cause unequal conditions on the water. There are no streams or waves, with the banks designed to absorb rather than reflect waves. For a World Championship or a Regatta World Cup a minimum of 8 racing lanes are available, plus sufficient water width on both sides of the course allowing for both safe traffic patterns and for moving lanes in case of unequal conditions.
Lake A & B	To maximise passive and active recreational activities.	In keeping with the floodplain landscape, foreshore profiles generally appear natural in gradient and planting types/ communities.

Table 6: Suggested terrestrial and water-based activities for the main recreation lakes.

SITE	TERRESTRIAL ACTIVITIES	WATER-BASED ACTIVITIES
SIRC Lakes	Picnic and BBQ areas within the public parklands.	Kayaking/canoeing/Regatta Fishing Beach activities such as swimming in designated areas, sunbathing.
Main Lake A	Exercise stations along walking tracks or within specific play areas and/or parklands. Mountain Bike riding on designated tracks. Attending staged special events. Informal and formal sports. Playing within playgrounds and other areas of interpretive play equipment. Picnic and BBQ areas within the public parklands.	Sailing Special intermittent use of the lakes by power boats including water skiing, wake boarding etc. Windsurfing Wildlife appreciation Designed and constructed to accommodate swimming activities
Main Lake B	Walking and cycling along the Great River Walk and other Heritage Trails. Guided tours of European and possibly Aboriginal Heritage Sites. Camping in designated areas. Picnic and BBQ areas within the public parklands. Horse and dog exercise tracks.	Sailing Fishing Kayaking/canoeing/Regatta Windsurfing Wildlife appreciation Designed and constructed to accommodate swimming activities

Table 7 summarises the purpose and the character of the Wildlife Lake, Eastern Lakes and other water bodies used primarily for wildlife habitat, conservation and water quality management respectively. Table 8 summarises the terrestrial recreational activities and water-based activities adopted by PLDC for modelling purposes and preparation of Two Year Plans.

Table 7: Purpose and design character of the Wildlife Lake, the Eastern Lakes and other water bodies.

SITE	PURPOSE	DESIGN CHARACTER
Wildlife Lake	Optimise attractiveness to wildlife, provide suitable habitat and enable scientific research and educational purposes. Retain some historical uses whilst supporting flood management, ecological water quality improvement and maintenance. The design of the Wildlife Lake and its immediate surrounds communicates different layers of history associated with the site through landscape features and interpretation.	Reflect a natural open water form with refuge islands, wetlands and a focus on wildlife habitat. Foreshore profiles generally appear natural in gradient and planting types/ communities. Foreshores are influenced by the geometric nature of the former land grant boundaries as appropriate near Landers Inn. This promotes natural ecological processes while integrating cultural heritage. Topography is constructed with natural resources from within the Penrith Lakes Scheme. Visually integrated within the context of the floodplain and river, including the use of trees of local provenance, shrubs and grasses of the original floodplain.
Eastern Lakes, including Duralia Lake, and other water treatment wetlands	Provide primarily passive recreation whilst also supporting flood management, ecological water quality improvement and maintenance, providing suitable habitat for wildlife and enabling research. Can accommodate some active water surface sports and land based activities with Duralia Lake being suitable for swimming.	Foreshore profiles generally appear natural in gradient and planting types/communities. Topography is constructed with natural resources from within the Penrith Lakes Scheme. Visually integrated within the context of the floodplain and river, including the use of trees of local provenance, shrubs and grasses of the original floodplain.

Table 8: Suggested terrestrial and water-based activities for the Wildlife Lake, Eastern Lakes and other water quality management wetlands.

SITE	TERRESTRIAL ACTIVITIES	WATER-BASED ACTIVITIES
Wildlife Lake	Conservation and research activities. Wildlife appreciation such as bird watching and eco-guided tours associated with the conservation area surrounding the Wildlife Lake. Guided tours of European and possibly Aboriginal Heritage Sites. Pick your own 'Farmers Gate' produce and other activities associated With potential agricultural and/or horticultural interpretation.	Wildlife appreciation Scientific research and educational purposes
Eastern Lakes	Passive recreation walking tracks cycling trails Picnic areas Amphitheatre (Duralia Lake)	Fishing Wildlife appreciation Some water surface sports Swimming in Duralia Lake
Southern Wetlands & Quarantine Lake	Walking and cycling along the Great River Walk Passive recreation Walking tracks Bird watching	Wildlife appreciation Scientific research and educational purposes

3 GROUNDWATER MANAGEMENT

The Penrith Lakes Scheme is located in a topographical depression on the alluvial floodplain of the Nepean River above Quaternary-aged alluvial deposits primarily comprising sand and gravel. Natural groundwater flows through the lower alluvial terrace across the Scheme in a west-northwest direction, ultimately discharging to the Nepean River.

The Scheme will result in a series of lake formations that interact with the natural groundwater flows. Potential risks associated with this interaction include the intrusion of poor water quality into the lakes as well as acting as a local groundwater sink, impacting available water from upstream aquifers. In response to these potential impacts PLDC has conducted several hydrogeological assessments across the Scheme to model and quantify the Scheme's impacts.

To protect surrounding aquifer water extraction licence holders from being affected by the Scheme, PLDC is required to provide alternative water sources to any licence holders that can show they have been impacted by the Scheme. To date PLDC has not been required to provide alternative water resources, and in compliance with part 4 consents, there have not been any adverse impacts on the surrounding aquifer or residents due to the Scheme.

The 2012 Water Balance study undertaken by Cardno as part of the Stage 1 Water Management Plan assessed infiltration rates from previous hydrogeological surveys conducted by PLDC. Cardno concluded that the diversity of weather events across a 100 year period can result in large variations in groundwater infiltration rates from 3.0 to 0.3 Gigalitres a year. Cardno's (2013) water balance model subsequently used a mean of 1.65 Gigalitres a year for groundwater modelling for the 2012 Water Management Plan.

Consistent with Cardno's (2012) model, BMT's (2019) hydrological model for the completed Scheme (inclusive of redesigned Southern Wetlands) used the following methodology to calculate groundwater flows:

- For the eastern lakes, a constant flow of 0.3 GL/yr was applied to Cranebrook Lake only.
- For the western lakes, total groundwater flow was taken to be proportional to annual rainfall, interpolated between a maximum of 2.7 GL/yr and average of 1.3 GL/yr and split between lakes Quarantine Lake to Wildlife Lake, weighted by catchment size.

BMT's Hydrological Modelling of Resized NRPP (2019) is **Appendix 2** to this document.

PLDC had also conducted previous investigations into the potential impacts of groundwater on the Scheme by installing three additional bores marked P30, P31 and P35 in Figure 3 as a means of further monitoring groundwater quality and volumes entering from the north-eastern locations of the Scheme. Monitoring data from these bores as well as historical bores were collated and reported by Nation (2014).

Nation (2014) included an assessment of historic reports and assumptions as well as incorporating water quality data previously collected from the bores across the site into their assessment. A key objective for the updated monitoring report was to build a conceptual model and provide details of what assumptions (if any) should be made when incorporating groundwater flows into the future Scheme operations and water quality assessments. The report concluded that even though groundwater would provide a beneficial contribution to the site wide water balance by reducing the

need to extract water from the Nepean River, most of it represents a direct infiltration from rainfall and runoff within the Scheme, with less than 1% of the total Scheme volume originating from off-site sources that include potential saline groundwater.

Considering the limited volumetric contribution of off-site sources including potential saline groundwater to the Scheme, accounting for groundwater quality inputs in future water quality assessments was not considered necessary.

Nation's Hydrogeological Assessment report is provided in **Appendix 3.**

The reports and associated data collated since the Scheme's inception have generally found that there is minimal interaction with surrounding aquifers and a low risk of impacting on the water quality within the Scheme.

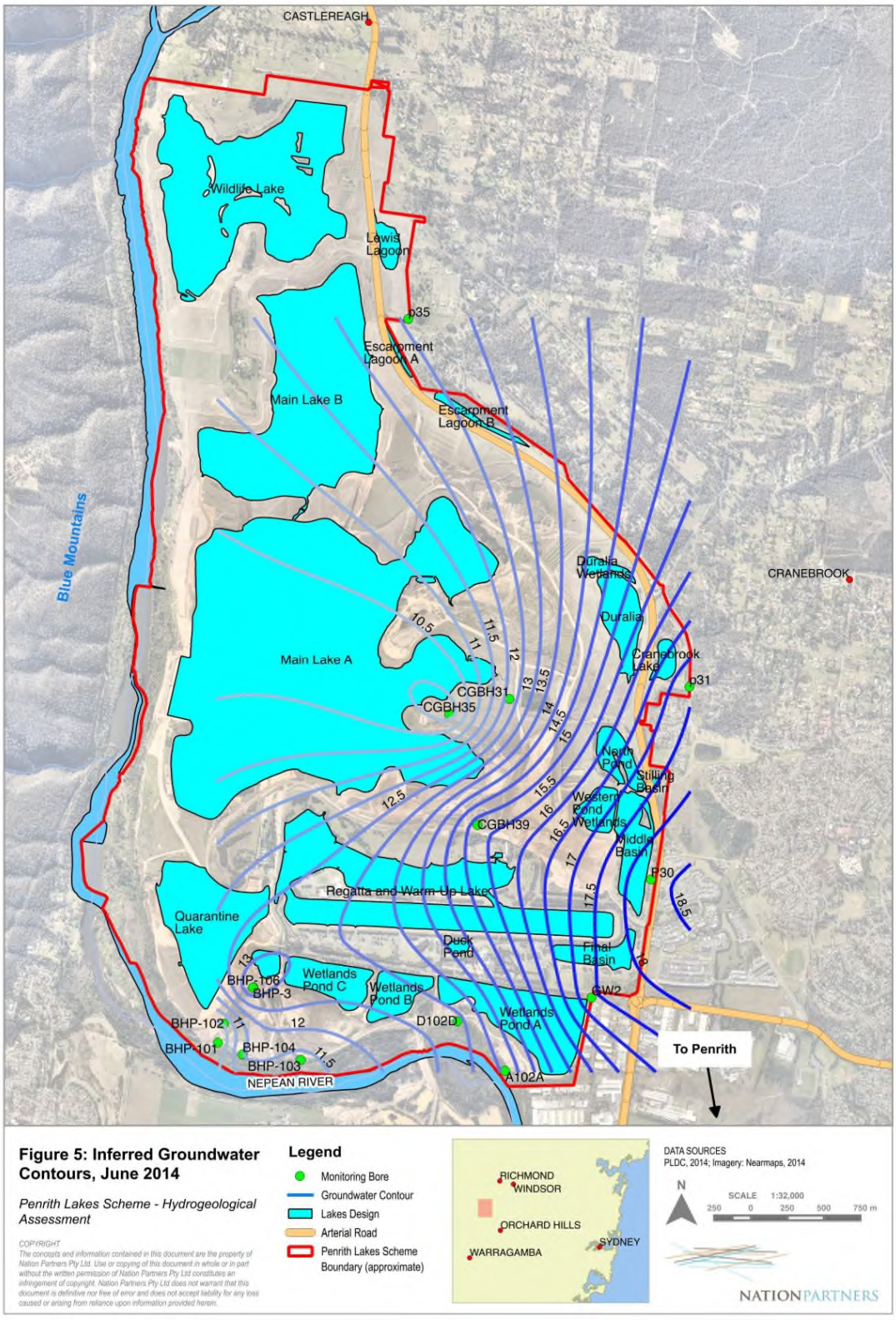


Figure 3: Inferred groundwater contours across the Penrith Lakes Scheme by Nation (2014).

4 STORMWATER MANAGEMENT

The Penrith Lakes Scheme receives stormwater from approximately 3,000 hectares of peri-urban development, dominated by rural residential properties to the north and intensive urbanisation to the south. The stormwater received from these catchments varies dramatically in quality, with water sources typically high in faecal bacteria pollution, particulate nutrients and suspended solids. Left untreated this water is likely to impact on the achievement of water quality to support the desired end uses of the Scheme.

Treatment options employed within the Scheme include treatment wetlands as well as high capacity detention basin systems fitted with sluice gates to increase water residence times. These treatment facilities and an extended period of management have shown to be highly effective in the treatment of stormwater as demonstrated by the historical water quality measurements from the SIRC lakes over the past decade and a half.

Wetland systems located at Duralia and Cranebrook Lake inlets have been developed to filter incoming stormwater prior to entering the lakes. These wetlands were established in 2004 with a wide variety of macrophyte species and have since developed to provide significant water quality and ecology benefits to the lakes. This is evidenced by the continually high water quality and fauna diversity recorded in these lakes. Also a water quality control pond (Lewis Lagoon) has been constructed to improve water quality flowing into the Wildlife Lake.

Ashbolt and Roser (2004) investigated the surrounding catchments and examined residence times required to control the risk of faecal bacteria pollution entering the SIRC lakes. The study concluded that inflows in excess of 43 megalitres from the Scope and Farrell's Creek pose a significant risk of faecal bacteria pollution entering the Scheme. Waters suspected of faecal bacteria pollution are retained in the detention basin system by closing the sluice gates, with the consequential extended residence times aiding in the natural UV disinfection of these waters.

Poor water quality from the surrounding catchment poses a significant risk to the long-term performance of the Scheme. AECOM (2013) were commissioned by Penrith City Council to review the catchment and assess the potential for applying WSUD features to improve water quality. Recommendations made with respect to WSUD could potentially provide significant improvements to the water received in the Penrith Lakes System and should be implemented in full to protect the Scheme. Source management of water quality is seen as critical to the future performance of the Scheme and ongoing achievement of the end use values.

Specifically, the Employment Land located to the east of the Southern Wetlands will ultimately discharge its stormwater into the wetland treatment system once the site is developed. These inflows have been accounted for in the revised wetlands layout as well as the Hydrological Modelling (**Appendix 2**) and Water Quality Modelling (**Appendix 4**) of the Scheme. The Employment Land development will be required to treat any stormwater with gross pollutant traps in accordance with WSUD guidelines prior to discharge into the wetland system. The Southern Wetlands will provide all further water quality treatment and on-site detention required to service the proposed Employment Land development in accordance with WSUD guidelines.

Overall, the management of stormwater inflows to the Scheme has been successful in delivering the targeted quality of waters entering the SIRC Lakes and the achievement of the desired end

water uses. Recent changes to the design and introduction of the new pump & pipeline connection between Final Basin and Southern Wetlands is expected to further improve the capacity of the Scheme to manage stormwater runoff entering through the Eastern Lakes.

Vigilance will be required in the future as further changes to land use occur in the catchments external to Penrith Lakes and some further deterioration in water quality entering the lakes from those catchments is expected to occur.

5 ECOSYSTEM DEVELOPMENT

Aligned with the original principles of the RES, PLDC has continually promoted the establishment of natural ecosystems and ecological processes. These include promoting in-lake aquatic ecology and establishing submerged and emergent macrophyte assemblages and structural habitat to support various trophic levels within the Lakes. These principles have been implemented and monitored and demonstrate considerable success in the completed and dedicated lakes and water bodies with PLDC applying an adaptive management approach aiming to continually improve the establishment of these ecosystems and processes.

Steps taken by PLDC to promote the development of various ecosystems and associated communities during the different phases of lake formation are summarised below in Figure 4 and expanded upon further through this section of the Plan.

Land forming	•Geotechnical assessment ensuring lake and landform stability •Aquatic habitat structures and macrophyte benches installed
Lake Filling	•Water sourced from pre-established areas •Surrounding landforms designed to complement lakes and treat runoff
Early Aquatic Ecosystem Establishment	•Planting of submerged and emergent macrophytes •Natural propagation allowing for establishment of invertebrates and small fish communities
Ecosystem Stocking	•When the ecosystem is established Australian Bass are stocked into the lakes as a predatory and health indicating species •Macrophyte plantations are assessed and altered as required
Ongoing Monitoring	•Monitoring the established ecosystem ensuring it meets requirements •Monitoring can include assessing water quality, as well as fish, invertebrate, amphibian, bird and macrophyte communities

Figure 4: Summary of ecosystem development stages and key features.

5.1 LAND FORMING

Landscape plans are developed well in advance of construction and approved via a Two Year Plan process under existing approved development consents. Landscaped features are designed to ensure a wide range of habitats are established providing opportunities for a diverse range of ecosystems. The landscape principles applied to the Scheme aim to optimise the extent and diversity of ecotones. They also provide a link between key habitats and core conservation zones while re-establishing native vegetation from pre-European settlement. Lake foreshores have been designed to, as far as practicable, replicate the historical Nepean floodplain landscape.

These goals are achieved by:

- reinstating Cumberland Plain Woodland vegetation communities and native provenance grasslands across the Scheme;
- designing no greater than 1:6 batters around lake edges with several macrophyte shelves and edge complexity providing various littoral zones within the lake foreshore;
- providing drainage channels that are protected with natural grass swales; and
- establishing habitat enriched with placement of soft woody debris and sandstone structures throughout lake foreshores and lake beds.

5.2 LAKE FILLING

As the Scheme has been established for well over a decade, natural ecosystems have been well established through the detention basin systems and the SIRC lakes. River-sourced water required to fill the remaining recreational lakes enter through the SIRC lakes (unless Quarantine to Lake A by-pass is activated) prior to flowing north into the recreational lakes, transferring with it a large volume of invertebrate biota, juvenile fish and macrophyte propagules and seeds. It is expected this enhancement will significantly reduce the time required for stable ecosystems to establish within the newly formed lakes and that has been the experience to date with the completed and dedicated lakes and water bodies.

Wetland systems have been designed into the Scheme where necessary or desirable to treat water prior to entering the lakes system. The wetland systems function to reduce nutrient and suspended solids loads entering the lakes as well as increase residence time to reduce bacterial contamination. Stormwater drainage from within the Scheme utilises a series of rock or fabric-protected grassed swales, providing water treatment for internal Scheme stormwater flows. The foreshores where practical also contain tree plantings and emergent macrophytes to enhance bank stability and nutrient and sediment retention.

5.3 EARLY AQUATIC ECOSYSTEM ESABLISHMENT

The Scheme relies heavily on the natural propagation of lower trophic biota such as macrophytes, algae and invertebrates. PLDC on-site experience and scientific studies have shown these processes readily take place in the developing lakes and treatment systems, with SIGNAL scores for invertebrates improving through the detention systems and reflective of the water quality achieved within the system.

Aquatic macrophytes are important as primary producers in aquatic food webs and are also critical

for nutrient re-cycling within the lakes and in the riparian zone. Different species occupy different parts of the riparian zones of the lakes. Those that can withstand high water regimes and flooding occupy the littoral zones, while those that can withstand prolonged dry periods extend from the upper riparian areas into the terrestrial environments. Others that are totally dependent on water occupy niches within the lakes, either as emergent, submerged, or as floating species. Submerged macrophytes create habit, modify hydraulic conditions, and affect temperature and light conditions in the water column.

Emergent macrophytes and riparian zone plants play an important role in stabilising lake margins and banks; they also slow runoff, filter sediments and take up nutrients entering the lake system.

The riparian zone provides habitat for fauna and a buffer between terrestrial and aquatic ecosystems. Extensive planting has occurred along the margins of the lakes and other water bodies using local native species from relevant Cumberland Plain plant communities. Canopy species provide shading of the lake edge through overhanging branches and sub-canopy, shrub and ground covering species provide faunal habitat, reduce stormwater runoff velocities and assist in reducing the amount of pollution entering the water column.

Aquatic macrophytes respond in various ways to hydrological and edaphic factors and are sensitive to disturbances. Information on the species present and their health is important for management to establish long-term trends and it is therefore necessary to measure levels of recruitment, extent, distribution and abundance of species. Assessments of species composition and community structure are indirect indicators of resilience to change. Noting the presence of noxious aquatic weeds and other undesirable species is important from a due diligence perspective and to reduce the risk of unexpected outbreaks or contamination of other water bodies.

Aquatic macro-invertebrates constitute a major component of aquatic food chains and are common and widely distributed. They rapidly colonise newly formed water bodies from surrounding catchments and landforms as they are sensitive to changes in ecological conditions, particularly physio-chemical stressors, and their use in biological assessments is well established.

5.4 ECOSYSTEM STOCKING

After the ecosystem has established, assessments of the aquatic community are conducted to assess if the water body can support stocks of Australian Bass (*Macquaria novemaculeata*). It is considered beneficial to stock Bass as soon as the ecosystem can support them as they provide a top-order predator and have been shown to control numbers of noxious fish populations such as European Carp (*Cyprinus carprio*) as well as Mosquito fish (*Gambusia holbrooki*).

PLDC has implemented a native fish stocking program since 1996. To date 207,200 Australian Bass fingerlings have been stocked into the Scheme. Some eight native fish species occur in the lakes together with three exotic pest species. The native fish dominate with small bodied species providing food for the larger bodied bass.

5.5 ONGOING MONITORING

PLDC has established an integrated monitoring program to inform a holistic review of the performance of these ecosystems. The monitoring programs undertaken across the Scheme include assessing key indicator species such as macrophytes, macroinvertebrates, amphibians

and fish as well as routine chemical and biological water quality monitoring to assess trends in algal and bacterial populations as well as overall nutrient loading within the lakes.
The integrated monitoring program has demonstrated significant progress in achieving environmental outcomes including:

- constructed lands and static environments showing comparable soil performance - Landscape Function Analysis;
- control and eradication of Salvinia (*Salvinia molesta*), Alligator weed (*Alternanthera philoxeroides*) and Water Hyacinth (*Eichhornia crassipes*);
- 9 native frog species observed around the Scheme;
- 165 bird, 23 mammals and 15 reptile species regularly recorded on site;
- 61 families of macroinvertebrates – showing improved community structures routinely across the Scheme;
- 91% of Total Phosphorus and 73% of Total Nitrogen loads removed from the surrounding peri-urban catchment inflows via the detention basin system*;
- the Sydney International Regatta Centre water quality suitable for Primary Contact 95% of the time since 1996*; and
- Duralia Lake water quality suitable for Primary Contact 95% of the time since 2008*.

*Note: PLDC ceased management and monitoring activities in Eastern Lakes and SIRC in 2014.

6 FISHERIES MANAGEMENT

Additional to the aforementioned ecological benefits of establishing a stable fish community, establishing the Penrith Lakes Scheme as a recreational fishery in Main Lakes A and B is a core end use objective envisaged in the 1987 Deed.

Australian Bass (*Macquaria novemaculeata*) is the only fish species that has been stocked within the Penrith lakes Scheme. Since 1996, 207,200 'fingerling' (approx. 3cm) sized Australian Bass have been stocked into the Penrith Lakes Scheme. These stocking events have been documented and approved by NSW fisheries, including participation in the Dollar for Dollar stocking initiatives.

The fish stocking has provided the SIRC lakes with an opportunity to develop a regular recreational fishing program open to the public currently administered by NSW Fisheries Fishcare volunteers. The venue also successfully hires out the lakes to fishing clubs to conduct fishing competition days for enthusiasts.

Details of fish stocking events post the year 2000 to date as well as total numbers stocked has been provided in Table 9.

Note that PLDC has not undertaken any additional fish stocking of lakes since 2012. It is envisioned that additional fish stocking would occur as required once Scheme wide lake levels are established and all water infrastructure is complete.

Table 9: Australian Bass stocking records across the Penrith Lakes Scheme.

Lakes Stocked	1996	1997	1998	1999	2000	2001	2002	2004	2005	2009	2011	2012	2016	2019	Total
Regatta Lakes	12,000	10,000	12,000	12,000	5,000	7,000	12,000	2,000	6,000	30,000		20,000	5,000	9,000	**142,000**
Main Lake A					5,000	1,200		4,500	6,000						**16,700**
Final Basin		2,000						4,000	2,000		2,000				**10,000**
Middle Basin					2,500				2,000		3,000				**7,500**
Northern Pond					2,500			5,000	2,000		2,000				**11,500**
Duralia Lake								6,000	3,000	6,000					**15,000**
Cranebrook									3,000		1,000				**4,000**
Duck Pond								500							**500**
TOTAL	**12,000**	**12,000**	**12,000**	**12,000**	**15,000**	**8,200**	**12,000**	**21,500**	**24,000**	**36,000**	**8,000**	**20,000**	**5,000**	**9,000**	**207,200**

The potential of the completed Scheme to operate as a desirable recreational fishery has been demonstrated by the successes at the SIRC. Considered management of fishing practice will be required if a sustainable fishing community is desired by the completed Scheme operators. This is due to the Australian Bass being a catadromous fish species, unable to breed within the landlocked Scheme.

Additional recreational fish that have populated the lakes include the Eel-Tailed Catfish (*Tandanus tandanus*) and the European Carp (*Cyprinus carpio*). While the Carp is generally not regarded as a sport fish in Australia, recreational fishers are encouraged to target the species and ensure they are euthanized to control carp numbers. All other fish captured on the Penrith Lakes Scheme are required to be released unharmed to maintain the populations.

No provisions are proposed for fish passage in and out of the Scheme under normal operations in the proposed Scheme design. This decision has been made with the concurrence of NSW Fisheries as it reduces the risk of stocked fish leaving the system, while preventing the entry of noxious fish species.

Work by the DIPNR Water Committee (2005) also emphasised the risks associated with fish passage being permitted from the Nepean River as there is a serious risk of the endemic Bullrout (*Notesthes robusta*) fish entering the lakes. The Bullrout is a relative of the scorpion-fish species, with venomous spines which are extremely hazardous in recreational areas.

7 WATER QUALITY MODEL

In preparing the Stage 2 Water Management Plan a predictive computer model was developed for PLDC by BMT for the Scheme simulating final conditions (**Appendix 4**). The model allowed for extensive monitoring data collected from the Penrith Lakes site spanning well over 10 years, to be incorporated into the modern computer modelling platform. This approach provided a robust, all-inclusive model for testing the efficacy of the Scheme water quality and aquatic ecology systems through a range measured climatic conditions.

This model, originally calibrated and validated in 2014, was used again in 2020 to simulate water movement and quality within the final design of the Penrith Lakes Scheme inclusive of the latest concept design of Southern Wetlands, resized and relocated NRP&P, as well as Final Basin to Southern Wetlands and Quarantine Lake to Lake A connections.

The predictive model is a combination of three individual models, including a catchment model, a hydrodynamic model and a biogeochemical aquatic ecosystem model. The system operations of these models are shown in Figure 5 below.

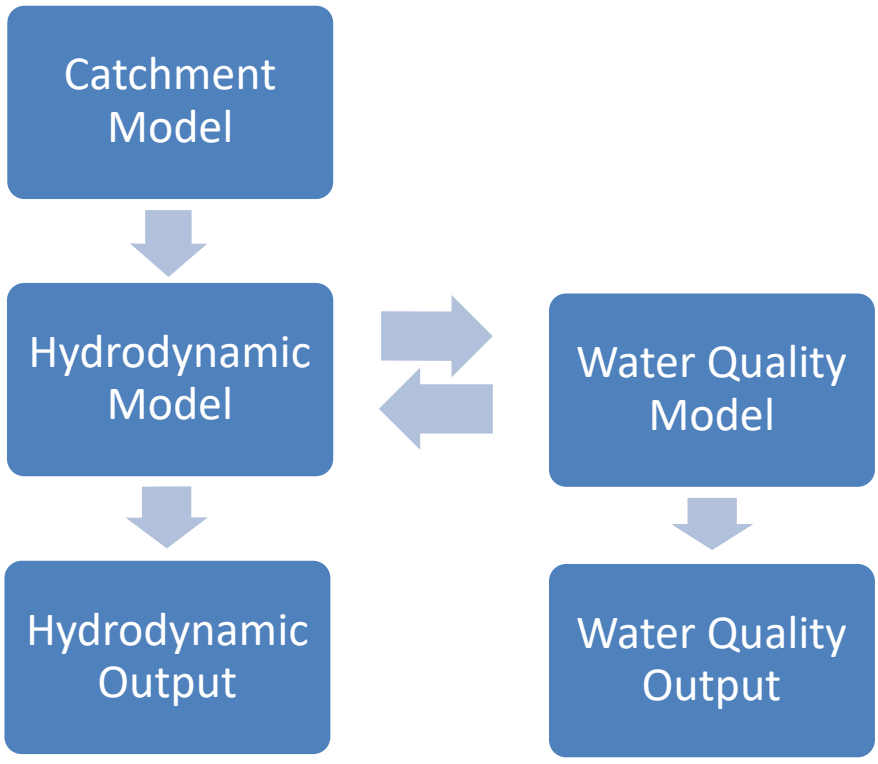


Figure 5: Systems representation of the Water Quality Model.

Preparation of the predictive model involved calibrating the water quality parameters for the updated Scheme model against the original water quality model calibration (BMT WBM 2014). To

achieve an acceptable level of calibration, and in absence of flux measurements, benthic sediment flux parameters were adjusted to compensate for the addition of simulated groundwater flows into the Scheme. Refer **Appendix 5** Water Quality Calibration Results.

7.1 USES OF A PREDICTIVE MODEL

The predictive model allows for hydraulic and water quality simulations of the individual lakes system as well as an evaluation of the overall operation of the lakes. These simulations cover the climate sequence from 1984 to 1995 which is consistent with other water management modelling undertaken by Government.

The key benefits of the model include the ability to:

- simulate existing water quality;
- envisage water quality performance in the developing lakes well before they are dedicated;
- test a variety of water management options including the validity of additional infrastructure; and
- test at source water management options.

7.2 CATCHMENT MODEL

Catchment boundary conditions were retained from previous modelling works (BMT WBM, 2014). PLDC supplied BMT with the MUSIC (Modelling Urban Stormwater Improvement Conceptualisation) models of the surrounding catchment inflows.

One being the same model used in the 2014 modelling over the same 95-year period (Cardno, 2012). The other catchment MUSIC model being for the Employment Land directly adjacent to the Southern Wetlands which accounts for the future development of that site.

The two models were merged by BMT and their rainfall and potential evapo-transpiration (PET) extracted for subsequent use in the hydrodynamic (TUFLOW FV) model.

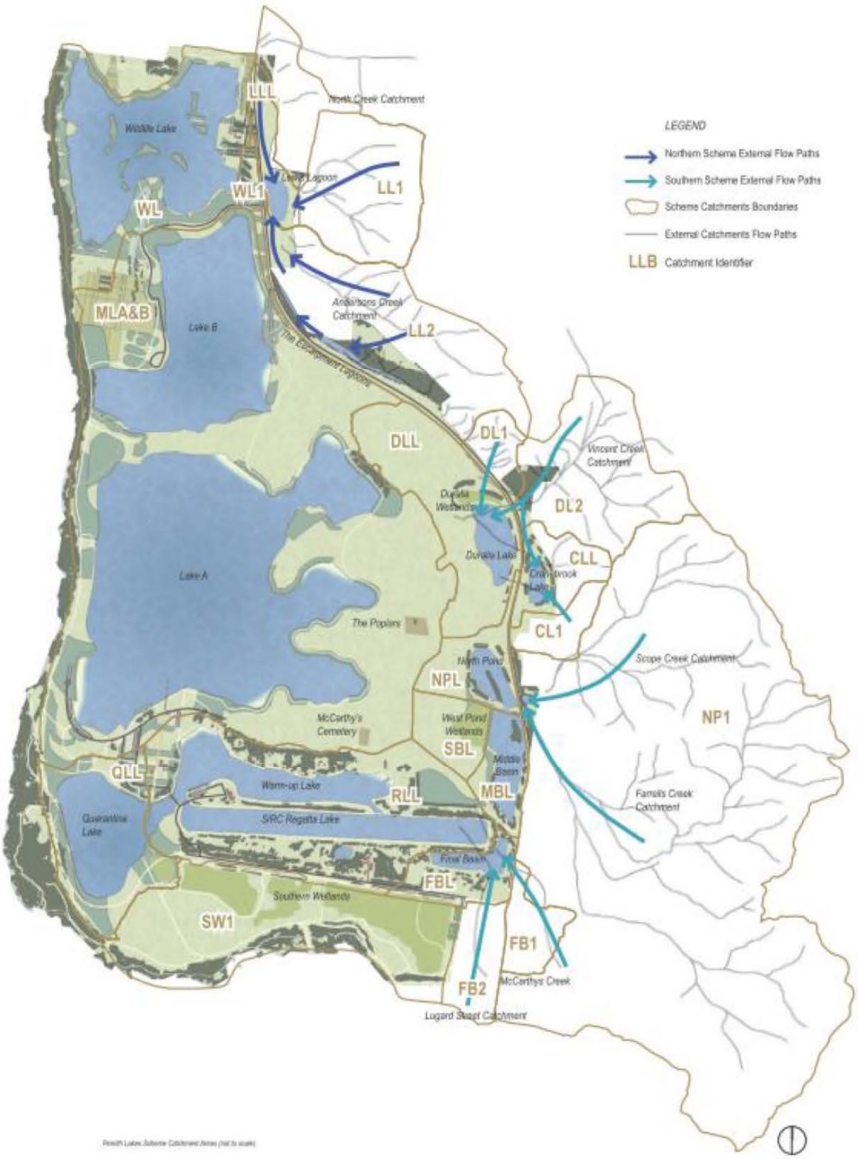


Figure 6: Penrith Lakes Catchment Inflows (not to scale) in Cardno (2012).

The catchment model covers an area of 2094 hectares of adjacent catchment and was calibrated using available time series data to simulate flow and water quality emanating from the adjacent catchments. The performance of the calibration model was then verified against measured data within the lakes and found to be fit for purpose.

7.3 LAKES HYDRODYNAMIC MODEL

The TUFLOW FV hydrodynamic water model was used to simulate the hydrodynamics of the Lakes

Scheme. This includes capturing the effect of flow regulating devices and culverts throughout the Scheme, inflows from catchment MUSIC models and groundwater, water extracted from the Nepean River through the resized Nepean River Pump & Pipeline (NRPP) as well as water pumped from Final Basin to Southern Wetlands, and responses to climatic conditions. The TUFLOW FV hydrodynamic model has been calibrated using a combination of water flows and level telemetry, climatic conditions and thermistor chain data. Further details relating to the Hydrodynamic model is provided in **Appendix 2** Hydrological Modelling of the Resized NRPP.

The resized NRPP flows have been modelled to maintain operating lake levels within the Scheme. Historical NRPP pumping rates have been modelled at 1.0m^3/s however this has been reconfigured to pump at a more sustainable 0.2m^3/s to maintain lake levels within the Scheme. The following NRPP pumping rules were applied for the Scheme hydrological modelling:

- The maximum rate of pumping from the Nepean was set at 0.2 m^3/s.
- Pumping was allowed from the Nepean when the flow at Penrith weir was greater than 50 ML/day. During periods of fish migration additional constraints were applied in addition to this rule:
    - The periods of fish migration were from 1 Sep to 30 Nov (Bass migration) and 1 Feb to 30 Apr (Mullet migration).
    - During these periods, pumping could commence only when flow at Yarramundi weir was greater than 500 ML/day.
    - Pumping was set to then cease during fish migration periods when the flow at Yarramundi was less than 350 ML/day.
- Pumping was triggered (subject to the above availabilities) when water levels fell below 15m or 13.5m in Regatta or Lake A, respectively.
- The annual pumped volume in a water year (1 July to 30 June) was capped at 3.3 GL.

The report concluded that both catchment hydrology and representative groundwater inflows will be essential for maintaining the water levels within the Scheme along with pumping from the Nepean River with up to 3.3GL expected to be required most years to maintain lake operating levels.

The effectiveness of the pumping is proved in Scenario 1 of the Hydrological Modelling when Wildlife Lake runs dry during low rainfall periods, while Regatta and Main Lakes are able to operate normally.

Addendum: Hydrological Modelling of the Resized NRPP in Appendix 2.

The rate for pumping between Final Basin and Southern Wetlands will be 0.2 m^3/s and not 0.4 m^3/s as modelled in the Hydrological Modelling of the Resized NRPP (**Appendix 2**, Table 2-1). The model therefore simulates pumping water between Final Basin and Southern Wetland at twice the rate intended. It should be noted, however, that this would not impact on the total volume of water pumped between the two systems as this is capped by the commence-to-pump (16.5 m AHD) and cease-to-pump (16.0 m AHD) rules.

7.4 LAKES WATER QUALITY MODEL

The AED model (Aquatic Eco Dynamics model, developed by the University of Western Australia)

allows for the simulation of the key biogeochemical processes within the Lakes Scheme. A schematic of these processes is shown in Figure 6. The AED model has been calibrated using the suite of in-lake water quality data collected within the existing Lakes Scheme. This data has then been used to define the biogeochemical processes and formulas within AED, replicating the measured performance of the existing lakes Scheme.

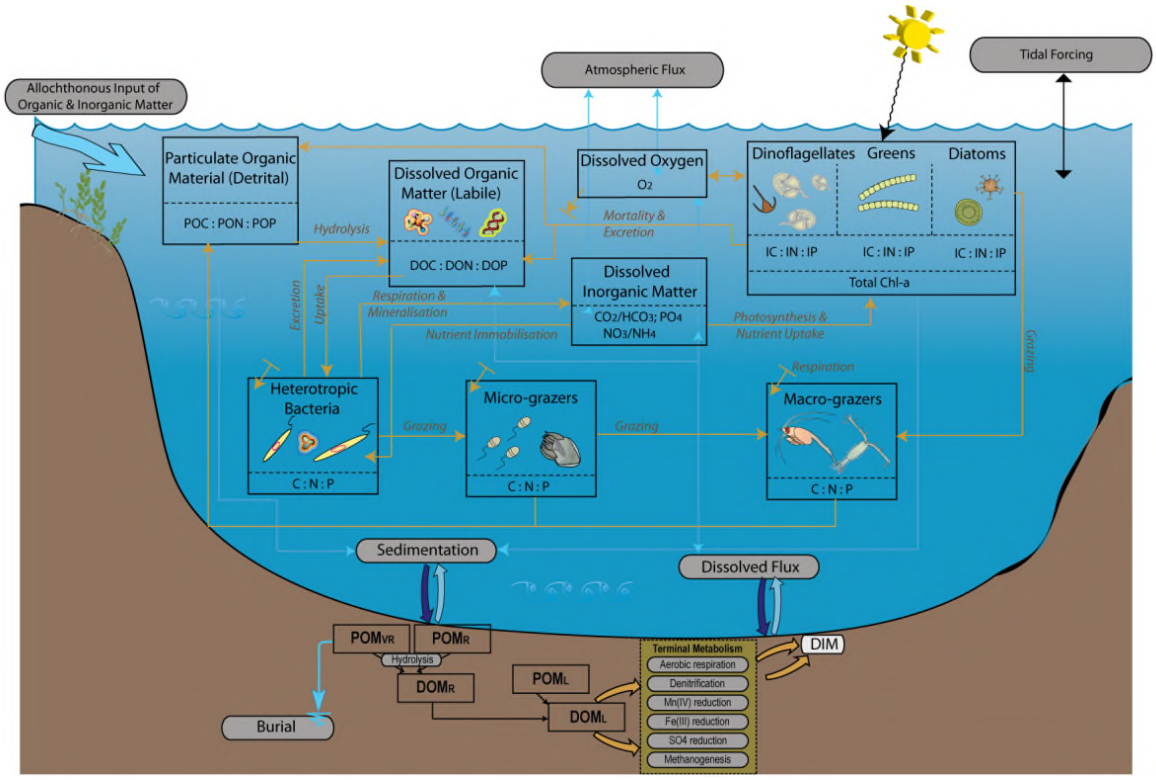


Figure 6: Diagram of AED carbon and nutrient flux pathways

8 WATER QUALITY MODEL OUTCOMES

The water quality model was operated, applying the calibrated parameters from the established lakes and applying these parameters to the proposed 2020 Scheme design. As discussed previously, the 2020 Scheme design has seen a number of changes including an improved design of the Southern Wetlands treatment system as well as additional hydrological connections between Final Basin and Southern Wetlands and Quarantine Lake and Lake A. The model is coupled to the resized Nepean River pump and pipeline hydrological model to permit initial filling and ongoing top-up water pumping when required.

The model has assumed all lakes start at operating level and contain an established ecosystem. The sluice gates across the Scheme have remained permanently open with exception of the Final Basin to Regatta Lake sluice gate connection which position varied depending on whether or not the Final Basin pump and pipeline was in use.

The model simulates a measured 10 year climatic sequence spanning from 1985 to 1994, allowing for the catchment and groundwater inflows, as well as for incidents of both dry and wet climatic sequences. The climatic span also aligns with the modelling undertaken on the Nepean River, allowing for full integration.

Two scenarios were simulated to assess the performance of the revised Southern Wetlands design:

Scenario 1: Pumping of water from Final Basin to the first cell of the Southern Wetlands.
Scenario 2: Allowing water from Final Basin to exit directly to Regatta Lake, thereby bypassing the Southern Wetlands.

Addendum: Penrith Lakes Scheme – Water Quality Model of Southern Wetlands (Appendix 4)

The rate for pumping between Final Basin and Southern Wetlands will be 0.2 m^3/s and not 0.4 m^3/s as modelled in Scenario 1 of the Water Quality Modelling (**Appendix 4**, Table 2-1). The higher pumping rate modelled simulates pumping water between Final Basin and Southern Wetland at twice the rate intended. It should be noted, however, that this would not impact on the total volume of water pumped between the two systems as this is capped by the commence-to-pump (16.5 m AHD) and cease-to-pump (16.0 m AHD) rules.

Because water is being pumped at twice the rate in Scenario 1 of the model simulations, this may have a variable impact on detention times within the wetlands. That is, depending on the volumetric status of the wetland at any point in time, detention time in the wetlands could be lower than it would have been if the correct flow rate was used. This would mean that the contact time of waters within the wetland would be slightly lower than otherwise so the uptake / assimilation of pollutants could potentially be slightly lower making this a more conservative water quality simulation than if the correct flow rate was used. Thus water quality entering Quarantine Lake could be expected to be slightly improved if the actual flow rate of 0.2m^3/s had been used.

Environmental Value Composite Indices:

The assessment of water quality in the Penrith Lakes Scheme was undertaken using a combination of water quality guidelines including:

- The 1987 Deed of Agreement (DoA).
- ANZECC (2000) Guidelines for Fresh and Marine Water Quality.
- NHMRC (2008) Guidelines for Managing Risks in Recreational Water.

These identified water quality parameters and their associated guideline values formed the basis of the calculation of composite indices for each of the three key environmental values (EVs) presented below:

- Protection of aquatic ecosystems – all lakes (not including the eastern detention basin system).
- Primary Contact Recreation - Regatta Lake, Warm-up Lake, Main Lakes A & B.
- Secondary Contact Recreation – Regatta Lake, Warm-up Lake, Main Lakes A & B.

Thematic maps illustrating the level of protection of the EVs of the primary lakes of the Scheme are presented in Figure 8. Actual percentages are provided below in Table 10.

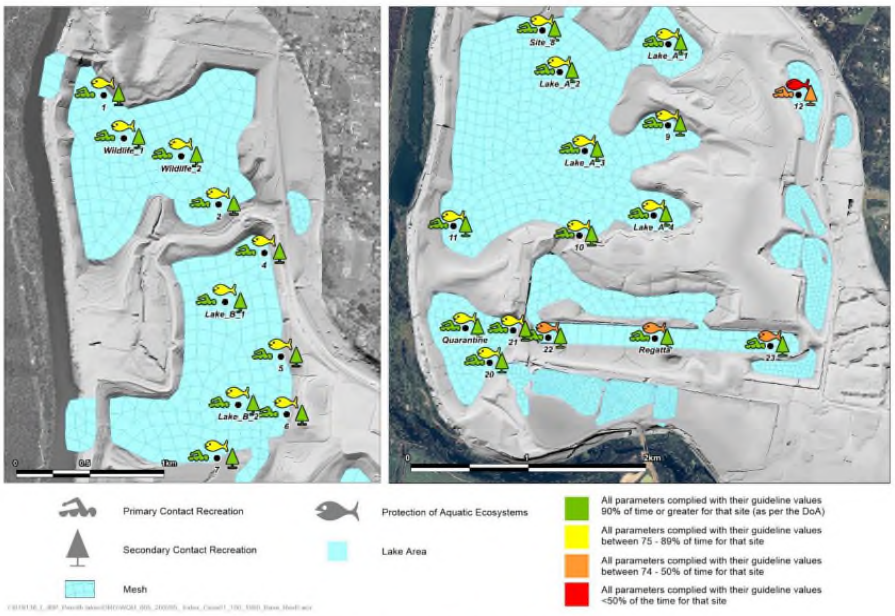


Figure 5-1 Composite Indices of lakes against Environmental Values in Scenario1

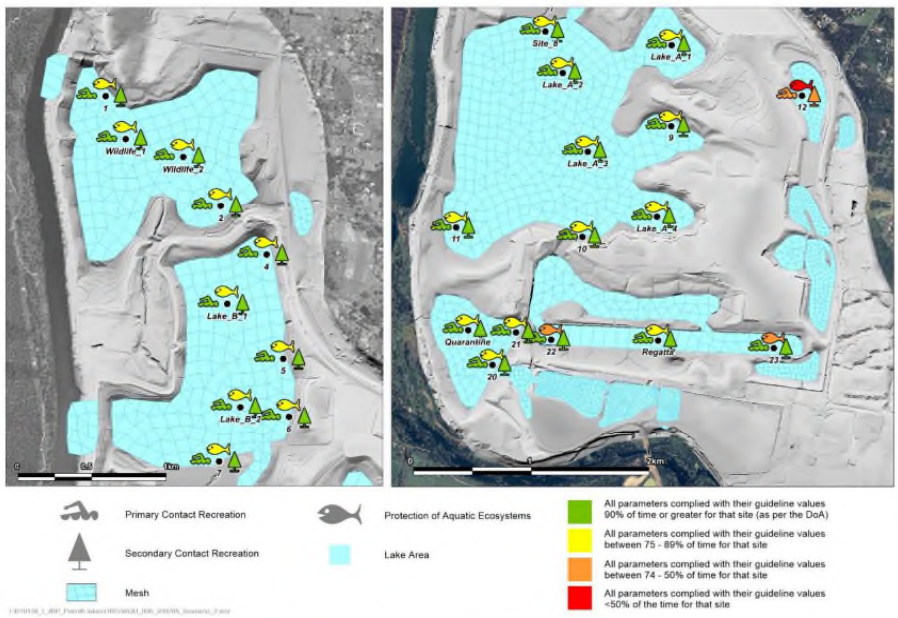


Figure 5-2 Composite Indices of lakes against Environmental Values in Scenario2

Figure 8: Composite Indices of lakes against Environmental Values in Scenarios 1 and 2

Table 10: Composite Indices of Lakes against Environmental Values

		Aquatic Ecosystems		Primary Contact Recreation		Secondary Contact Recreation	
Lake Name	Locations of Interest *	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Regatta	Site_22	73	74	99	98	99	98
	Site_23	72	71	98	94	98	94
	Regatta_extra	73	76	99	98	99	98
Lake A	Site_8	83	84	100	100	100	100
	Site_9	80	81	100	100	100	100
	Site_10	81	82	100	100	100	100
	Site_11	85	86	100	100	100	100
	Lake_A_extra_1	82	82	100	100	100	100
	Lake_A_extra_2	83	83	100	100	100	100
	Lake_A_extra_3	82	82	100	100	100	100
	Lake_A_extra_4	82	83	100	100	100	100
Lake B	Site_4	81	82	100	100	100	100
	Site_5	80	80	100	100	100	100
	Site_6	80	81	100	100	100	100
	Site_7	82	82	100	100	100	100
	Lake_B_extra_1	84	84	100	100	100	100
Lake B	Lake_B_extra_2	82	83	100	100	100	100
Duralia	Site_12	29	29	56	56	56	56
Quarantine Lake	Site_20	79	78	NA	NA	NA	NA
	Site_21	76	76	NA	NA	NA	NA
	Quarantine_extra	78	78	NA	NA	NA	NA
Wildlife Lake	Site_1	87	87	NA	NA	NA	NA
	Site_2	85	85	NA	NA	NA	NA
	Wildlife_extra_1	86	86	NA	NA	NA	NA
	Wildlife_extra_2	86	86	NA	NA	NA	NA

* refer **Appendix 4**, page 31 for measurement location within each Lake

Water quality parameters for the Primary Lakes against EVs in the Penrith Lakes Scheme have been summarised in Table 11 below, detailing the protection levels of the EVs for individual water quality parameters for the Primary Lakes.

Table 11: Protection Levels of the Environmental Values for individual water quality parameters

Primary Lakes	Locations of Interest *	DO saturation (%)		TN (mg/L)		Chlorophyll a (µg/L)		Cyanobacteria		Enterococci		NOx		NH4		FRP	
		Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Regatta / SIRC	Site 22	73	74	97	97	96	96	100	100	99	98	60	38	1	1	100	99
	Site 23	72	71	94	94	94	94	99	99	98	94	61	42	2	3	99	99
	Regatta extra	73	76	97	97	96	96	100	100	99	98	60	39	1	1	99	99
Main Lake A	Site 8	83	84	100	100	99	99	100	100	100	100	99	99	89	88	42	50
	Site 9	80	81	100	100	97	97	100	100	100	100	100	100	89	88	42	50
	Site 10	81	82	100	100	99	99	100	100	100	100	99	99	88	97	43	51
	Site 11	85	86	100	100	99	99	100	100	100	100	99	99	89	88	43	51
	Lake A extra 1	82	82	100	100	97	97	100	100	100	100	100	100	93	90	39	42
	Lake A extra 2	83	83	100	100	99	99	100	100	100	100	99	99	89	88	42	50
	Lake A extra 3	82	82	100	100	99	99	100	100	100	100	99	99	89	88	43	51
	Lake A extra 4	82	83	100	100	98	98	100	100	100	100	100	100	89	88	42	49
Main Lake B	Site 4	81	82	100	100	95	95	100	100	100	100	95	95	93	93	31	35
	Site 5	80	80	100	100	95	95	100	100	100	100	95	95	93	93	32	35
	Site 6	80	81	100	100	95	95	100	100	100	100	95	95	93	92	32	36
	Site 7	82	82	100	100	95	95	100	100	100	100	95	95	93	93	32	35
	Lake B extra 1	84	84	100	100	95	95	100	100	100	100	95	95	93	93	31	34
	Lake B extra 2	82	83	100	100	95	95	100	100	100	100	95	95	93	93	32	35
Duralia	Site 12	90	90	29	29	78	78	100	100	56	56	68	68	1	1	99	99
Quarantine	Site 20	79	78	94	94	99	99	100	100	100	100	88	95	34	64	99	99
	Site 21	76	76	96	96	100	100	100	100	100	100	87	95	34	64	100	100
	Quarantine extra	78	78	95	95	99	99	100	100	100	100	88	95	34	63	100	99
Wildlife	Site 1	87	87	95	95	94	94	100	100	100	100	96	96	77	76	60	60
	Site 2	85	85	95	95	92	92	100	100	100	100	96	96	79	78	62	62
	Wildlife extra 1	86	86	95	95	94	94	100	100	100	100	96	96	77	77	61	61
	Wildlife extra 2	86	86	96	96	93	93	100	100	100	100	96	96	78	77	61	61

* refer **Appendix 4**, page 31 for measurement location within each Lake

The simulations suggest that all Primary and Secondary Contact Recreation and the majority of Protection of Aquatic Ecosystem EVs (with exception of DO saturation parameter on the western side of scheme) are met throughout the Scheme under the composite index measures. The redirection of Final Basin outflow into the Southern Wetlands increases EV compliance of Regatta Lake.

Southern Wetlands

A revised layout and bathymetry for the Southern Wetlands was provided to BMT (Figure 9) and included in the modelling. The Southern Wetlands were configured to function as a nutrient sink with pollutant assimilation rates developed by E2 Design Lab specifically for this modelling exercise. The full report reviewing the efficiency of the re-configured Southern Wetlands can be found in **Appendix 6**.

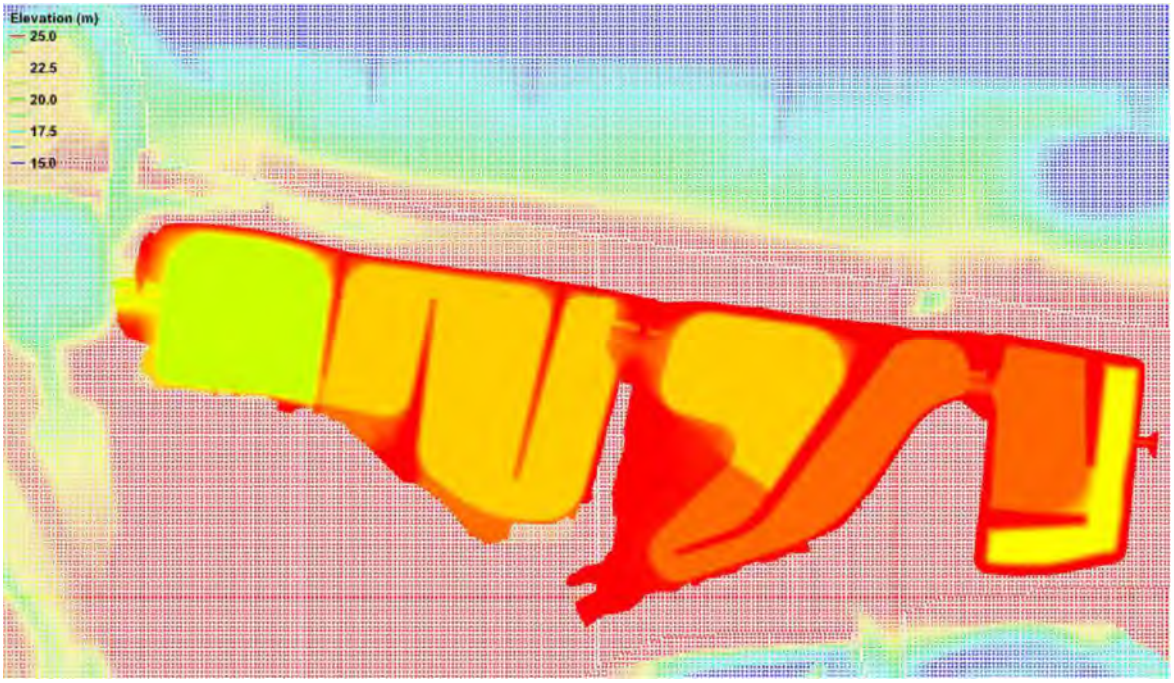


Figure 9: Updated digital elevation model for the Southern Wetlands.

To quantify the effectiveness of the revised Southern Wetlands system, pollutant fluxes at the entrance and exit of the Southern Wetlands were extracted from the model, compared and the percent reduction calculated. Nutrient loads are presented in Table 12 as annual average tonnes of TSS, TN, TP and algal carbon, and as CFU for Enterococci.

Table 12: Annual pollutant load reduction through Southern Wetlands.

Protection Value	Pollutant Load (tonnes/year)	Entrance		Exit		Percent reduction	
		Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Aquatic Ecosystems	TSS	28.8	6.6	17.1	2.7	41%	55%
	TN	2.5	1.5	0.3	0.2	87%	98%

	TP	0.15	0.03	0.005	0.001	97%	98%
	Algae	2.0	0.40	1.7	0.33	17%	24%
Primary Contact Recreation	Cyanobacteria	1.7	0.20	0.78	0.15	55%	26%
	Enterococci	8.95E+12	8.66E+12	0.65E+12	0.26E+12	93%	97%
Average						**65%**	**67%**

The model outcomes see the quality of water leaving the Southern Wetlands is improved in both scenarios. Water quality parameters such as TN, TP, Enterococci, and TSS show compliance with the respective guideline values at the exit from Southern Wetlands in both scenarios.

The percent reduction in pollutant loads through the Southern Wetlands were slightly greater in Scenario 2 due to the lower flow rates (i.e. no pumping from Final Basin) and increased retention times. In other words, more contact time allowed for greater pollutant removal.

The pollutant loads exiting the Southern Wetlands in Scenario 1 were greater than Scenario 2 due to the significantly higher pollutant loads entering the system as a result of Final Basin pumping directly to the wetlands (note Addendums to Appendix 2 and 4 regarding pumping rate). Absolute pollutant loads are therefore difficult to compare between scenarios at the exit of the Southern Wetlands.

Overall, the water quality simulation provides a high degree of confidence that the revised 2020 Scheme design is suitably sized and equipped to achieve the desired water quality objectives and lake end uses. The model demonstrates the effectiveness of the designed treatment lakes and wetlands and reticulation system to achieve a significant improvement in water quality through the system, ultimately 'polishing' the source water to reach the desired water quality in the Primary Lakes.

Further breakdown of the water quality model results have been provided in the BMT "Water Quality Modelling Report" included in **Appendix 4.**

9 OPERATIONAL INFRASTRUCTURE

The overall goal for the Scheme is to construct and maintain recreational lakes and aquatic ecosystems that are resilient to normal disturbance events at minimum capital and operating cost. PLDC has taken an adaptive management approach to achieving this goal with a commitment to continual improvement. The day to day management of the lakes and water bodies by PLDC over the past 20 years have been part of a continuous process of testing, learning and understanding the various behaviours. This has allowed PLDC to adapt its approach for the differing climatic conditions and, where appropriate, refine operational infrastructure and management procedures for future operations.

As part of PLDC's testing it has trialled the use of aeration devices to determine whether they are effective in destratifying the lakes system to assist in meeting the end use objectives. Experience gained at the Scheme has shown that the existing aeration devices are ineffective in that they have been unable to prevent or 'treat' cyanobacterial blooms in the eastern detention basin system. PLDC has also used thermistor chains to gain valuable information and scientific data about stratification and temperature and correlate these with lakes and water body behaviour and performance. The data obtained by PLDC has been used in the calibration of the water quality model. It is considered thermistor chain monitoring will no longer be required by future water managers.

Furthermore, in response to the changes to the State Environment Planning Policy (Penrith Lakes Scheme) Amendment 2017 (the 'SEPP') that effectively rezoned 47 hectares of the land originally allocated for the wetlands system in the south of the Scheme for employment purposes, PLDC in consultation with DPIE have developed a revised design of the water supply and treatment system that is schematically represented in Figure 10 and includes the following:

- New location and more realistic water supply design of the Nepean River Pump and Pipeline (NRPP);
- Installation of a new pump and pipeline system that allows excess water from Final Basin to be pumped into the Southern Wetland system to extend detention time of catchment inflows prior to them entering any of the recreational lakes. The Final Basin pump and pipeline will allow for pumping at 0.2m^3/s;
- Improved design of Southern Wetlands treatment system, inclusive of several sluice gates and strategically placed berms that increase the length to width ratio of wetland cells, capable of treating water pumped from both the Nepean River, Final Basin and adjacent Employment Land;
- Manually operated sluice gate between Quarantine Lake and Warm-up Lake;
- Inclusion of the Quarantine Lake to Lake A channel with a manually operated sluice gate that can be activated by the water manager to divert water from Quarantine Lake into the main lakes (A and B) by-passing the SIRC lakes if required.

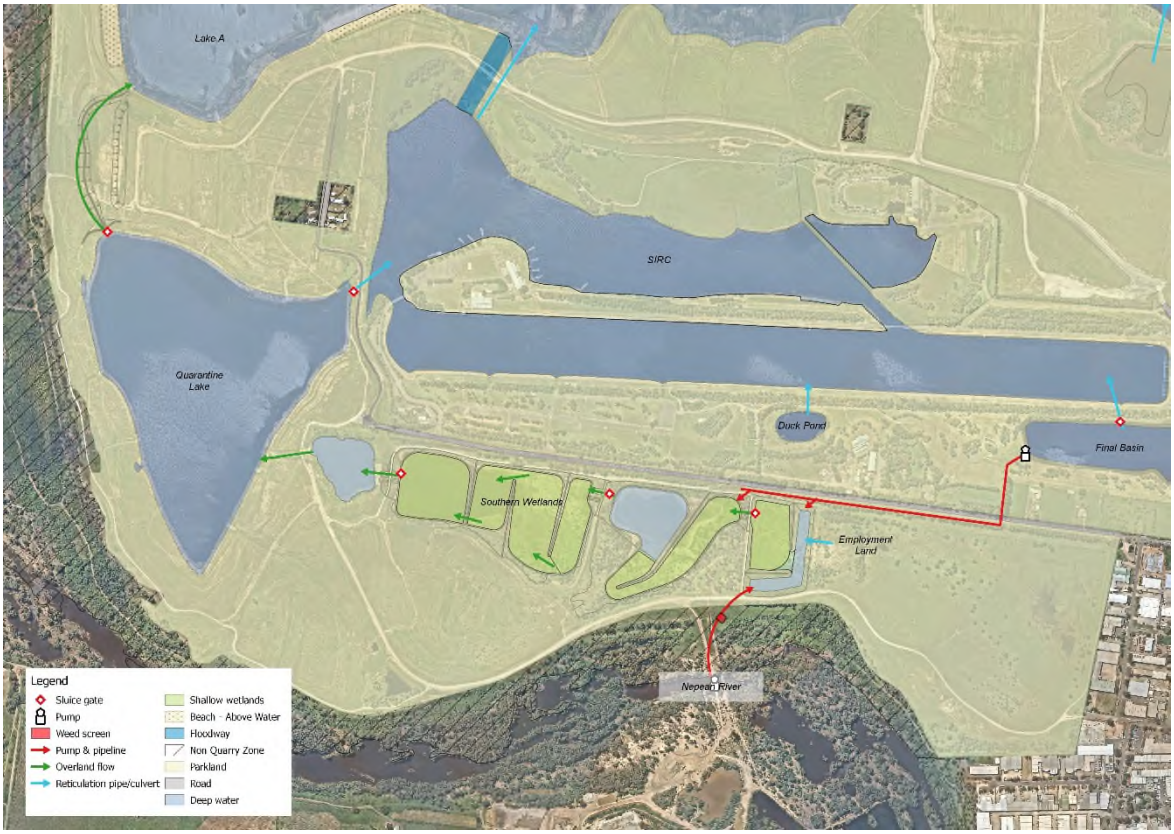


Figure 10: Revised design of water supply and treatment system in the South.

The revised location of the NRPP is to be at the existing BMG Causeway ('Boral Bridge') infrastructure allowing for pumping directly into the eastern most Cell of the Southern Wetlands through a weed structure. The NRPP will be constructed to undertake the initial filling of the lakes system as well as for the ongoing top up to maintain lake levels.

The inlet side of the pumps will have mesh screens fitted to ensure large weeds and fish are not pumped from the river into the Scheme. There will also be a weed structure constructed prior to discharge into the Southern Wetlands system which will ensure removal of smaller weeds pumped from the Nepean River prior to entering the lakes system.

The pumping rate and rules for the NRRP will be as follows (as per Hydrological Modelling pumping rules detailed in Section 7.3):

- The maximum rate of pumping from the Nepean for lakes top up 0.2 m^3/s.
- Pumping can commence from the Nepean when the flow at Penrith weir is greater than 50 ML/day. During periods of fish migration additional constraints are applied in addition to this rule:
    - The periods of fish migration are from 1 Sep to 30 Nov (Bass migration) and 1 Feb to 30 Apr (Mullet migration).
    - During these periods, pumping will commence only when flow at Yarramundi weir is greater than 500 ML/day.
    - Pumping will cease during fish migration periods when the flow at Yarramundi is less than 350 ML/day.

To enable the initial filling of the lakes, PLDC has applied for a Specific Purpose Access Licence (SPAL). During the initial lake filling campaign, the NRPP pumping rate and rules, as per the licence application, will be as follows:

- The maximum rate of pumping from the Nepean for lake filling 0.5 m^3/s (43.2ML/day).
- Pumping can commence from the Nepean River to the lakes when the total river flow exceeds 500 ML/day at Yarramundi Gauge.
- Pumping must cease when the total Nepean River flow drops below 350 ML/day at Yarramundi Gauge.
- Environmental flows cannot be pumped. When pumping occurs, the remaining flow in the Nepean River must exceed the environmental flows

The revised NRPP design and configuration will allow for both the lake filling and ongoing top up scenarios.

Further details of changes to the wetlands design can be found in Southern Wetlands Design Review in **Appendix 6**, engineering drawings of the new infrastructure are attached as **Appendix 7** and the hydrological modelling of the resized NRPP is presented in **Appendix 2**.

Due to the water quality model results set out in **Appendix 4** of this submission and 20 years of water monitoring and management by PLDC there is a high degree of confidence that the currently proposed lake designs and infrastructure will deliver a Scheme that meets the desired targets for water quality and associated end water uses and that no further infrastructure is warranted.

The proposed Scheme will contain all operational infrastructure as detailed in Stage 1 of the Water Management Plan, as well as the more recent changes to water supply, reticulation system and Southern Wetland system described above.

10 LAKES OPERATIONS PLAN

10.1 OVERVIEW

The Lakes Operations Plan guides the day to day management of both the quantity and quality of water entering the lakes system as well as the passage of water throughout the Scheme. The plan provides background information on the lakes system, documents the goals for water quality and aquatic ecosystem health and outlines procedures for management of various parts of the Scheme. It documents how water movement through the system is controlled and how water quantity, water quality and aquatic ecosystem health are monitored. Response plans determining specific decisions and actions to be taken, such as during high water levels, cyanobacteria blooms, bacteria (faecal) contamination, and low dissolved oxygen, are also included.

The Lakes Operations Plan meets the evolving requirements of water quality and water balance management across the Scheme and is progressively updated as the Scheme develops. The Scheme-wide Lakes Operations Plan accompanies this document and can be found in **Appendix 8**.

10.2 WATER LEVEL MANAGEMENT

Table 2 and were approved in the Stage 1 Water Management Plan. The recommended tolerances in operating levels set for these lakes has been included, with tolerances based on operational requirements and ecological considerations depending on their purpose and provide the added protection of providing buffer water storage to reduce the need to top up the lakes from the Nepean River.

The monitoring and management of the lakes water levels is assisted by the use of the numerous sluice gates and level monitoring stations (automatic and manual) across the scheme. Monitoring stations collect real time data of water levels (accurate to 0.01m) and water temperature profiles. Water level stations are currently located in the Final Basin, Middle Basin, North Pond and Duralia Lake. The system is designed to alert water managers via SMS when alarm levels are triggered. Water volumes can then be managed accordingly to maintain operational levels. Water levels of other lakes are monitored by recording the manual depth gauges levels located in convenient location around the lakes.

10.3 WATER QUALITY MANAGEMENT

10.3.1 Flows and Quality

Stormwater and run-off water entering the Scheme through the eastern detention basin system can contain high concentrations of bacterial contaminants, sediment loads together with nutrients and

other pollutants, including gross pollution and organic material including weeds.

An inflow monitoring station was installed by PLDC to provide information on the potential for bacterial contamination. Discharge from the Stilling Basin into the North Pond was measured over a weir by means of a Cipoletti notch, developed by Manly Hydraulics Laboratory (MHL) and made available to PLDC from the MHL website. PLDC used a guide of >43 000m^3 water (43ML) within 72 hours as a trigger for potential faecal bacteria inflows into the system from the surrounding catchment. This trigger was developed through the work of Ashbolt and Roser (2004). An SMS alert was sent to water managers when this threshold had been reached and, provided storage was available in the detention basins, water was consequently withheld from the SIRC lakes.

A sluice gate installed between Final Basin and SIRC lakes also allows highly turbid water to be held back during intense rainfall events so residence time is extended to allow sediment and other water quality improvements to occur prior to water entering the SIRC lakes. This gate is very effective in isolated rainfall events. With prolonged rainfall a considerable storage volume must be retained and water levels may increase by up to 2.55m above normal operating level in the Final Basin.

Prolonged storage in Final Basin however impacts adversely on both emergent and submerged macrophytes; therefore a pump and pipeline will be installed on the western bank of Final Basin that will allow pumping of excess water directly to the Southern Wetlands. This will increase detention time of the catchment inflows by travelling through the Southern Wetlands system. The pump is designed to operate at a rate of 0.2 m^3/s. Careful and vigilant management is required if optimal outcomes are to be achieved in this part of the Scheme.

10.3.2 Management of Weeds and Silt

Floating weed booms located in North Pond, Middle Basin, Final Basin, and Warm-up Lake aid in confining floating noxious weeds. They are also present in Lewis Lagoon, Wildlife Lake, Quarantine Lake and Main Lake A. A combined weed boom and silt curtain is present in the Final Basin and acts as a barrier to prevent weeds, rubbish and sediment entering the SIRC lakes. The silt curtain is less effective in severe rainfall events when lake levels rise and the boom can be bypassed at the lake's edge. Careful monitoring is required in this regard.

10.3.3 Monitoring of Recreational Water Quality

In order to meet the recreational water quality goals, monitoring of various physio-chemical and biological variables is undertaken on a regular basis.

Sampling is carried out at monthly intervals and after rainfall events in the SIRC lakes and in the detention basins and the eastern ancillary lakes. Techniques employed follow standard water quality sampling protocols.

The physio-chemical variables measured include: pH, Dissolved Oxygen, Turbidity, Total Suspended Solids, algae, nutrients (Nitrogen - Ammonium N, NOX, TN; Phosphorus – SRP, TP), and includes depth profiles of the water column for temperature, dissolved oxygen and pH.

The biological variables measured include algae and cyanobacteria, the species composition and

abundance (cell counts) of phytoplankton assemblages and bio-volumes of Cyanobacteria (blue-green algae) are measured. The microbial indicators of Faecal Coliforms and Enterococci are also measured. The monitoring results are provided to the NSW Department of Health and SIRC venue management to ensure that proper action is taken in circumstances where water quality results represent a danger to venue patrons and the general public.

10.3.4 Algal Response Plan

For the period that PLDC agreed to maintain water quality in the Eastern Lakes and SIRC a draft Algal Response Plan specific to the management of the SIRC and Penrith White Water Stadium (PWS) was adopted. The plan was developed to ensure an adequate monitoring regime was in place to alert users of public waterways of the potential toxins present in the water body for safe usage. The plan was developed in conjunction with NSW Office of Water and the NSW Department of Health, as well as SIRC and PWS. This plan is included in the Lakes Operation Plan (**Appendix 8**).

This plan informs all stakeholders of their responsibilities and outlines specific testing and response requirements and should be updated by the future operators of the Scheme to ensure ongoing compliance.

10.3.5 Aquatic Weed Response Plan

Aquatic weeds adversely impact on the ecological functioning of the lake systems as well as having negative effects on recreational use and aesthetic amenity. The adverse impacts of invasive species are largely due to their ability to rapidly colonise areas, often forming mono-specific stands, which lead to displacement of native species and alterations to habitat. The dominance of these species usually results in losses of biodiversity (both plants and animals) and degradation of the ecosystem.

From the list of most problematic, difficult-to-control aquatic invasive species in the Sydney basin, the highest threat for the water bodies within the Scheme are the emergent Alligator Weed (*Alternanthera philoxeroides*), the submergent Egeria (*Egeria densa*), Cabomba (*Cabomba caroliniana*) and Elodea (*Elodea canadensis*), and the floating Water Hyacinth (*Eichhornia crassipes*) and Salvinia (*Salvinia molesta*) species. All of these species (except Cabomba) are abundant either in the Hawkesbury-Nepean River or on its floodplain in which the Scheme is located. Some, like Alligator Weed, Water Hyacinth and Salvinia are relatively common in the upstream Cranebrook and Londonderry catchments.

A monitoring and control program has been developed in order to manage exotic weed species within the scheme. Weed species targeted as part of this program include any noxious or environmental weed scheduled under the Biosecurity Act 2015. Currently priority weeds include Willows (Black (*Salix nigra*), Crack (*Salix fragilis*) and their associated hybrids), Peruvian Water Primrose (*Ludwigia peruviana*), Water Hyacinth, Salvinia, Sagittaria (*Sagittaria platyphylla*), Spiny Rush (*Juncus acutus*) and Alligator Weed.

10.4 AQUATIC ECOSYSTEM MANAGEMENT

Monitoring programs focused initially on the recreation water quality values and on surveys of submerged macrophytes and fish populations. The monitoring program was reviewed and revised by an expert panel in 2009 and monitoring now focuses more clearly on site management objectives so that environmental quality information obtained and changes over time can better inform the decision making process (ALS 2009). It was advised that macro-invertebrates and amphibians are to be included in the surveys sand more detailed information on emergent macrophytes is gathered. The monitoring has also been targeted more closely on the SIRC lakes, detention basins, and the eastern ancillary lakes and water bodies.

The key monitoring programs include:

10.4.1 Fish Populations

Fish populations are a good indicator of aquatic ecosystem health as they occupy key roles in aquatic ecosystem function. They are considered to be a proven and cost effective method of assessing ecosystem health. Regular fish monitoring also allows PLDC to respond in a timely manner to any potential invasions or population increases of pest fish such as European Carp.

Surveys of fish populations used to occur on annual or biennial basis at the SIRC lakes, detention basins, and eastern ancillary lakes using current fish sampling protocols (electro-fishing, panel gill netting, bait trapping). Species composition and abundance of fish was recorded and changes over time analysed. The abundance of the exotic pest species was carefully assessed to ensure they did not become dominant within any of the lakes, with Australian Bass being effectively stocked to predate on juvenile carp to control populations. As the remainder of the lakes come online and are transferred to Government it is suggested that the fish monitoring programme expands to cover these lakes as well.

10.4.2 Macrophytes

Monitoring of the aquatic macrophytes at Penrith Lakes had been undertaken since the 1990s, focusing initially on the recreational lakes and issues relating to their use.

Submerged macrophytes were surveyed at the SIRC lakes, detention basins, and eastern ancillary lakes every two years. Echo-sounding technology was employed in 2011, combined with spot diving to gather information on species composition, abundance, distribution and extent, and changes over time. Overall plant health was noted and the presence and abundance of any invasive and highly undesirable species is recorded.

Emergent macrophytes and riparian zone taxa were surveyed at the SIRC lakes, detention basins, eastern ancillary lakes and their associated lagoons. A monthly walk-through of the perimeter of all lakes was undertaken to check the health of riparian areas and the presence of any invasive noxious weed species. An annual survey of all riparian zones was undertaken also using a series of line transects from the shore to 1-1.5m depth.

Similar to the fish monitoring, it is recommended that all lakes are added to the regular macrophyte surveys once they are in service. Changes over time of species composition, abundance and

percentage cover, distribution and extent of submerged and shoreline macrophyte vegetation should be recorded. The presence of invasive and highly undesirable species should also be recorded.

10.4.3 Macro-invertebrates

While benthic macro-invertebrates (those that live in stream or lake-bed sediments) are the most commonly used indicators, the sampling and laboratory analyses of these organisms is labour-intensive, and hence, expensive. Initially 'edge' macro-invertebrates were surveyed, using rapid assessment techniques in order to obtain a 'picture' or 'signature' of macro-invertebrate community structure. Site-specific macro-invertebrate details for the different water bodies allow a SIGNAL-2 score and an EPT Index to be calculated. In situ water quality sampling and physical habitat assessments are also carried out at the monitoring sites enabling the macro-invertebrate data to be interpreted more fully.

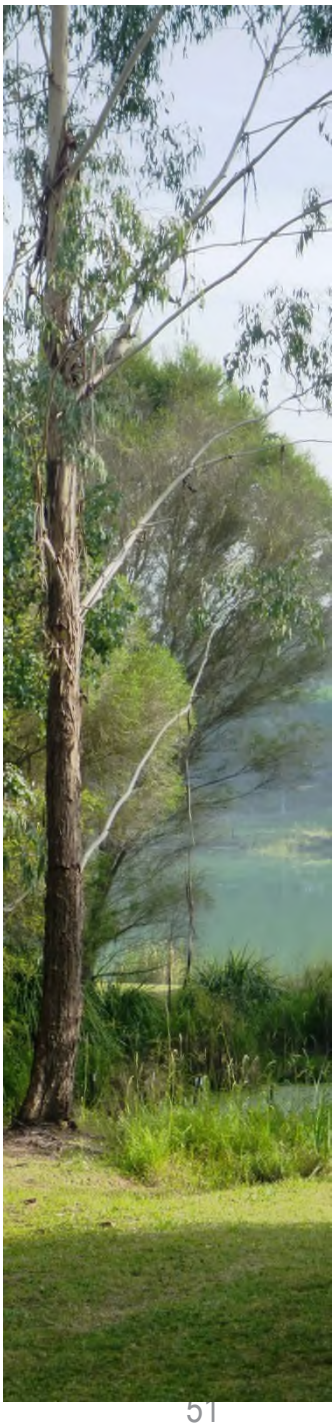
Building a 'baseline' of macro-invertebrate community structure will assist in monitoring changes over time within the marginal lake environments and provide information on habitat quality that may reflect impacts from external or local catchment activities.

Sites are suggested to be surveyed twice yearly (autumn and spring) in the detention basins, eastern ancillary lakes and their associated water bodies. Five marginal sites will be designated at each lake and water body and standard sampling protocols for Rapid Bio-Assessment followed. Species composition and abundance data will be collected to enable SIGNAL-2 and EPT Indices to be calculated.

10.4.4 Amphibian Populations

Amphibians provide both a primary and secondary consumer role within the aquatic ecosystems. They prey on a variety of invertebrates and are also prey to other species such as various birds. Amphibian populations are regarded as excellent indicators of environmental conditions, particularly in regards to ecological changes in relation to water quality, habitat fragmentation and water regime. Monitoring amphibians is relatively inexpensive, non-destructive and it is considered that it would be a useful component to the Penrith Lakes Integrated Ecological Health Monitoring Program.

Amphibians at the detention basins and eastern ancillary lakes and their associated water bodies were surveyed annually using call playback and spot-lighting techniques. Species composition and abundance of frogs, abundance of tadpoles and changes over time can be documented. A possibility of allowing interested environmental and/or educational groups to conduct independent monitoring with results submitted to the scheme managers for assessment could also be considered.



10.5 LANDSCAPE MANAGEMENT

The SIRC lakes are a proven recreational attraction for a wide variety of community activities, such as regattas, white water rafting, triathlons, cycling, running and fishing events, as well as various

community gatherings and organised events. As the area develops as a regional recreation resource a variety of different management regimes will need to be implemented including regional open space, local open space, and water management.

Regional open space management will apply to the bushland, woodland, grassland and other mass planted parts of the Scheme. Many of these areas are designed to become self-sustaining and maintenance would be expected to be less than that of a public park.

Local open space management will apply to camp sites, public parks, picnic areas and beaches where a higher expected volume of usage would require higher-intensity maintenance. Such areas would not form a major part of the Scheme and would be located where access was readily available. Use, access and therefore maintenance requirements can be regulated through careful operational management policies and practices.

The management and maintenance of the lakes within the Scheme would need to balance recreational needs with the capacity to monitor and maintain ecological values and ensure cost-effective management and maintenance.

PLDC is developing Landscape Management Plans for the completed landforms and remnant landscapes to direct their ongoing management and these will provide information to assist the development of future Management Plans and Maintenance Programs.

Technical Specifications have also been developed and outline how a particular task or operation should be carried out to ensure current industry standards and guidelines are met. They cover a range of activities including weed management (both aquatic and terrestrial), land surface stabilisation, land rehabilitation and maintenance works amongst others.

10.6 COMPLETED LAKES OPERATIONS PLAN

The completed Lakes Operations Plan forms part of this WMP Stage 2 submission and is attached in **Appendix 8**. It has to be noted though that the Lakes Operations Plan will always be a living document based on an adaptive management approach and will require to be continually improved based on the growing knowledge gained from practical day to day management of completed water bodies within the Scheme.

11 CONCLUSION AND RECOMMENDATIONS

11.1 CONCLUSION

The Scheme is being implemented under the Deed, SEPP (Penrith Lakes) 1989, development consents and other relevant approvals. The Water Management Plan is being submitted to the Secretary, Department of Planning, Industry and Environment under Condition 27 of DA4.

The Plan has been submitted in two (2) stages. Stage 1 was submitted on 17 August 2012 and approved by the Director-General, Department of Planning and Infrastructure on 15 November 2013. This Stage 2 WMP submission focuses primarily on the resultant water quality outcomes, water balance and operational requirements for the short and long term management of water taking into consideration the infrastructure that was delivered in the Stage 1 WMP, as well as the infrastructure changes under the In-Principle Agreement between PLDC and DPIE (2019). The Stage 2 WMP simulates the water quality inflows from the eastern catchment, models water quality through the established ecosystems and treatment pathways before and after water enters the gravity flow system inherent in Stage 1 and provides for optimal flexibility in management regimes available to the long term managers to achieve the end water uses set out in Schedule 7 of the Deed.

In completing Stage 2 of the Plan, PLDC and its consultants have relied on the Stage 1 approval as the basis for developing the suite of assumptions underpinning the detailed analysis and modelling which has been undertaken over a period of more than 24 months. The water quality modelling provides a scientific prototype of the Scheme's lakes, wetlands and detention basins to inform the preparation of the Stage 2 documentation. Additionally, reliance has also been placed on PLDC's extensive on-site experience as the primary water managers of the Eastern Lakes detention basin, wetland treatment system and the water quality outcomes of the SIRC lakes. This experience has been invaluable in testing and verifying in a practical sense the results and outputs of the theoretical modelling.

PLDC has also, where relevant to the Stage 2 WMP, considered the recommendations of a number of previously commissioned studies which detail highly technical component parts of water bodies and aquatic plant ecology. The modelling work undertaken has also used contemporary eastern catchment and Hawkesbury Nepean River inflow data provided by Government and Sydney Water.

This Stage 2 Water Management Plan has been prepared in consultation with Government water agencies, NSW Department of Health, OSL and Department of Planning, Industry and Environment. A number of workshops were held during the Stage 2 Water Management Plan preparation period and progressive feedback from the analysis and modelling work was shared with the relevant stakeholders. This modelling completes a trial of interim bodies for a period of 10 years and effectively simulates final conditions including the redesigned Southern Wetlands system, demonstrating the Scheme design is fit for purpose and capable of achieving the desired water quality outcomes.

The Stage 2 Water Management Plan as submitted:

1) provides a robust and cost-effective management regime for the day to day operation of the Scheme to best achieve the end water uses defined in Schedule 7 of the Deed;
2) optimises the water quality objectives for the Scheme without the need for chemical intervention or frequent accessing of water from the Nepean River;
3) provides management options for the expected range of climatic conditions from dry to wet periods;
4) supports the hierarchy of lakes for recreational uses proposed in the approved Stage 1 Water Management Plan;
5) minimises ongoing capital and operational costs for the long term management and operation of the Scheme;
6) confirms the terrestrial and aquatic ecosystems as designed and constructed by PLDC as suitable to achieve the water end uses;
7) is consistent with the recommendations contained in the DIPNR Water Committee Report 2005; and
8) optimises the flexibility for recreational uses of the Scheme and allows a practical and cost effective staging of opening up the Scheme to public use.

The Stage 2 Water Management Plan also acknowledges that as a State Significant Site water licensing is required only for extraction of water from the Nepean River to fill the lakes and for ongoing "topping up" of the lakes. In 2019 PLDC applied for the relevant water access licence, Specific Purpose Access Licence (SPAL), to allow for initial filling of the lakes and is currently working on modification of the existing NRPP development consent to allow for its resizing and relocation.

The ongoing top up of the lakes from the NRPP is expected to be undertaken using existing Water Access Licences (3.3GL) to maintain operational levels. It is expected that most years will require up to the 3.3GL to offset evaporation.

This submission appends the relevant technical and analytical reports prepared by independent experts upon which the outcomes and recommendations contained in Stage 2 Water Management Plan have been arrived at by PLDC.

The Stage 2 Water Management Plan completes PLDC's requirements for lodgement under Condition 27 of DA4 and satisfies the conditions of the In-Principle Agreement between PLDC and DPIE.

11.2 RECOMMENDATIONS:

It is recommended that the Secretary of the Department of Planning, Industry & Environment approves and adopts this Stage 2 Water Management Plan.

It is further recommended that following specific recommendations be approved:

a) the Wildlife Lake and surrounding precinct continues to be managed as a core conservation zone - applying the maintenance principles of natural asset management;
b) consistent with the results of the water quality modelling and the importance of the terrestrial and aquatic ecology in achieving the ultimately desired Scheme water

objectives, the filling of the lakes system be completed as soon as practically possible;

c) the protocols for water management of SIRC and Eastern Lakes under the Eastern Lakes Operations Plan be implemented by SIRC and the water manager for recreational purposes;

d) Penrith City Council be urged by the State Government to immediately install the appropriate stormwater infrastructure connecting to existing Scheme infrastructure in the eastern catchment which has a direct impact on the quality of water inflows into the SIRC Lakes;

e) Penrith City Council be urged by the State Government to immediately impose relevant WSUD features as a condition in any consent issued by Council for development in the eastern catchment; and

f) Government, Scheme managers and operators agree to generally adopt the monitoring regime and operational programs contained in the Scheme-wide Lakes Operations Plan based on the contents of Section 10 of this submission.

12 REFERENCES

ANZECC 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines ALS 2009, Review of Aquatic Macrophyte Monitoring Program for the Penrith Lakes Scheme. Report prepared for the Penrith Lakes Scheme.

Ashbolt N. & Roser D. (2004). Review of Penrith Lakes Water Quality Monitoring Program. Public Health: Review of Historic Data and Proposed Risk Management based Monitoring Framework. Report prepared for the Penrith Lakes Development Corporation Ltd. Centre for Water and Waste Technology, The University of New South Wales.

Cardno (2013) Water Balance and Lake Operating Levels – Addendum Report. Report prepared for Penrith Lakes Development Corporation.

IEP. 2005, *Penrith Lakes Water Principles and Water Plan Peer Review Stage 1 & 2 Review*, Report by the Independent Expert Panel for Penrith Lakes Water Committee,

Nation (2014) Penrith Lakes Scheme – Hydrogeological Assessment. Report prepared for the Penrith Lakes Development Corporation.

National Health and Medical Research Council (2008) Guidelines for Managing Risks in Recreational Water, National Health and Medical Research Council of Australia, Canberra, ACT.

WBM BMT (2014) Penrith Lakes Schemes – Numerical Assessment of Thermal Stratification in Main Lake A. Report prepared for Penrith Lakes Development Corporation.

13 APPENDICIES

APPENDIX 1: WATER MANAGEMENT PLAN STAGE 1 (CARDNO, 2012)

APPENDIX 2: HYDROLOGICAL MODELLING OF RESIZED NRPP (BMT R.B23771.001.02, 2019)

APPENDIX 3: HYDROGEOLOGICAL ASSESSMENT (NATION PARTNERS, 2014)

APPENDIX 4: WATER QUALITY MODELLING REPORT (BMT R.B24088.001.02, 2020)

APPENDIX 5: WATER QUALITY MODEL CALIBRATION RESULTS (BMT M.B24088.001.PLS2012, 2019)

APPENDIX 6: SOUTHERN WETLANDS DESIGN REVIEW (E2 DESIGN LAB, VERSION 2, 2019)

APPENDIX 7: SOUTHERN WETLANDS INFRASTRUCTURE DRAWINGS (JWP 11008808CC01-23, 100-114, 200-212; 16880-S1-S8 A, 2019)

APPENDIX 8: LAKES OPERATIONS PLAN (PLDC, 2020)

APPENDIX 9: SOUTHERN WETLANDS PERMEABILITY (PSM 2541-286L REV1, 2019)

Appendix C Penrith Council Email Correspondence

Matthew Lester

From: Dean Dehghan-Khalaji <Dean.Dehghan-Khalaji@penrith.city>
Sent: Tuesday, 24 November 2020 10:39 AM
To: Michael Hodges
Cc: Dylan Baudinet; Matthew Lester; David Piccolo
Subject: RE: Nepean Business Park

Hi Michael,

After meeting with Council to come to a resolution of the drainage and road gradients due to multiple site constraints at the proposed Nepean Business Park. At this current time, Council's assessment of the gradients of the proposed stormwater system and roads detailed in the plans by Enspire P/L, drawing number SKET022 dated 11/11/2020 are satisfactory in concept.

Further assessment will be undertaken by Council, during the application process where a referral from the Department of Planning is required.

Regards,

Dean Dehghan-Khalaji
Senior Engineer - Major Developments

E Dean.Dehghan-Khalaji@penrith.city
T +612 4732 7453 | F | M +61 434 154 831
PO Box 60, PENRITH NSW 2751
www.visitpenrith.com.au
www.penrithcity.nsw.gov.au

PENRITH
CITY COUNCIL

Follow us

From: Michael Hodges <michael.hodges@enspiresolutions.com.au>
Sent: Monday, 23 November 2020 7:52 AM
To: Dean Dehghan-Khalaji <Dean.Dehghan-Khalaji@penrith.city>
Cc: Stephen Masters <stephen.masters@penrith.city>; Dylan Baudinet <dylan@precinctgroup.com.au>; Matthew Lester <Matthew.Lester@enspiresolutions.com.au>; David Piccolo <david.piccolo@psm.com.au>
Subject: RE: Nepean Business Park

Good Morning Dean,

I hope you had an enjoyable weekend.

Just wanted to make contact with you post the message I left last week to see how you are going with the letter endorsing the design principles associated with the Nepean Business Park development.

We would like to finalise the DA documents, but need to understand Council is O.K with the road and drainage gradients.

If you could give me a call on 0417 044 451 to discuss status, that would be appreciated.

Kind Regards

Michael Hodges
DIRECTOR

Mobile +61 417 044 451
Address 205 / 275 Alfred Street N, North Sydney NSW 2060
Email michael.hodges@enspiresolutions.com.au

From: Michael Hodges
Sent: Monday, 16 November 2020 10:08 AM
To: 'Dean Dehghan-Khalaji' <Dean.Dehghan-Khalaji@penrith.city>
Cc: Stephen Masters <stephen.masters@penrith.city>; Dylan Baudinet <dylan@precinctgroup.com.au>; Matthew Lester <Matthew.Lester@enspiresolutions.com.au>; David Piccolo <david.piccolo@psm.com.au>
Subject: RE: Nepean Business Park

Hi Dean,

Further to our discussion this morning, we understand you are aiming to have the review of the Nepean Business Park concept drainage and road grading finalised this week along with a letter endorsing the design principles issued by the end of the week.

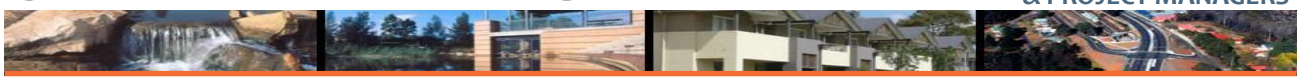
Thanks for your assistance with this matter. Should you have any questions regarding the concept design, please don't hesitate to contact Matthew or myself.

Kind Regards

Michael Hodges
DIRECTOR

Mobile +61 417 044 451
Address 205 / 275 Alfred Street N, North Sydney NSW 2060
Email michael.hodges@enspiresolutions.com.au

Appendix D JWP On-site Stormwater Detention and Stormwater Quality Assessment



ABN 67 002 318 621

Our Ref: 110088-8-OSD and WQ Certification letter.docx

28 July 2020

Penrith Lakes Corporation
PO Box 457
CRANEBROOK NSW 2749

Attn: Arthur Ashburn

Subject: PLDC Southern Wetland;
On-site Stormwater Detention and Stormwater Quality Assessment.

Dear Arthur

This letter has been prepared to investigate the stormwater quality and quantity management provided within the proposed Southern Wetland Cells A, B and C which will be constructed to support Penrith Lakes Employment Lands development located at 14 – 98 Old Castlereagh Road, Castlereagh.

As agreed, we have specifically addressed the items raised in your email dated 15 July 2020 and subsequent discussions. For the purposes of this letter, the "Employment Lands" are understood to comprise 14 – 98 Old Castlereagh Road, Castlereagh, formally identified as Lots 1-3 of DP 1263486.

As the details of the proposed Employment Lands development are uncertain at the time of writing this letter, we have undertaken two (2) scenarios which reflect full development potential of the Employment Lands:

1. Full industrial development (90% impervious) of the land with Gross Pollutant Traps (GPTs) prior to further stormwater management provided in the Southern Wetlands; and
2. Full industrial development of the land with GPTs, with 15% of the developed catchment bypassing the Southern Wetlands treatment.

The Wetlands Cells A, B and C are to be located at 100 - 278 Old Castlereagh Road, Castlereagh, specifically Lots 302 – 307 and 325 of DP 752021 and Lot 1 of DP 45727, and this letter should be read in conjunction with the following engineering drawings which document the construction of the proposed Southern wetlands:

- J. Wyndham Prince Engineering Drawing set 11008808/CC01 to CC23 (Individual sheet revisions as per the drawing index on drawing CC02 (Rev I Dated 24/07/2020);
- J. Wyndham Prince Engineering Drawing set 11008808/CC100 to CC114 (Individual sheet revisions as per the drawing index on drawing CC101 (Rev C Dated 16/08/2019).

Plate 1 below provides an overview of the development site together with the proposed treatment location.

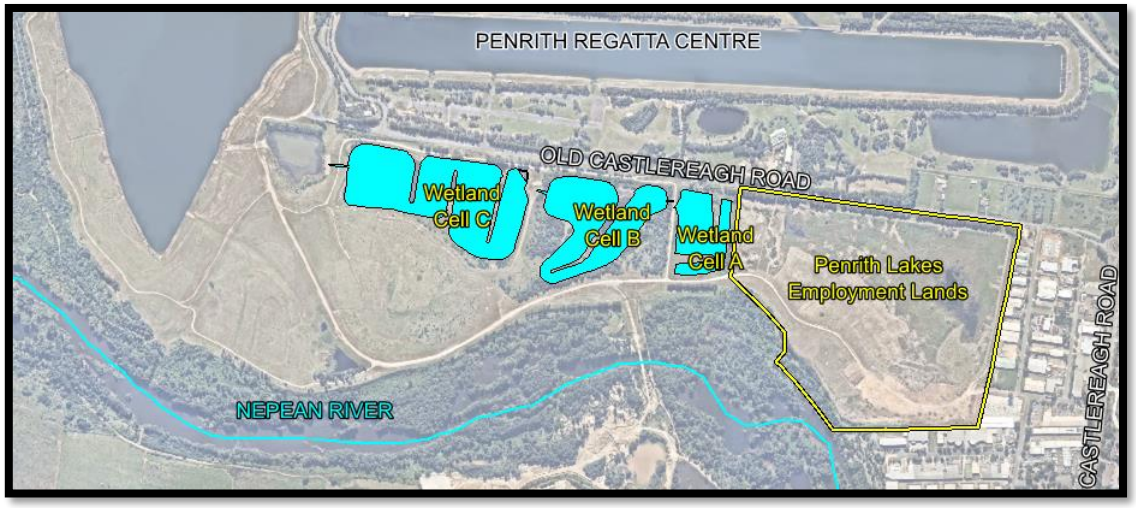


Plate 1 – Site Locality

1. BACKGROUND

J. Wyndham Prince undertook a "high level" stormwater review of the site on 5 September 2018. The investigation concluded that the very eastern portion of the site falls within an area requiring OSD under Penrith City Council's *Stormwater Drainage Guideline for Building Developments* (May, 2018). For this portion of the land that required OSD (approx. 5 ha of the site), it was determined from Council's guideline that approximately 1,400 m³ of storage would be required, however, it is noted that this simplified calculation only relates to sites up to 5000 m². Given the proximity to the Nepean River, the review noted that an argument for no OSD could be supported. However, it was recommended that this should be discussed with Council as part of the DA process.

In the scenario that OSD is required for the site, a hydrologic investigation to confirm that post development peak discharges from the site for storms up to the 1% AEP event (100 year ARI) are no greater than existing conditions has been undertaken.

Stormwater quality modelling was also undertaken to demonstrate that the stormwater quality management system proposed downstream of the Employment Lands development will result in reductions in overall post-development pollutant loads that comply with the Penrith City Council's target objectives.

2. HYDROLOGIC MODELLING

The hydrologic analysis from this study was undertaken using the rainfall – runoff flood routing model XP-RAFTS version 2018.1 (Runoff and Flow Training Simulation with XP Graphical Interface). XP-RAFTS is a non-linear runoff routing model that generates runoff hydrographs from rainfall data. The objective of the hydrologic analysis was to confirm that the design detention storage available in Southern Wetland Cells A, B and C to the west of the site is sufficient to restrict peak post-development flows to at or below existing flows for the site.

The modelling was undertaken using both the Australian Rainfall & Runoff (AR&R) 1987 and 2019 methodologies. It should be noted that the 1987 methods are no longer supported, however, some Councils still require the 1987 methods to be undertaken for comparison purposes.

Plate 2 provides an overview of the existing catchment areas considered in the modelling and the existing conditions XP-RAFTS model layout is shown in Plate 3.

Plate 2 – Existing Conditions Catchment Plan

The modelling accounts for the entire Employment Lands site and the adjacent Southern Wetland Cells A, B and C and their respective catchments.

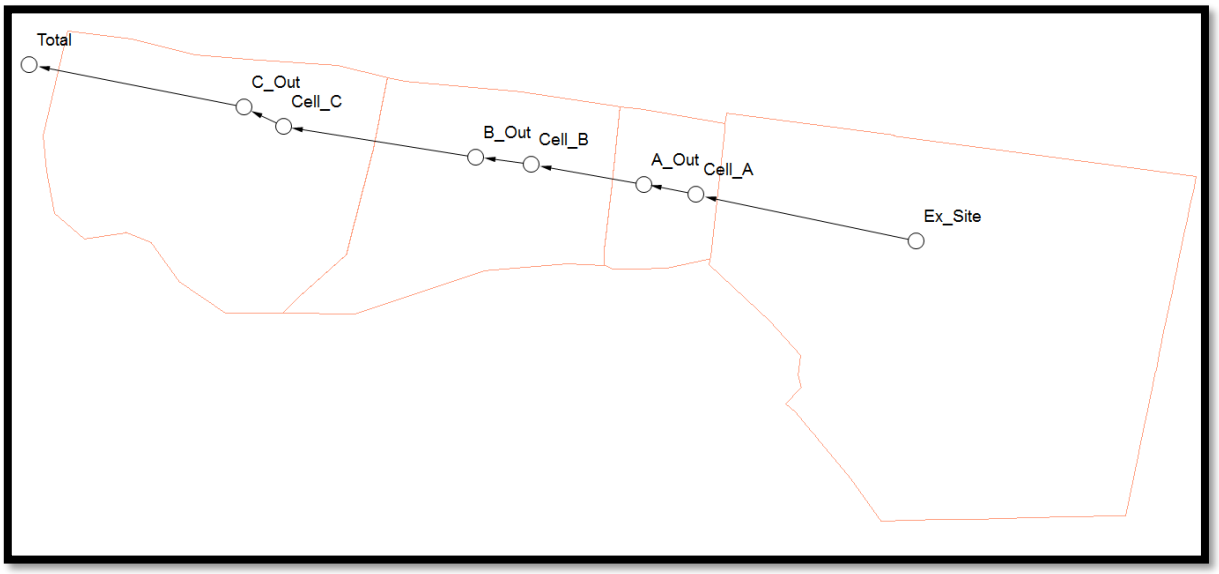


Plate 3 – Existing Conditions XP-RAFTS model layout (Ex_002.xp)

Similarly, the developed conditions catchment plan is shown in Plate 4 and the developed conditions XP-RAFTS model layout shown in Plate 5.

Plate 4 – Developed Conditions Catchment Plan

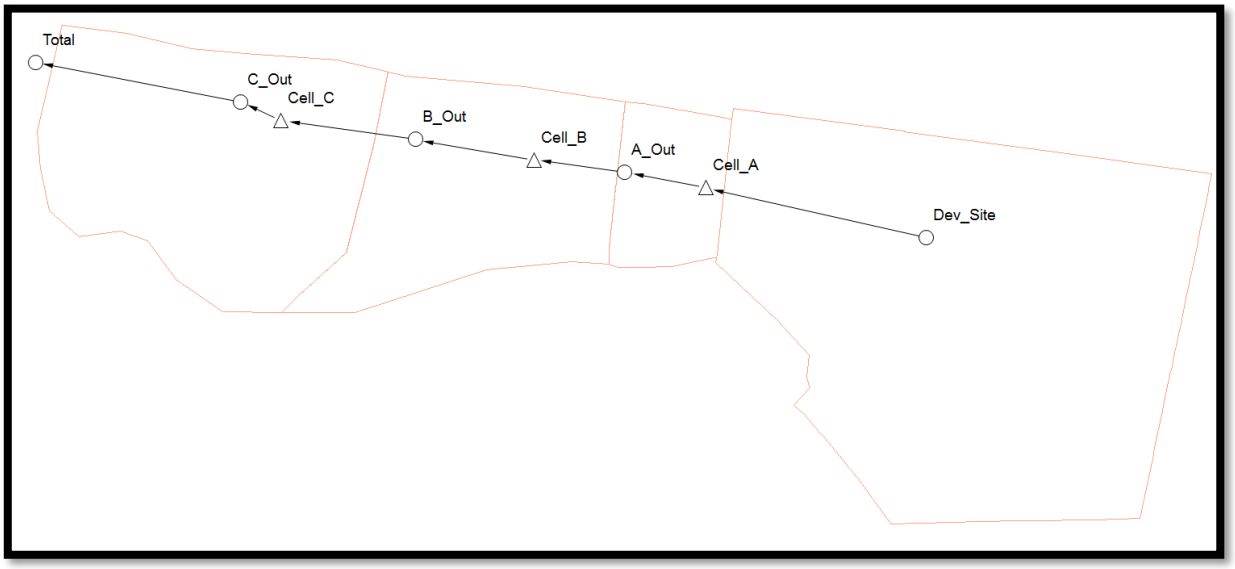


Plate 5 – Developed Conditions XP-RAFTS Model Layout No Bypass (Dev_005.xp)

We have also considered a scenario where up to 15% of the employment lands bypasses the OSD, which is the maximum allowable under Penrith City Council's *Stormwater Drainage Guideline for Building Developments* (May, 2018). Plate 6 provides an overview of the XP-RAFTS model layout with 15% bypass considered.

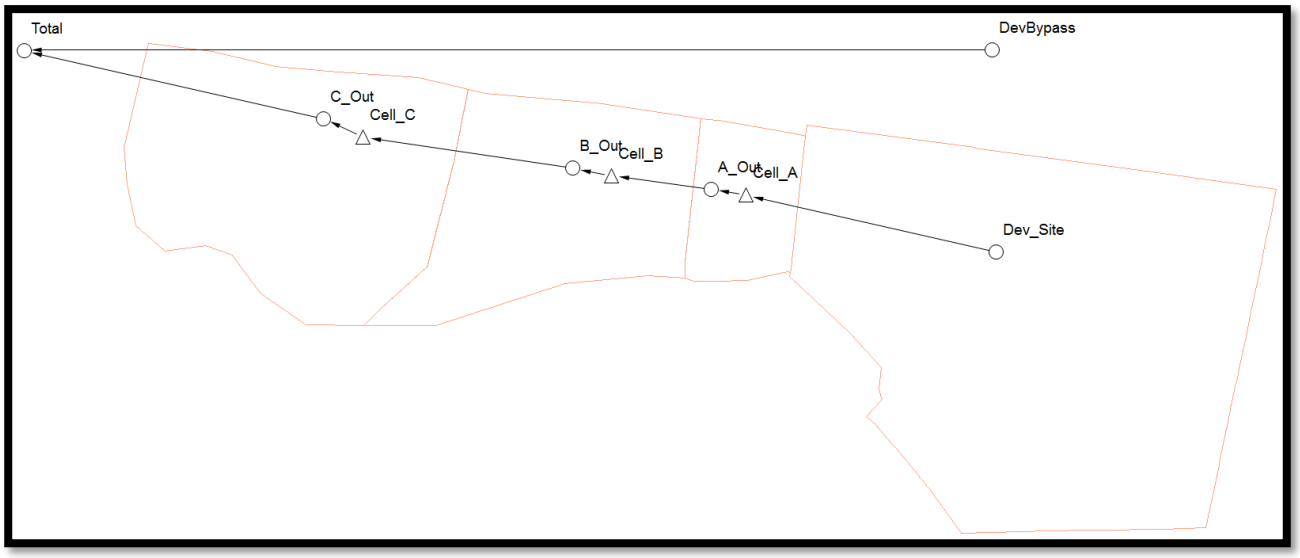


Plate 6 – Developed Conditions XP-RAFTS Model Layout 15% Bypass (Dev_004.xp)

The OSD storage available above the overflow weir of Wetland Cells A, B and C has been extracted from the 12d design surface of the wetlands, and only utilises the storage available above the respective Permanent Water Levels (PWL):

- Cell A PWL = 24.40 m AHD
- Cell B PWL = 24.35 m AHD
- Cell C PWL = 22.35 m AHD

It is assumed that the sluice gate for wetland maintenance is normally closed and all flows during storm events are directed to the overflow weirs only. The trapezoidal weir arrangements shown on engineering drawings 1100808/CC106 (Cell A), CC107 (Cell B) and CC111 (Cell C) have been reflected as a stage/discharge curve in the hydrologic model.

The XP-RAFTS model was run for all storm durations from 10 minutes to 24 hours to determine the peak discharge from the site for both existing and developed conditions.

The results for the AR&R 1987 methods are presented in Table 1.

Table 1 – Peak Flow Comparison (AR&R 1987 Methodology)

Event	No Bypass			15% Bypass		
	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex
0.5 EY	4.83	2.27	0.47	4.83	2.22	0.46
20% AEP	7.04	3.49	0.50	7.04	3.29	0.47
10% AEP	8.31	4.24	0.51	8.31	4.02	0.48
5% AEP	10.25	5.36	0.52	10.25	4.99	0.49
1% AEP	14.68	7.67	0.52	14.68	7.18	0.49

Table 2 provides an overview of the detention performance under the AR&R 1987 methods. The results indicate that flow depth of between 230 mm to 570 mm would occur through the overflow spillways, depending on the amount of development bypassing the OSD system.

Table 2 – OSD Performance (AR&R 1987 Methodology)

Event	No Bypass					15% Bypass				
	Peak Inflow (m3/s)	Peak Outflow (m3/s)	Peak Active Storage Used (m3)	OSD Stage (RL m)	OSD Depth (m)	Peak Inflow (m3/s)	Peak Outflow (m3/s)	Peak Active Storage Used (m3)	OSD Stage (RL m)	OSD Depth (m)
Cell A										
50% AEP	12.50	2.65	13087	24.73	0.33	10.76	2.19	11827	24.70	0.30
20% AEP	16.29	3.63	15650	24.79	0.39	14.05	3.09	14230	24.75	0.35
10% AEP	18.58	4.28	17088	24.82	0.42	16.03	3.58	15513	24.78	0.38
5% AEP	21.62	5.30	19201	24.87	0.47	18.65	4.32	17169	24.82	0.42
1% AEP	26.54	7.41	22957	24.96	0.56	22.89	6.02	20625	24.91	0.51
Cell B										
50% AEP	3.45	2.01	18822	24.61	0.25	3.01	1.71	17128	24.58	0.23
20% AEP	4.74	3.07	23220	24.66	0.31	4.20	2.61	21331	24.64	0.29
10% AEP	5.52	3.67	25706	24.70	0.35	4.86	3.17	23627	24.67	0.32
5% AEP	6.86	4.61	28663	24.73	0.38	5.86	3.90	26500	24.71	0.36
1% AEP	9.84	6.44	34151	24.81	0.45	8.36	5.58	31646	24.77	0.42
Cell C										
50% AEP	2.51	2.27	11073	22.65	0.30	2.28	2.04	10441	22.63	0.28
20% AEP	3.87	3.49	14124	22.73	0.38	3.40	3.05	13188	22.70	0.35
10% AEP	4.66	4.24	15707	22.77	0.42	4.41	3.76	14695	22.74	0.39
5% AEP	5.83	5.36	17840	22.83	0.48	5.10	4.67	16608	22.79	0.44
1% AEP	8.14	7.67	21589	22.92	0.57	7.29	6.82	20315	22.89	0.54

As discussed earlier, the AR&R 1987 methods have been superseded by new research and modelling approaches, however, the detention requirements can be achieved using this approach. We have then used the same hydrologic model setup and assessed the detention management achieved using AR&R 2019 methodologies.

A peak flow comparison presented in Table 3 reflects the results using the AR&R 2019 methodology.

Table 3 – Peak Flow Comparison (AR&R 2019 Methodology)

Event	No Bypass			15% Bypass		
	Ex	Dev	Dev/Ex	Ex	Dev	Dev/Ex
50% AEP	2.00	1.01	0.50	2.00	1.58	0.79
20% AEP	2.95	1.85	0.63	2.95	2.23	0.76
10% AEP	3.95	2.52	0.64	3.95	2.67	0.68
5% AEP	5.15	3.32	0.64	5.15	3.15	0.61
1% AEP	8.44	6.97	0.83	8.44	5.02	0.59

The difference in flow estimates between the AR&R 1987 and AR&R 2019 methodologies is significant, however, both methods indicate similar flow depths are anticipated at the overflow weir from all the Southern Wetland cells. The differences are predominantly related to adopted rainfall depths, temporal patterns and initial and continuing losses (AR&R 2019 is significantly higher) between the two (2) hydrologic methods.

Table 4 provides an overview of the detention performance under this scenario. The results indicate that flow depths of between 170 mm to 570 mm would occur through the weir outlet, depending on the amount of development bypassing the OSD system.

Table 4 – OSD Performance (AR&R 2019 Methodology)

Event	No Bypass					15% Bypass				
	Peak Inflow (m3/s)	Peak Outflow (m3/s)	Peak Active Storage Used (m3)	OSD Stage (RL m)	OSD Depth (m)	Peak Inflow (m3/s)	Peak Outflow (m3/s)	Peak Active Storage Used (m3)	OSD Stage (RL m)	OSD Depth (m)
Cell A										
50% AEP	12.85	1.99	11101	24.68	0.28	11.07	1.60	9734	24.64	0.24
20% AEP	18.52	3.20	14524	24.76	0.36	16.00	2.55	12821	24.72	0.32
10% AEP	23.06	4.26	17052	24.82	0.42	19.94	3.53	15388	24.78	0.38
5% AEP	27.18	5.30	19192	24.87	0.47	23.47	4.43	17397	24.83	0.43
1% AEP	38.14	7.66	23378	24.97	0.57	32.83	6.16	20855	24.91	0.51
Cell B										
50% AEP	2.34	1.21	13966	24.54	0.19	2.22	1.01	12709	24.52	0.17
20% AEP	3.43	2.10	19168	24.61	0.26	3.17	1.79	17609	24.59	0.24
10% AEP	5.52	3.14	23505	24.67	0.32	4.80	2.71	21729	24.64	0.29
5% AEP	7.00	3.92	26556	24.71	0.36	6.09	3.38	24494	24.68	0.33
1% AEP	9.04	5.93	32710	24.79	0.44	7.75	5.16	30353	24.76	0.41
Cell C										
50% AEP	1.53	1.24	7771	22.56	0.21	1.34	1.10	7214	22.55	0.20
20% AEP	2.79	2.39	11391	22.66	0.31	2.56	2.12	10653	22.64	0.29
10% AEP	4.25	3.58	14301	22.73	0.38	3.88	3.20	13496	22.71	0.36
5% AEP	5.26	4.47	16181	22.78	0.43	4.84	4.03	15253	22.76	0.41
1% AEP	7.70	6.97	20579	22.90	0.55	6.98	6.25	19344	22.87	0.51

Both the AR&R 1987 and AR&R 2019 methods indicate that the OSD storage and outlet arrangements within proposed Wetland Cells A, B & C downstream of the Employment Lands will ensure that post development flows are no greater than existing conditions flows for all events up to the 1% AEP.

3. WATER QUALITY MODELLING

The stormwater quality analysis for the employment land was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). This water quality modelling software was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology, which is based at Monash University and was first released in July 2002. Version 6.3.0 and MUSIC-link data version 6.32 was adopted for this study.

The model provides a number of features relevant for the development including the potential nutrient reduction benefits of pond and wetland treatment train approaches as well as more traditional Gross Pollutant Traps and Bio-retention raingardens if required. It also provides mechanisms to evaluate the attainment of water quality objectives.

Penrith City Council's Water Sensitive Urban Design (WSUD) Policy (PCC, 2013) requires the following Pollution reduction targets to be achieved for this development:

- 90% Gross Pollutants
- 85% Total Suspended Solids (TSS)
- 60% Total Phosphorous (TP)
- 45% Total Nitrogen (TN)

Council's WSUD Policy (PCC, 2013) also requires that the duration of developed conditions stream forming flows are not greater than 3.5 times the duration of existing conditions streaming flows. This assessment is known as the Stream Erosion Index (SEI).

The MUSIC modelling was undertaken to demonstrate that the stormwater management system proposed for the Employment Lands development will comply with Council's WSUD Policy.

3.1. Catchments

A MUSIC model was prepared to reflect the proposed development, together with the treatment train. The model considers all catchments discharging to the wetlands. A MUSIC Catchment Plan is provided in Plate 7.

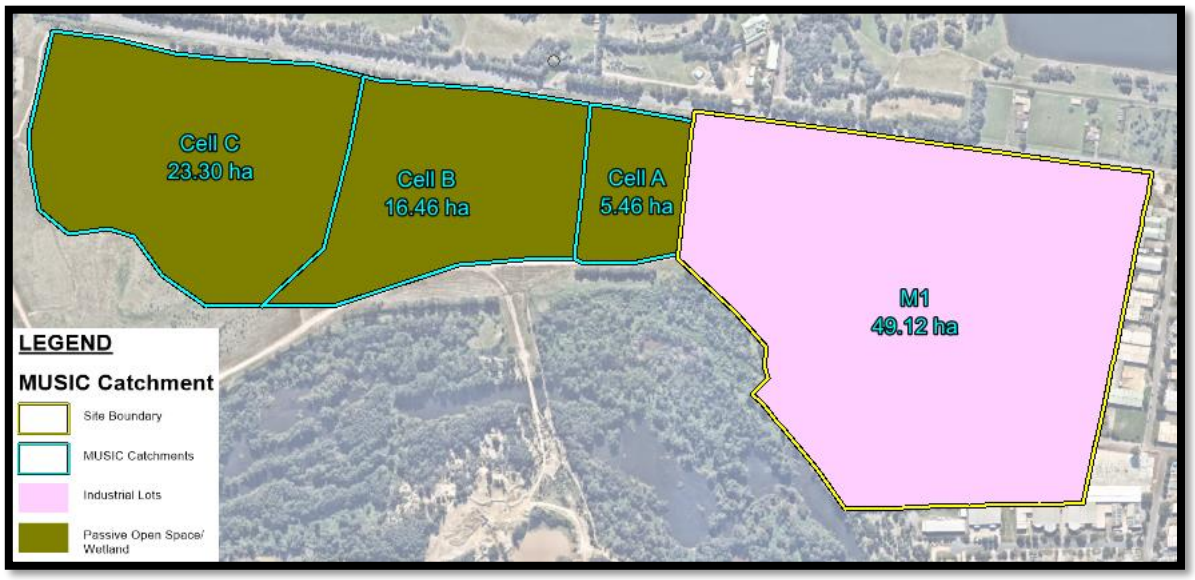


Plate 7 – MUSIC Catchment Plan

Plate 8 provides an overview of the MUSIC model arrangement.

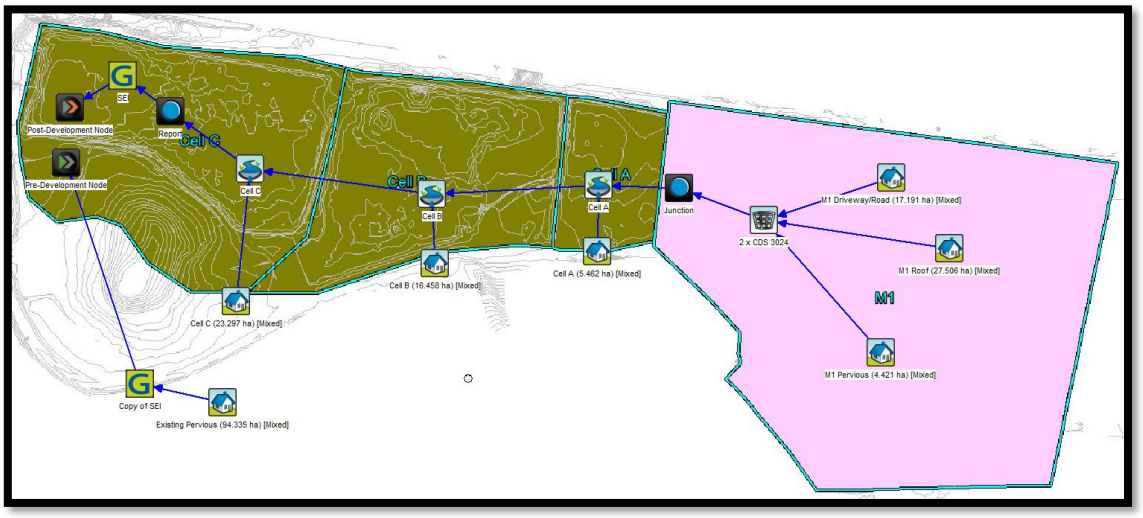


Plate 8 – MUSIC Model Arrangement No Bypass (110088-08_MU5.sqz)

The following catchment assumptions were adopted in the MUSIC model:

- Road Reserve = 20% of the Employment land Catchment (M1)
- Industrial lots = 80% of the Employment land Catchment (M1)
- Industrial Lots = 90% Impervious which comprises:
  - 70% Roof
  - 20% Driveway/Carpark
  - 10% Landscape
- Landscaped Area = 0% impervious
- Road reserve = 95% Impervious
- Wetlands = 100% impervious for the permanent pool, 0% for areas outside the permanent pool. Details of the pond parameters are provided in Section 3.2.

Consistent with the hydrologic modelling, a scenario with up to 15% of the Employment Lands catchment bypassing the wetlands treatment has also been modelled. Plate 9 provides an overview of the MUSIC model arrangement for this scenario. It should be noted that to achieve the stormwater pollution targets for this scenario, a GPT was still required on the bypassing catchment. It may be possible for a small amount of road to bypass treatment completely (i.e. without a GPT), however this would need to be proven up with detailed modelling based on the Employment Lands development design information once it is known.

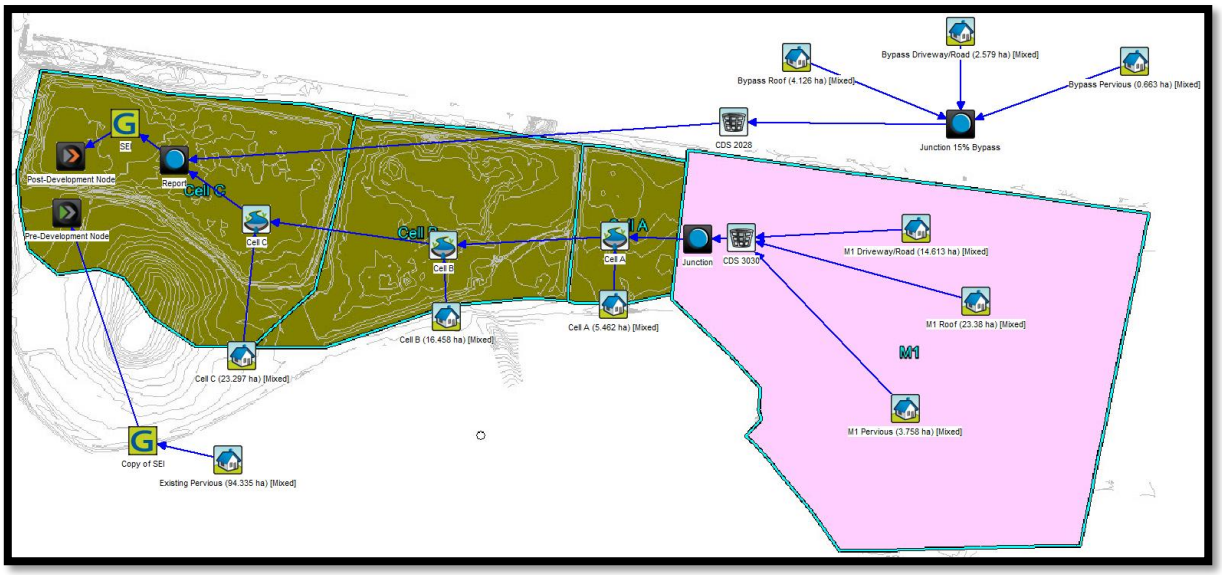


Plate 9 – MUSIC Model Arrangement 15% Bypass (110088-08_MU4.sqz)

The proposed wetlands are documented in J. Wyndham Prince Engineering Drawing set 11008808/CC01 to CC23 and Engineering Drawing set 11008808/CC100 to CC114. The wetland planting density & configuration is unknown at this stage, and therefore we have conservatively modelled the proposed wetlands as ponds only (i.e. no nutrient removal via vegetation) within the MUSIC model.

3.2. Treatment Train

Details of the treatment measures used in this assessment are provided below.

- Vortex style Gross Pollutant Traps with the performance criteria outlined in Table 5.

Table 5 – GPT Performance Criteria

Parameter	No Bypass Catchment	15% Bypass Catchment	
	M1	M1	Bypass
Low Flow Bypass (m^3/s)	0	0	0
High Flow Bypass (m^3/s)	2.5	1.75	0.8
Gross Pollutants (kg/ML)			
Input	**Output**		
0	0		
100	2		
TSS (mg/L)			
Input	**Output**		
0	0		
75	75		
1000	300		
TP (mg/L)			
Input	**Output**		
0	0		
0.5	0.5		
10	7		
TN (mg/L)			
Input	**Output**		
0	0		
50	50		

- Three (3) cascading wetlands as documented on J. Wyndham Prince Engineering Drawing set 11008808/CC01 to CC23 and Engineering Drawing set 11008808/CC100 to CC114 have been conservatively modelled as ponds (i.e. no planting). Table 6 provides details of the pond parameters adopted in the MUSIC modelling.

Table 6 – Pond Parameters

Parameter	Cell A	Cell B	Cell C
Low Flow Bypass (m^3/s)	0	0	0
High Flow Bypass (m^3/s)	100	100	100
Surface Area (m^2)	39121	72377	36597
Permanent Pond Volume (m^3)	34886	55535	12576
Initial Volume (m^3)	34886	55535	12576
Exfiltration Rate (mm/hr)	0	0	0
Evaporative Loss as % PET	75	75	75
Pipe Outflow (Custom weir outlet) - eng. Dw. Ref.	11008808/CC06 (Rev . F)	11008808/CC108 (Rev . B)	11008808/CC112 (Rev . B)

3.3. Pollutant Load Estimates

Total annual pollutant load estimates were derived from the results of the MUSIC model based on a 'stochastic' assessment of the developed site incorporating the proposed water quality treatment system. Table 7 details the results of the assessment.

Table 7 – Summary of Estimate Mean Annual Pollutant Loads and Reductions

Pollutant	Total Developed Source Nodes	Minimum Reduction Required	Total Residual Load from Site	Total Reduction Achieved	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)	(%)	(%)
No Bypass						
TSS	51900	44115	3290	48610	85.0%	93.7%
TP	97.7	58.6	23.8	73.9	60.0%	75.6%
TN	834	375	298	536	45.0%	64.3%
Gross Pollutants	11100	9990	0	11100	90.0%	100.0%
15% Bypass						
TSS	52600	44710	6900	45700	85.0%	86.9%
TP	97.4	58.4	31.7	65.7	60.0%	67.5%
TN	839	378	339	500	45.0%	59.6%
Gross Pollutants	11100	9990	31.3	11069	90.0%	99.7%

The results in Table 7 indicate that Penrith City Council's pollution reduction targets are comfortably met.

3.4. Stream Erosion Index

The methodology to determine the SEI complies with the NSW MUSIC Modelling Guide (BMTWBM, 2015). The node used to represent the site under existing conditions was a 0% impervious urban node.

Details of the determination of the critical flow for the SEI assessment are provided in Table 8 below SEI results are provided in Table 9.

Table 8 – SEI Critical Flow Determination

Assessment Location	Determination of Critical Flow						
	Area (km^2)	$t_c = 0.76A^{0.38}$ (hour)	t_c (minutes)	I_2 (mm/hr)	C_2	Q_2 (m^3/s)	Q_{crit} (m^3/s)
Wetland C Discharge Location	0.943	0.74	45	34.7	0.72	6.55	3.28

Table 9 – SEI Results

Scenario	Stream Erosion Index		
	Pre Dev Outflow (ML/yr)	Post Dev Outflow (ML/yr)	SEI
No Bypass	14.3	30.3	2.12
15% Bypass	14.3	29.5	2.06

Results indicate that the SEI for the proposed development is 2.1 for both the no bypass and 15% bypass scenarios, which is below the maximum allowable target of 3.5. The provision of WSUD elements within the development (GPTs), together with the downstream wetlands will assist in minimising the impact of urbanisation on the waterway stability of the receiving watercourse.

3.5. Sediment and Erosion Management

To protect the wetlands from sediment load, the Employment Lands development will need to ensure appropriate sediment and erosion control management practices in accordance with the requirements of Council and the guidelines set out by Landcom (the "Blue Book" 2004) are implemented during construction until the catchment is fully developed or stable.

3.6. Employment Lands Discharge Level

A maximum RL of 24.5 m at the western boundary of the Employment Land has been allowed for in this assessment. While 11008808/CC01 to CC23 indicate the location of the proposed channel, the final location can be anywhere along the western boundary as part of the final Employment Land design, but must consider the potential tailwater impact that the OSD provided by Cell A will have on the internal drainage design of the Employment Lands.

4. CONCLUSION

This letter has been prepared to confirm the performance of the stormwater quality and quality management provided within Southern Wetland Cells A, B and C which is proposed to service the expected runoff from Penrith Lakes Employment Lands development located at 14 – 98 Old Castlereagh Road, Castlereagh.

As the details of the proposed Employment Lands development are uncertain, we have considered full development of the Employment Lands with GPTs prior to discharge to the Southern Wetlands and a separate assessment of up to 15% of the development bypassing the Southern Wetlands.

Given the proximity to the Penrith Lakes Scheme to the Nepean River, as detailed in our previous advice (JWP, 2018) OSD for the site should not be required. However, based on the available information and the assessment presented above using the current industry best practice, construction of Southern Wetland Cell A, B and C in accordance with engineering drawings listed above will ensure that post development flows are no greater than pre-development flows for all events up to and including the 1% AEP event, even with up to 15% of the Employment Lands bypassing both the quality and quantity management that these wetlands will provide.

Our investigation has also confirmed that the proposed wetland Cells A, B and C, once constructed in accordance with the plans listed above, will ensure that Penrith City Council's WSUD policy objectives are achieved, even with up to 15% of the Employment Lands development bypassing the wetland stormwater management system. It should be noted that GPTs need to be provided to all catchments (including bypassing catchments) to ensure that Council's statutory pollutant load objectives are achieved. If the detailed design of the Employment Lands results in bypass catchment that cannot be treated via a GPT, other treatment measures such as pit filter inserts or a refined assessment will need to be considered to ensure Penrith City Council's stormwater quality objectives are met.

We recommend that during the Employment Lands construction phase, soil and erosion management practices in accordance with the requirements of Council and the guidelines set out by Landcom (the "Blue Book" 2004) are implemented to protect the Southern Wetlands from sediment load.

This assessment is only suitable to support the development of the Penrith Lake employment Lands development together with the associated stormwater management devices and does not assess any potential impact that this development may have on the wider Penrith Lakes scheme.

Yours faithfully,

David Crompton
BEng (Civil) MIEAust NER

Appendix E Additional Reports

28 September 2021

ENSPIRE SOLUTIONS
ABN 71 624 801 690

ENGINEERING
LAND DEVELOPMENT
PROJECT MANAGEMENT

1302/83 Mount Street
North Sydney
NSW 2060
Australia

Mills Oakley
Attention: Clare Collett
Level 7, 151 Clarence Street
Sydney NSW 2000

Dear Clare,

RE: NEPEAN BUSINESS PARK PUBLIC UTILITY INFRASTRUCTURE

We refer to the below extract of clause 35 of the Penrith Lakes SEPP.

> ***35 Public utility infrastructure***
> *(1) Development consent must not be granted for development on land in an urban release area*
> *unless the consent authority is satisfied that any public utility infrastructure that is essential for*
> *the proposed development is available or that adequate arrangements have been made to make*
> *that infrastructure available when it is required.*
> *(2) This clause does not apply to development for the purpose of providing, extending, augmenting,*
> *maintaining or repairing any public utility infrastructure.*
> *(3) In this clause—*
> ***public utility infrastructure**, in relation to an urban release area, includes infrastructure for any*
> *of the following—*
> *(a) the supply of water,*
> *(b) the supply of electricity,*
> *(c) the disposal and management of sewage.*

We confirm that public utility infrastructure that is essential for the development is available as outlined below.

The Supply of Water

Please refer to the letter Sydney Water response to the public exhibition for DA 9876 (**attachment 1**). This letter confirms that drinking water is available to the property and the Sydney Water network will need to be extended service the development. Please refer to Enspire Solutions plan 200044-DA-C12.01 (**attachment 2**) which shows the extension and connection points.

The Supply of Electricity

Please refer to the letter from Power Solutions regarding the supply of electricity (**attachment 3**). There is high and low voltage power available in Lugard Street, Leland Street and Old Castlereagh Road. Electricity connection points are shown on Enspire Solutions plan 200044-DA-C12.01 (**attachment 2**). Approximately 6 to 7 padmount substations may be required throughout the subdivision. The supply requirements will vary depending on the final users within the estate and it is not anticipated that there will be major upstream electricity supply work required. On approval of the subdivision application an application can be made with Endeavour Energy to supply the first stage of the development.

The Disposal and Management of Sewage

Please refer to the letter Sydney Water response to the public exhibition for DA 9876 (**attachment 1**). This letter confirms that the sewer lead in mains to service the proposed development has been lodged with Sydney Water in accordance with their reference CN 185877. These works have since been approved by Sydney Water and Dexcon Civil has been awarded the contract. The lead in sewer works are anticipated to be completed in 2021. Please refer to Enspire Solutions plan 200044-DA-C12.01 (**attachment 2**) which shows the extension and connection points. Please also refer to the Sydney Water sewer lead plans (**attachment 4**)

Please do not hesitate to contact me if you require any further information.

Sincerely

Andrew Dawes
Director
For Enspire
andrew.dawes@enspiresolutions.com.au

Enc.

1. Sydney Water letter dated 26 August 2021
2. Enspire Solutions plan 200044-DA-C12.01
3. Letter from Power Solutions
4. Sydney Water sewer lead in plans

26 August 2021 Our Ref: 185877, 178834

Michelle Niles
A/Team Leader, Alpine Resorts Team
Planning & Assessment
michelle.niles@planning.nsw.gov.au

RE: Development Application DA 9876 at 14-278 Old Castlereagh Road, Castlereagh (Penrith Lakes Employment Lands Subdivision and Works)

Thank you for notifying Sydney Water of DA 9876 at 14-278 Old Castlereagh Road, Castlereagh, which proposes the staged Torrens title subdivision of three existing lots into 93 lots and 4 residual lots, earthworks to achieve the final site levels, construction of internal roads, footpaths, shared pathways and infrastructure, landscaping works and business identification signage. The development will occur over 13 stages. The majority of the site is zoned 'Employment' under the Penrith Lakes SEPP and it is intended for the site to deliver predominantly a light industrial estate. Sydney Water has reviewed the application based on the information supplied and provides the following comments to assist in planning the servicing needs of the proposed development.

Water Servicing

- Drinking water is currently unavailable to this property.
- Extensions of Sydney Water assets will be required to service the development.

Wastewater Servicing

- The Applicant has lodged an Adjustment and Deviation case with Sydney Water for the construction of sewer lead in mains to service the proposed development, under CN 185877. The Applicant will need to comply with any current or future requirements set out under CN 185877.

This advice is not formal approval of our servicing requirements. Detailed requirements, including any potential extensions or amplifications, will be provided once the development is referred to Sydney Water for a Section 73 application. More information about the Section 73 application process is available on our web page in the Land Development Manual.

Further advice and requirements for this proposal are in Attachment 1. If you require any further information, please contact the Growth Planning Team at urbangrowth@sydneywater.com.au.

Yours sincerely,

Kristine Leitch
Commercial Growth Manager
City Growth and Development, Business Development Group
Sydney Water, 1 Smith Street, Parramatta NSW 2150

Attachment 1

Sydney Water Servicing

A Section 73 Compliance Certificate under the Sydney Water Act 1994 must be obtained from Sydney Water.

The proponent is advised to make an early application for the certificate, as there may be water and wastewater pipes to be built that can take some time. This can also impact on other services and buildings, driveways or landscape designs.

Applications must be made through an authorised Water Servicing Coordinator. For help either visit www.sydneywater.com.au > Plumbing, building and developing > Developing > Land development or telephone 13 20 92.

Building Plan Approval

The approved plans must be submitted to the Sydney Water Tap in™ online service to determine whether the development will affect any Sydney Water sewer or water main, stormwater drains and/or easement, and if further requirements need to be met.

The Tap in™ service provides 24/7 access to a range of services, including:

- building plan approvals
- connection and disconnection approvals
- diagrams
- trade waste approvals
- pressure information
- water meter installations
- pressure boosting and pump approvals
- changes to an existing service or asset, e.g. relocating or moving an asset.

Sydney Water's Tap in™ online service is available at: https://www.sydneywater.com.au/SW/plumbing-building-developing/building/sydney-water-tap-in/index.htm

Sydney Water recommends developers apply for Building Plan approval early as in some instances the initial assessment will identify that an Out of Scope Building Plan Approval will be required.

Out of Scope Building Plan Approval

Sydney Water will need to undertake a detailed review of building plans:

1. That affect or are likely to affect any of the following:
    - Wastewater pipes larger than 300mm in size
    - Pressure wastewater pipes
    - Drinking water or recycled water pipes
    - Our property boundary
    - An easement in our favour
    - Stormwater infrastructure within 10m of the property boundary.

2. Where the building plan includes:
    - Construction of a retaining wall over, or within the zone of influence of our assets
    - Excavation of a basement or building over, or adjacent to, one of our assets
    - Dewatering – removing water from solid material or soil.

The detailed review is to ensure that:

- our assets will not be damaged during, or because of the construction of the development
- we can access our assets for operation and maintenance
- your building will be protected if we need to work on our assets in the future.

The developer will be required to pay Sydney Water for the costs associated with the detailed review.

PENRITH LAKES REGIONAL PARK

CONNECT TO EXISTING ELECTRICAL INFRASTRUCTURE IN OLD CASTLEREAGH ROAD.

CONNECT TO EXISTING WATER INFRASTRUCTURE IN OLD CASTLEREAGH ROAD.

CONNECT TO EXISTING SEWER INFRASTRUCTURE, REFER SYDNEY WATER DESIGN DRAWINGS 1 TO 3 CASE No.185877WW.

OLD CASTLEREAGH ROAD

WETLANDS

ROAD 1

ROAD 2

ROAD 3

EXISTING DEVELOPMENT

STREET

LELAND STREET

LUGARD STREET

CONNECT TO EXISTING SEWER INFRASTRUCTURE, REFER SYDNEY WATER DESIGN DRAWINGS 1 TO 3 CASE No.185877WW.

CONNECT TO EXISTING ELECTRICAL INFRASTRUCTURE IN LUGARD STREET.

CONNECT TO EXISTING WATER INFRASTRUCTURE IN LUGARD STREET.

EXISTING DEVELOPMENT

NEPEAN RIVER

CASSOLA PLACE

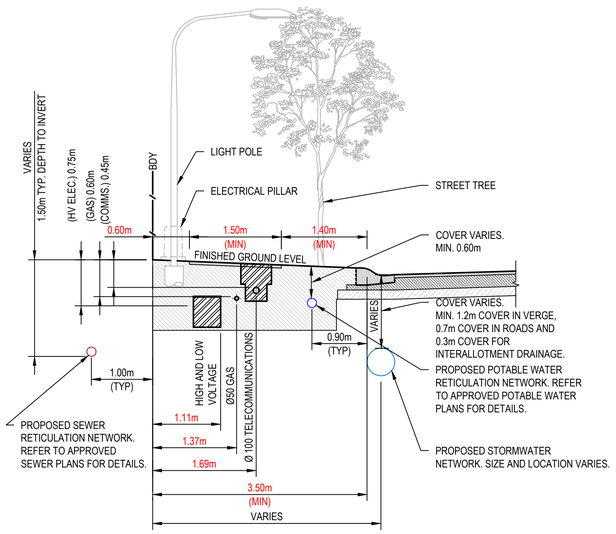
UTILITIES LEGEND

EXISTING

- OVERHEAD ELECTRICAL — e o/h — e o/h —
- COMMUNICATIONS — c — c —
- SEWER — s — s —
- WATER — w — w —

PROPOSED

- STORMWATER DRAINAGE PIPE
- STORMWATER DRAINAGE CULVERT
- KERB INLET PIT
- SURFACE INLET PIT/JUNCTION PIT
- HEADWALL
- SEWER
- TYPICAL LOCAL ROAD SERVICES ALLOCATION - REFER DETAIL



TYPICAL LOCAL ROAD SERVICES ALLOCATION

SCALE 1:50

NOTES

1. COMMUNICATION AND GAS INFRASTRUCTURE TO BE PROVIDED TO NEW ROAD NETWORK AND CONNECTED TO EXISTING NETWORK. EXACT LOCATION AND SCOPE TO BE DETERMINED BY SERVICE AUTHORITY.
2. FINAL CONNECTION AND LEAD IN WORKS ARE SUBJECT TO CONSULTATION WITH THE SERVICE AUTHORITIES, ALL COSTS SHALL BE BORNE BY THE DEVELOPER.

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF	APPD.
1	9/09/2021	ISSUED FOR INFORMATION	MDH	ML	MKH	MKH

Client: NEPEAN BUSINESS PARK

Scale: SCALE 1:50 @A1; SCALE 1:1750 @A1

North

Enspire Solutions Pty Ltd
205/275 Alfred Street N, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK PENRITH

Title: CONCEPT SERVICES INFRASTRUCTURE COORDINATION PLAN

Scale: 1:1750

Date: 09/09/2021

Size: A1

Datum: AHD

Status: FOR INFORMATION ONLY — NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-DA-C12.01

Revision: 1

DATE PLOTTED: 10 September 2021 10:13 AM BY : MARK HENNESSEY

CAD File: P:\200044 NepeanBusinessPark\D-Civil\01-Subdivision\Drawings\6-DACC\3-DA COURT DRAWINGS\200044-DA-C12.01 CONCEPT SERVICES INFRASTRUCTURE COORDINATION PLAN.dwg

power solutions

Quality designs in a guaranteed time

To Whom it may concern,

Power Solutions were engaged by Penrith Lakes Business Park Pty Ltd to; Review the existing electrical supply infrastructure, provide preliminary advice on upstream upgrade requirements and complete a Preliminary Application with Endeavour Energy for Lots 308, 309 & 310 DP752021 at14-278 Old Castlereagh Rd Castlereagh

Preliminary load assessments have indicated that the estate may require 6 or 7 Padmount Substations. The actual supply requirements can vary significantly depending on the actual use of the lots.

Existing 11kV overhead mains are located adjacent to the site along Old Castlereagh Rd and at the corner of Lugard St and Leland St. 33kV and LV overhead mains are also in Old Castlereagh Rd. The 11kV supply is from Cranebrook Zone substation only approx. 1.8 km to the east of the proposed subdivision.

It is not anticipated that there will be major upstream electricity supply work required, however this will need to be confirmed with Endeavour Energy via the supply application process.

The next step will be to submit to Endeavour Energy an “Application for the Provision of an Electricity Network for a Subdivision” for stage 1.

NBN is available in Old Castlereagh Rd via the existing Telstra network. An application to NBN for stage 1 is to be submitted for NBN to review and advise any upstream works

Regards

Chris Lever

Electrical Designer

Postal
PO Box 278
Charlestown NSW 2290

Head Office
The Landmark
C106/215 Pacific Highway
Charlestown NSW

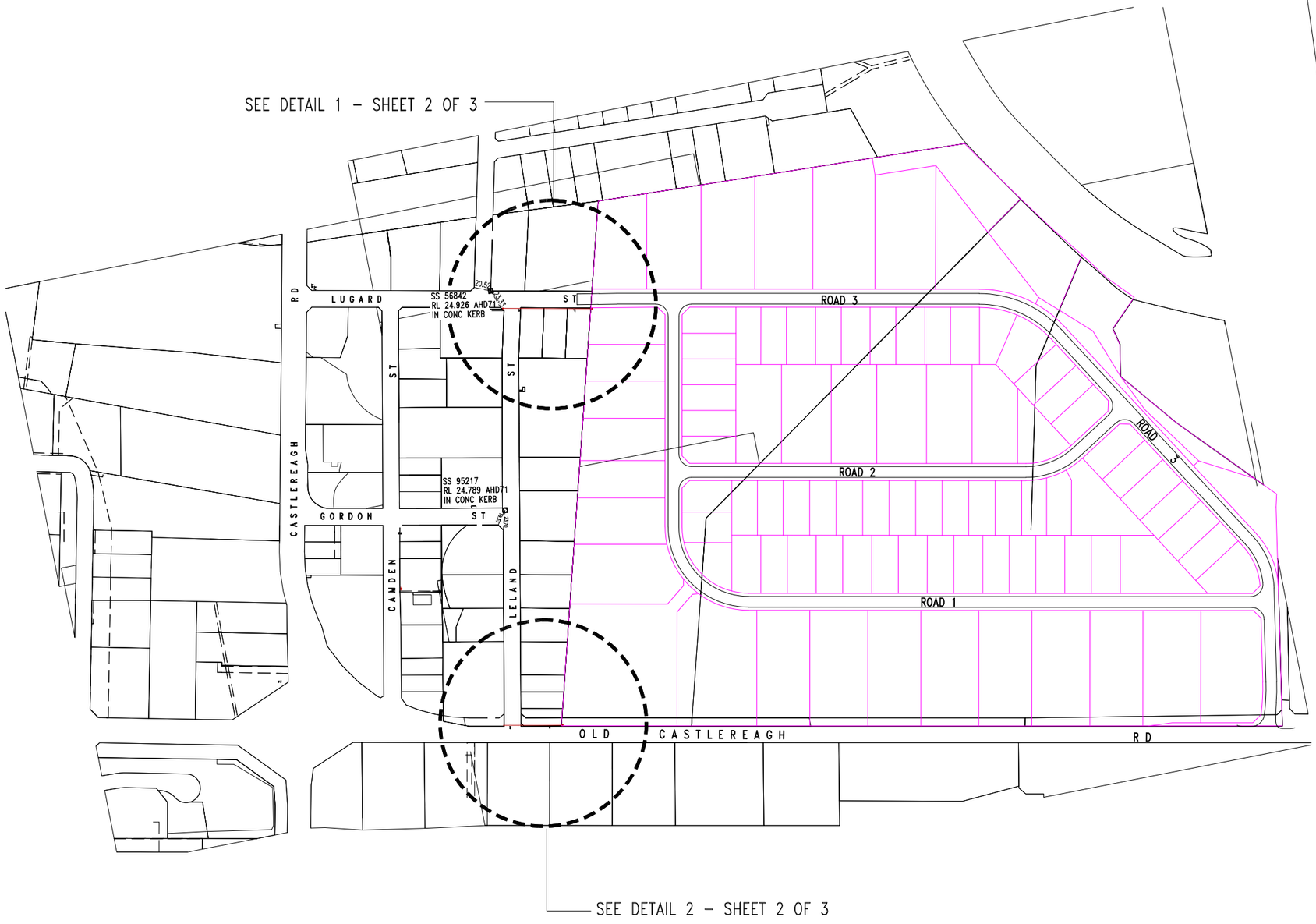
Sydney Office
810 Pacific Highway
Gordon NSW 2072

Phone 1300 732 293
office@powersol.com.au
www.powersol.com.au

A1

FILE LOCATION: 18478 | DESIGNED: M.L | DRAFTED: J.L | VERIFIED: T.O | REVIEWED: T.O | APPROVED: T.O | ISSUED: 22.04.21

DEVELOPER CONTRACT PLAN



0 10 20 30 40 50 METRES

NOTES:

1. WATER SERVICING COORDINATORS:
   OLSEN INFRASTRUCTURE PTY LTD
   P.O. BOX 552 KELLYVILLE NSW 2155
   PH: (02) 9899 4001 FAX: (02) 9899 6005

   FOR:
   GREAT RIVER NSW PTY LTD
   LEVEL 1, 2 BARRACK STREET, SYDNEY NSW 2000
   PH: +61 2 9994 0202
2. ALL LOTS WERE VACANT AT TIME OF SURVEY.
3. ALL STRUCTURES TO BE CONSTRUCTED TO PROPOSED FINISHED SURFACE LEVELS.
4. THE PROPOSED WORKS DETAILED HERE ON MUST BE CONSTRUCTED IN ACCORDANCE WITH THE WATER SERVICES ASSOCIATION OF AUSTRALIA (W.S.A.A.) NATIONAL CODES AND APPLICABLE SYDNEY WATER SUPPLEMENTS AND TECHNICAL REQUIREMENTS – MAJOR WORKS SEWER.
   THE CONSTRUCTOR MUST HAVE A COPY OF THESE DOCUMENTS ON SITE ALL TIMES:
   – SEWER RETICULATION CODE OF AUSTRALIA WSA 02–2002–2.2 VERSION 4 MAY 2017
   – SYDNEY WATER SUPPLEMENTS AND APPENDICES
5. PRIOR TO APPLICATION FOR CONSTRUCTION COMMENCEMENT NOTICE (CCN AUDIT) THE CONSTRUCTOR MUST FORWARD TO THE WSC (DELIVERY) THE FOLLOWING DOCUMENTATION OUTLINING:
   –Q.A. SYSTEM CERTIFICATE OF CURRENCY.
   –CONSTRUCTION PROGRAM (INCLUDING ALL PRECAUTIONS TO MINIMISE INCONVENIENCE, RESTORATION)
   –PROPOSED ENVIRONMENTAL PROTECTION MEASURES DURING CONSTRUCTION.
   –S.W.M.S.
   –DETAILS OF SYDNEY WATER ACCREDITED PERSONNEL THAT WILL CARRY OUT THE WORKS.
   –EVIDENCE OF CURRENT D.B.Y.D. SERVICES INVESTIGATIONS AND REPORT.
6. CONSTRUCTOR SHALL SUBMIT COMMENCEMENT NOTICE TO SYDNEY WATER FIELD OFFICER GIVING A MIN. 48 HRS, PRIOR TO START CONSTRUCTION WORKS
7. CONSTRUCTOR SHALL INSTALL NON–DETECTABLE TAPE & RAISE TO THE SURFACE AT ALL JUNCTIONS.
8. PIPES TO BE CONCRETE ENCASED SHOWN ACCORDINGLY:

9 BUILDING OVER/ADJACENT TO SEWER. CONDITIONS APPLY.

10. ALL LEVELS ELECTRONICALLY GENERATED. NO LEVEL BOOK AVAILABLE.
11. THE MINIMUM NUMBER OF FIELD COMPACTION TESTS REQUIRED TO SATISFY THE SEWERAGE CODE OF AUSTRALIA ARE:

PIPE EMBEDMENT ZONE:	NIL (BASED ON WSA 02–2002 PART 3 CL.22.3.3.1)
TRENCH FILL ZONE	– TRAFFICABLE (1 PER 300mm LAYER /50m): 2
TRENCH FILL ZONE	– NON TRAFFICABLE (1 PER 300mm LAYER /100m): 2
ADJACENT M.H./M.S.	– 2 PER M.H./M.S.: 4

12. ALL M.H. COVERS SHALL BE CLASS 'D'
13. NEW CUSTOMER DRAIN CONNECTIONS CONSTRUCTED CONCURRENTLY WITH THE NEW SEWER MUST BE CONSTRUCTED BY A LICENSED PLUMBER. THE WORKS MUST BE INSTALLED IN ACCORDANCE WITH THE CURRENT NSW CODE OF PRACTICE FOR PLUMBING AND DRAINAGE AND AS/NZS3500. THE CUSTOMER DRAIN CONNECTION MUST BE INSPECTED BY A NSW FAIR TRADING PLUMBING INSPECTION ASSURANCE SERVICE (PIAS) OFFICER PRIOR TO BACKFILL.
14. A REGISTERED SURVEYOR IS TO VERIFY EXISTING INVERT LEVELS, LOCATION AND LEVEL OF EXISTING SERVICES PRIOR TO COMMENCING CONSTRUCTION. THE CONSTRUCTOR MUST OBTAIN AN UPDATED SERVICES SEARCH (DB4YD).
15. THIS PLAN TO BE READ IN CONJUNCTION WITH DEEMED TO COMPLY DRAWINGS AS LISTED BELOW:
    DTC–2000 – C – 18/03/2015
    DTC–2200 – F – 18/03/2015
    DTC–2220 – D – 18/03/2015
    DTC–2221 – B – 01/03/2013
    DTC–2222 – C – 18/03/2015
    DTC–2223 – B – 18/03/2015
16. ⊕ PCP JUNCTIONS TO BE DN225x225 TO SERVE FUTURE INDUSTRIAL DEVELOPMENTS ON LOTS 1, 2 & 3 DP.979378 No.31 LUGARD STREET AND No.1–13 LELAND STREET.
17. THIS PLAN USES GDA94 COORDINATES

ENVIRONMENTAL NOTES:–

E1. AREAS DOWNSLOPE OF CONSTRUCTION ACTIVITY ARE TO BE ADEQUATELY PROTECTED FROM SEDIMENT POLLUTION ETC. SILT TRAP DEVICES ARE TO BE INSTALLED PRIOR ANY CONSTRUCTION ACTIVITY, EFFECTIVELY MAINTAINED AND TO BE REMOVED ONLY AFTER THE AREA HAS BEEN SATISFACTORILY REVEGETATED.
E2. ALL STORMWATER GRATES DOWNSLOPE OF CONSTRUCTION ACTIVITY TO BE ADEQUATELY PROTECTED BY STRAWBALES WRAPPED IN GEOTEXTILE FABRIC.
E3. ALL OPEN CHANNELS AND OPEN DRAINAGE LINES DOWNSLOPE OF CONSTRUCTION ACTIVITY TO BE ADEQUATELY PROTECTED BY STRAWBALE OR GEOTEXTILE FENCE.
E4. THE EXTENT OF CLEARING OF VEGETATION IS TO BE KEPT TO AN ABSOLUTE MINIMUM NECESSARY TO EFFECT THE WORKS.

LOCALITY PLAN

(NOT TO SCALE)

WARNING: *Services shown are indicative only.* **Currency and accuracy are not to be presumed.** *A current services search, including Dial Before You Dig services plans, and site checking all existing services will be necessary prior to commencing any work. Appropriate procedures, precautions and care to be taken when in close proximity to any service.*

No.	AMENDMENT DESCRIPTION	BY	DATE
C	GENERAL REVISION	M.L.	22.04.21
B	GENERAL REVISION	M.L.	08.02.21
A	ISSUE FOR APPROVAL	J.L	30.06.20

PLAN TO BE READ IN CONJUNCTION WITH CURRENT SYDNEY WATER STANDARDS
SYDNEY WATER CORPORATION

PRIOR TO COMMENCEMENT OF EXCAVATION FOR PROPOSED AND EXISTING SERVICES CONTACT :-

DIAL BEFORE YOU DIG	Ph. 1100
ELECTRICITY	Ph.
GAS	Ph.
TELECOMMUNICATIONS	Ph.
	Ph.

GIVING AT LEAST 48 HOURS NOTICE.

UTILITIES

TYPE	DATE	REF.	TYPE	DATE	REF.
WATER: DN100 Water	30.06.20	HYDRA			
SEWER: S S	30.06.20	HYDRA			
TELSTRA: TEL TEL	30.06.20	DBYD			
GAS: G G	30.06.20	DBYD			
PROP STORMWATER: SWD SWD	30.06.20	ENG			

WORK AS CONSTRUCTED CERTIFICATION

DEVELOPER
WATER SERVICE CO-ORDINATOR
CONSTRUCTOR
COMPLETED W.A.C. PREPARED

DESIGNER

I CERTIFY THAT THE WORKS HAVE BEEN CONSTRUCTED IN ACCORDANCE WITH THE WORK AS CONSTRUCTED DRAWINGS.

PIPE SCHEDULE

SIZE DN	TYPE	CLASS	LENGTH	PIPE JOINING METHOD / NOTES
225	U.P.V.C.	SN8	108.0	S.W.J.
300	U.P.V.C.	SN8	72.0	S.W.J.

DESIGN HEAD . . m

BOUNDARY TRAPS REQUIRED.

AUSTRALIAN HEIGHT DATUM

SCALES

PLAN 1:500 SECTION HOR. 1:500 VERT. 1:125

CROSS SECTIONS — NATURAL

LENGTHS, DEPTHS & LEVELS ARE IN METRES.

NO AMENDMENTS ARE TO BE MADE TO THIS PLAN WITHOUT REFERENCE TO SYDNEY WATER. THIS PLAN IS NOT NECESSARILY UP TO DATE OR CORRECT AND SYDNEY WATER ACCEPTS NO RESPONSIBILITY.

U.B. DIRECTORY 143_D16 (41st Ed)

SHEET 1 OF 1 File No. N/A

SYDNEY WATER CORPORATION

Case No. 185877WW

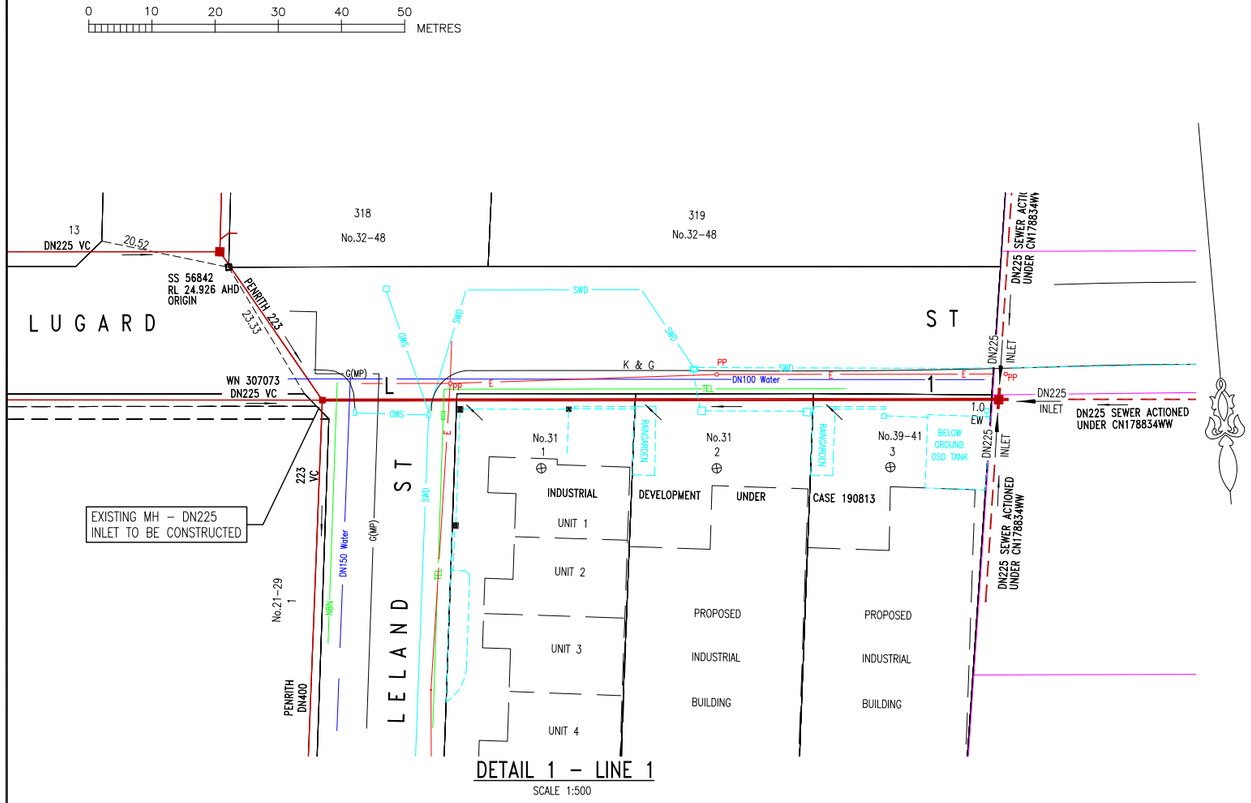
PENRITH SEWERAGE
DRAINS TO
PENRITH S.T.W.

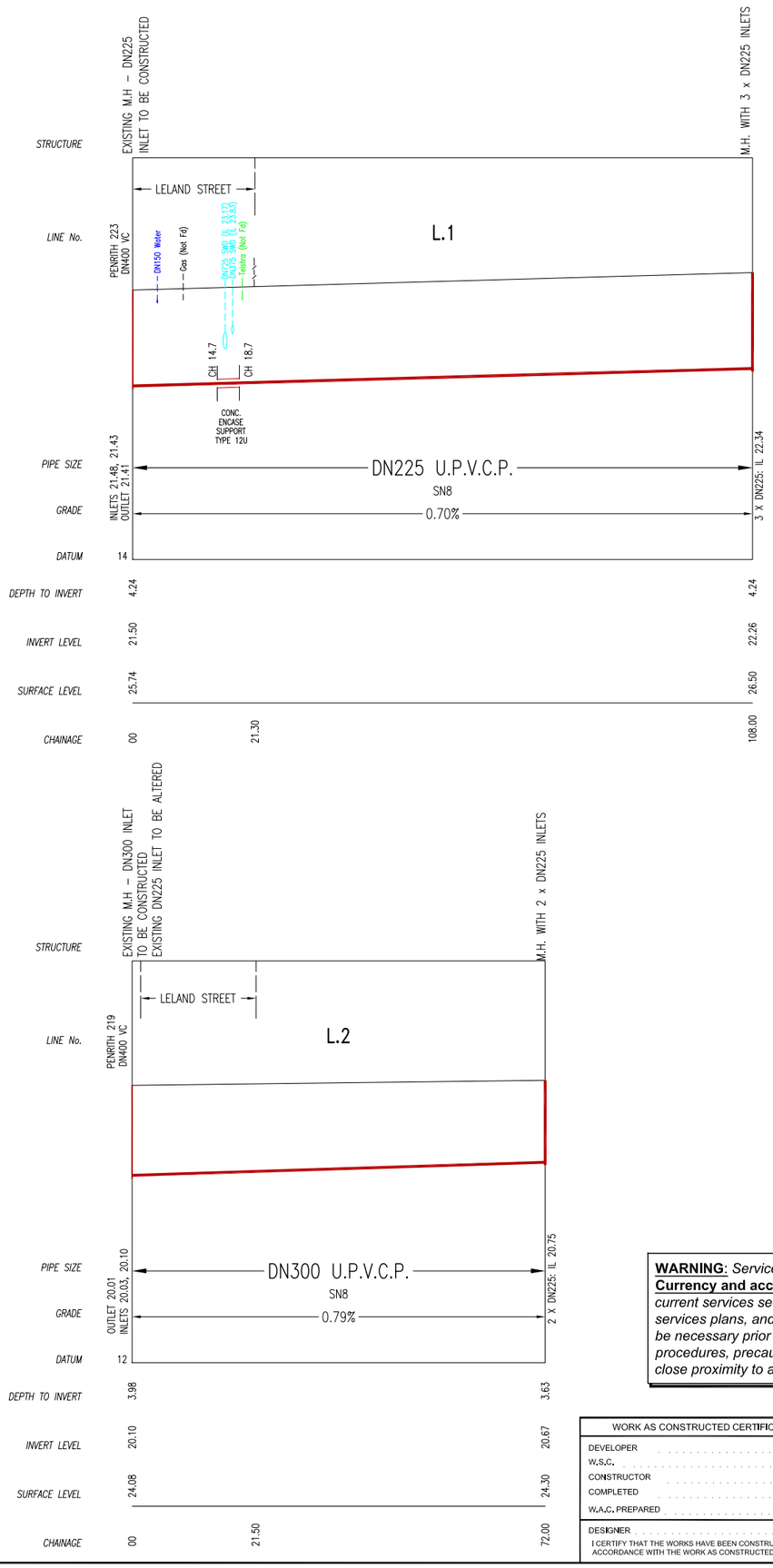
PLAN DRAWN DATE: 22.04.21 VERSION: C SHEET 1 OF 3 SHEETS

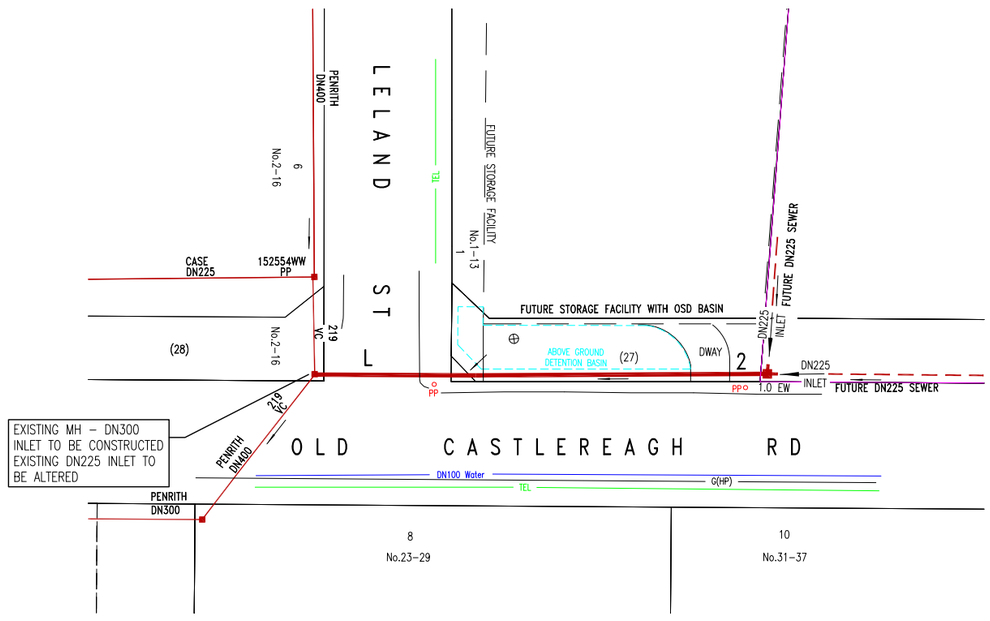
A1F

FILE LOCATION: 18478 | DESIGNED: M.L | DRAFTED: J.L | VERIFIED: T.O | REVIEWED: T.O | APPROVED: T.O | ISSUED: 22.04.21

DEVELOPER CONTRACT PLAN







No.	AMENDMENT DESCRIPTION	BY	DATE
C	AMENDED AS PER SW COMMENTS	M.L.	22.04.21
B	GENERAL REVISION	M.L.	08.02.21
A	ISSUE FOR APPROVAL	J.L.	30.06.20

WARNING: *Services shown are indicative only.* **Currency and accuracy are not to be presumed.** *A current services search, including Dial Before You Dig services plans, and site checking all existing services will be necessary prior to commencing any work. Appropriate procedures, precautions and care to be taken when in close proximity to any service.*

WORK AS CONSTRUCTED CERTIFICATION	
DEVELOPER	
W.S.C.	
CONSTRUCTOR	
COMPLETED	
W.A.C. PREPARED	
DESIGNER	

I CERTIFY THAT THE WORKS HAVE BEEN CONSTRUCTED IN ACCORDANCE WITH THE WORK AS CONSTRUCTED DRAWINGS

SYDNEY WATER CORPORATION

Sydney WATER

Case No. 185877WW | SHT 2 OF 3 SHTS.

SYDNEY WATER CORPORATION

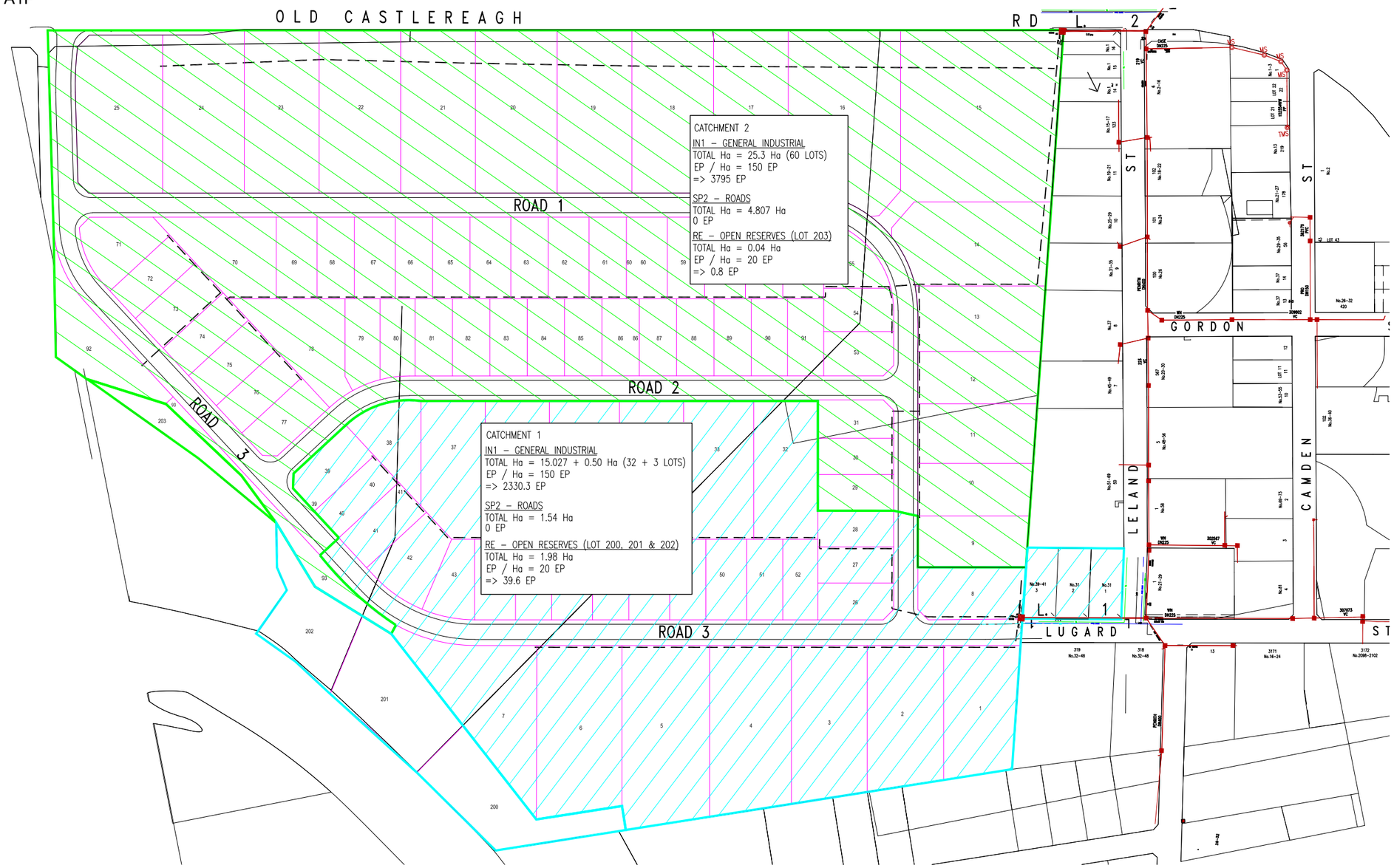
FOR DETAILS OF SERVICES SEE SHEET 1

PLAN DRAWN DATE: 22.04.21 VERSION: C SHEET 2 OF 3 SHEETS

A1F

FILE LOCATION: 18478 | DESIGNED: M.L | DRAFTED: J.L | VERIFIED: T.O | REVIEWED: T.O | APPROVED: T.O | ISSUED: 22.04.21

DEVELOPER CONTRACT PLAN



CATCHMENT PLAN

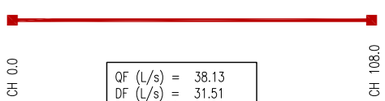
NOT TO SCALE

PROPOSED CATCHMENT 1

IN1 – GENERAL INDUSTRIAL
TOTAL LOTS = 32 + 3
TOTAL AREA = 15.027 + 0.508 Ha
EP UNITS USED = 150 EP / Ha
= 2330.25 EP

SP2 – INFRASTRUCTURE (ROADS)
TOTAL AREA = 1.54 Ha
EP UNITS USED = 0 EP / Ha
= 0 EP

RE – OPEN RESERVES (LOT 200, 201, 202)
TOTAL Ha = 1.98 Ha
EP / Ha = 20 EP
=> 39.6 EP



QF (L/s) = 38.13
DF (L/s) = 31.51
PDWF (L/s) = 10.69
PIPE SIZE = DN225
PIPE TYPE = U.P.V.C.
MIN GRADE = 0.70%

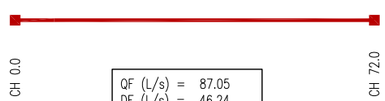
LEAD–IN LINE 1 CHAINAGE & EP CALCS

PROPOSED CATCHMENT 2

IN1 – GENERAL INDUSTRIAL
TOTAL LOTS = 60
TOTAL AREA = 25.3 Ha
EP UNITS USED = 150 EP / Ha
= 3795 EP

SP2 – INFRASTRUCTURE (ROADS)
TOTAL AREA = 4.807 Ha
EP UNITS USED = 0 EP / Ha
= 0 EP

RE – OPEN RESERVES (LOT 203)
TOTAL Ha = 0.04 Ha
EP / Ha = 20 EP
=> 0.8 EP



QF (L/s) = 87.05
DF (L/s) = 46.24
PDWF (L/s) = 15.67
PIPE SIZE = DN300
PIPE TYPE = U.P.V.C.
MIN GRADE = 0.79%

LINE 2 CHAINAGE & EP CALCS

WARNING: *Services shown are indicative only.* **Currency and accuracy are not to be presumed.** *A current services search, including Dial Before You Dig services plans, and site checking all existing services will be necessary prior to commencing any work. Appropriate procedures, precautions and care to be taken when in close proximity to any service.*

No.	AMENDMENT DESCRIPTION	BY	DATE
B	GENERAL REVISION	M.L.	08.02.21
A	ISSUE FOR APPROVAL	J.L	30.06.20

WORK AS CONSTRUCTED CERTIFICATION

DEVELOPER
W.S.C.
CONSTRUCTOR
COMPLETED
W.A.C. PREPARED
DESIGNER

I CERTIFY THAT THE WORKS HAVE BEEN CONSTRUCTED IN ACCORDANCE WITH THE WORK AS CONSTRUCTED DRAWINGS

SYDNEY WATER CORPORATION

Case No. 185877WW | SHT 3 OF 3 SHTS.

SYDNEY WATER CORPORATION

FOR DETAILS OF SERVICES SEE SHEET 1

PLAN DRAWN DATE: 22.04.21 VERSION: C SHEET 3 OF 3 SHEETS

28 September 2021

ENSPIRE SOLUTIONS
ABN 71 624 801 690

Ms Clare Collett
Special Council
Mills Oakley
Level 7, 151 Clarence Street
Sydney NSW 2000

ENGINEERING
LAND DEVELOPMENT
PROJECT MANAGEMENT

1302/83 Mount Street
North Sydney
NSW 2060
Australia

Dear Clare,

RE: NEPEAN BUSINESS PARK – STORMWATER DISCHARGE - SCOUR PROTECTION AND GROSS POLLUTANT TRAP ASSESSMENT

This letter has been prepared to provide additional information in relation to the proposed scour protection treatment and Gross Pollutant Trap specification for stormwater discharge associated with the proposed Nepean Business Park development.

Stormwater Discharge Scour Protection

Scour protection has been designed in accordance with the adopted industry guideline, Soils and Construction Volume 1 (March 2004), prepared by Landcom (know as “The Blue Book”).

A summary of the design is included below.

Discharge Location 1

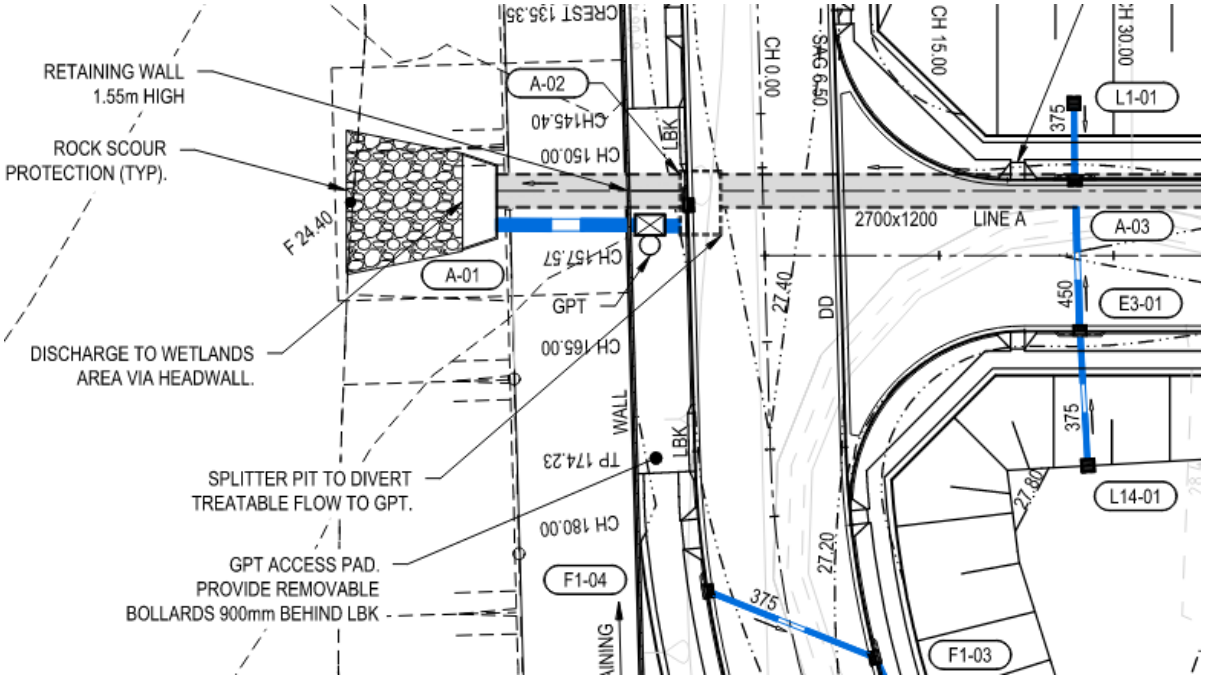


Figure 1 – Discharge Location 1 - Northern outlet A-01 (200044-DA-C05.01)

Table 1 – Discharge Location 1 – Scour Protection Design Inputs

Flowrate (Q_{100})	9.486 m3/s
Velocity	3.63 m/s
Outlet size	2700 x 1200mm RCBC
Equivalent Adopted Outlet size	1800mm diameter

We note the design chart does not include RCBC's so an equivalent pipe size has been adopted to match the design flow rate. The adoption of a smaller pipe size is considered conservative as velocity increases as the pipe size is reduced, for an equivalent flow rate, therefore the scour protection will be larger due to the higher velocity.

Adopting design chart Figure 5.10, the calculation is presented in *Figure 2*.

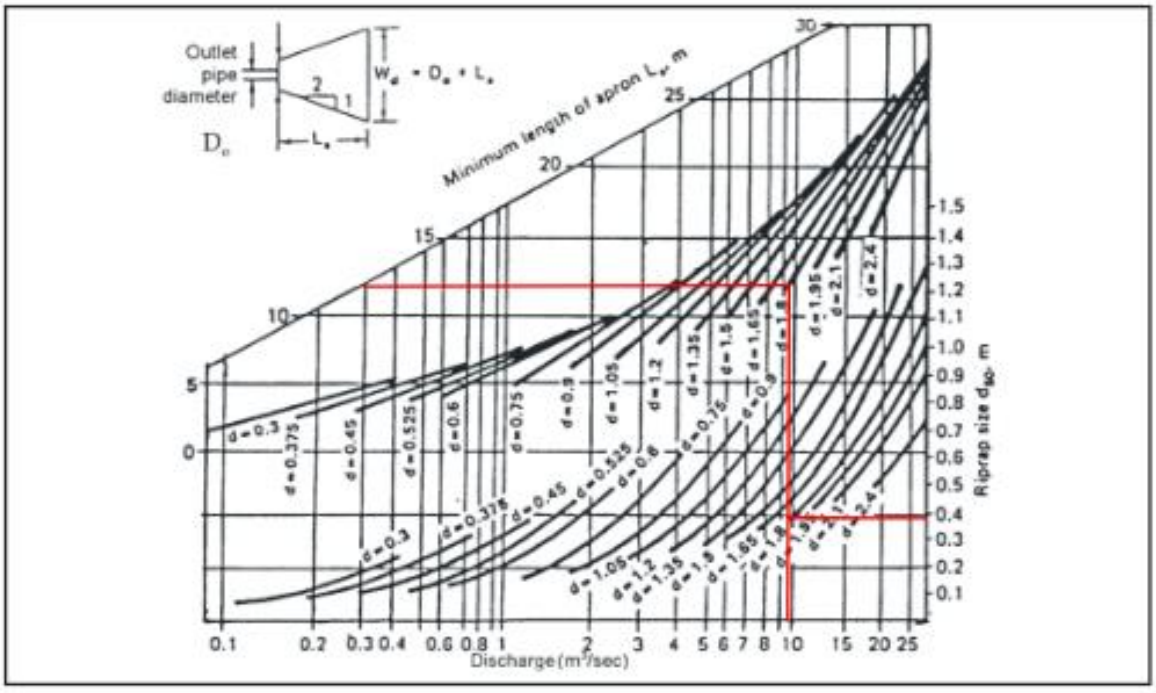


Figure 5.10 Design of riprap outlet protection – minimum tailwater conditions (MWRA, 1983)

Figure 2 – Discharge Location 1 - Scour Protection Calculation

The results are presented in *Table 2* below.

Table 2 – Discharge Location 1 – Scour Protection Results

Riprap Size d_{50}	0.4m
Scour protection apron length	12m
Scour protection apron width	14.7m

Discharge Location 2

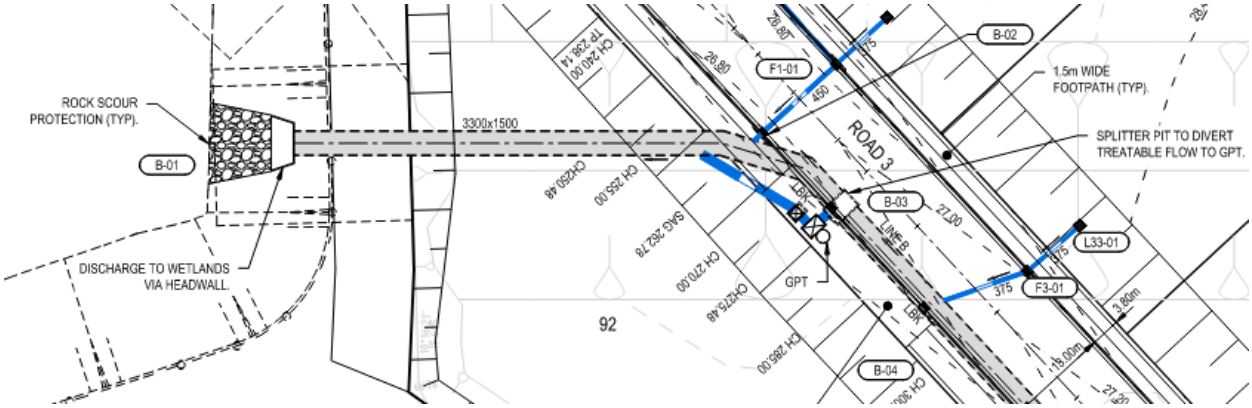


Figure 3 – Discharge Location 2 - Southern outlet B-01 (200044-DA-C05.04)

Table 3 – Discharge Location 2 – Scour Protection Design Inputs

Flowrate (Q_{100})	12.682 m3/s
Velocity	3.82 m/s
Outlet size	3300 x 1500 RCBC
Equivalent Adopted Outlet size	1950mm diameter

Adopting design chart Figure 5.10, the calculation is presented in *Figure 4*.

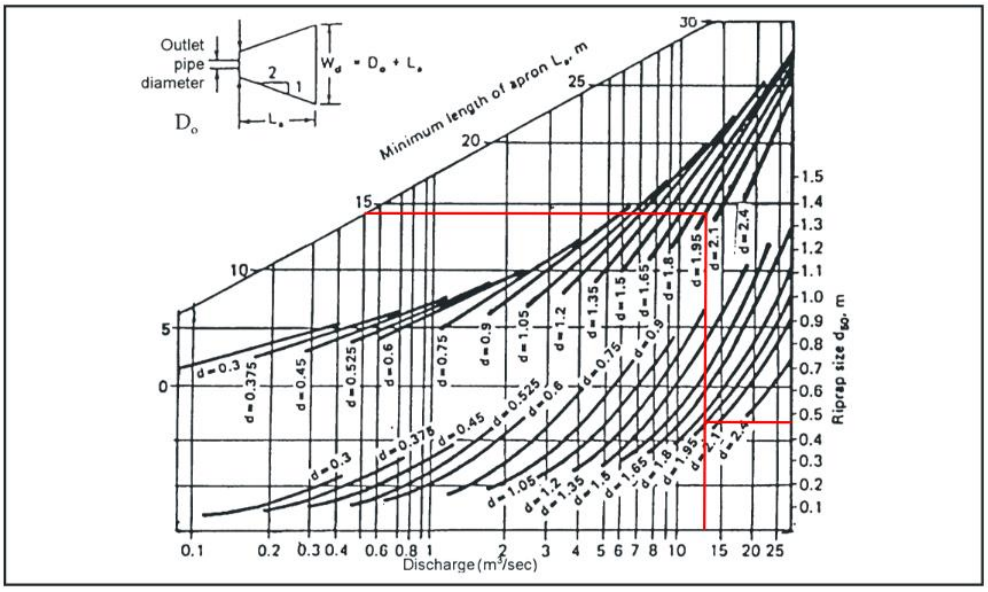


Figure 5.10 Design of riprap outlet protection – minimum tailwater conditions (MWRA, 1983)

Figure 4 – Discharge Location 2 - Scour Protection Calculation

Table 4 – Discharge Location 2 – Scour Protection Results

Riprap Size d_{50}	0.5m
Scour protection apron length	15m
Scour protection apron width	18.3m

Based on the above, we confirm the scour protection can be designed for a conservative discharge flowrate in accordance with Landcom's "The Blue Book".

Gross Pollutant Trap Compliance

The design of water quality treatment for the proposed subdivision development incorporates Gross Pollutant Traps (GPTs) and has been demonstrated to be compliant with the following guidelines.

- Stage 2 Penrith Lakes Water Management Plan (WMP);
- Penrith City Councils Water Sensitive Urban Design (WSUD) Technical Guidelines; and
- Draft Penrith Lakes Development Control Plan – Stage 1

A detailed GPT assessment was undertaken by Enspire Solutions to determine the suitability and availability of appropriate proprietary devices that would meet the requirements of the relevant guidelines.

Through this assessment it was determined that multiple manufacturers of vortex GPT system can achieve the performance requirements as presented in *Table 5*.

Table 5 – Enspire Solutions GPT Assessment Findings

Item	**Gross Pollutant > 5mm**	**TSS**	**TP**	**TN**
Rocla CDS	98%	70%	30%	0%
SPEL Vortceptor	99.99%	70%	30%	Variable

Figure 5 – Extract from Enspire Solutions GPT Assessment Report

Manufacturer brochures for the above GPT options have been enclosed with this letter **(refer attachment 1)**.

The scour protection treatment and Gross Pollutant Traps are documented on Enspire drawings 200044-DA-C05.01, 200044-DA-C05.04 and 200044-DA-C18.03 **(refer attachment 2)**.

Please do not hesitate to contact me if you require any further information.

Sincerely

Andrew Dawes
Director
For Enspire
andrew.dawes@enspiresolutions.com.au

Enc.

1. Vortex GPT Manufacture Brochures
2. Enspire Solutions Civil Engineering Drawings 200044-DA-C05.01, 200044-DA-C05.04 and 200044-DA-C18.03

PRODUCT
BROCHURE

CDS® SEPARATOR

Rocla®

131 004
rocla.com.au

CDS® SEPARATOR

CDS® Separator are designed to capture and retain gross pollutants, litter, grit, sediments and associated oils, utilising patented CDS® indirect screening technology.

Rocla offers a complete design service for CDS® products that takes into account the catchment's characteristics, pollution load, hydraulic site constraints and opportunities, system capacities, velocity, backwater, as well as the location of services and access for cleaning.

Hydraulic reports are available on request and are automatically carried out for larger units.

CHARACTERISTICS

- Non-blocking functionality
- 95% capture of gross pollutants >1mm
- 95% sediment capture >200µm
- Captures organics and oils
- Captures adsorbed toxics and nutrients
- Can treat any pipe or multiple pipes
- Various sump sizes available
- Customised bypass requirements
- Underground - small footprint
- Easy installation
- No moving parts
- Lowest life cycle costs
- More water treated than comparable treatment designs
- Pollutants stored in the sump, not the screens

BENEFITS

- Subdivisions and roads
- Residential, commercial and industrial developments
- Car parks and shopping centres
- Pre-treatment for wetlands
- Pre-treatment for reuse applications
- Pipes, channels, culverts and creeks

Other CDS® models are available for non-stormwater applications involving high flow solids/ liquids separation, such as industrial processes and sewer overflows.

CDS® CONTINUOUS DEFLECTIVE SEPARATION

The CDS® Separator utilises the energy of the inflow to create a vortex flow regime within the CDS® screening chamber.

The CDS® Separator simply creates a whirlpool that draws all the deflected and settling pollutants to the centre of the screening chamber where they fall out into the storage sump below.

The pollutant storage sump located below the screening chamber allows pollutants to be removed from the flow path and away from the screens, thus maintaining a reliable treatment efficiency.

The unique CDS® technology is the most reliable way to effectively and efficiently treat gross pollutants in stormwater drainage systems.

One of the leading storm water traps

CDS® UNIT MODELS

The size and type of CDS® separator required depends on catchment area, flows, pollution loads, performance requirements, maintenance method, hydraulic limitations and site constraints.

Visit the Rocla website for a sizing request form. Details submitted with this form provide all the information needed to calculate the size of device most applicable for the site.

CDS® Separator Model No.[4]	Overall Dia[1] (mm)	Treatment[3] Flow (L/s)	Weir Height[2] (mm)	Minimum DTI[5] (mm)
Nipper 0506	1300	20-22	300	1035
CDS 0708	1750	50-55	400	1105
CDS 0708Maxi	2600	50-55	400	1185
CDS 1009	1950	100-110	500	1610
CDS 1012	1950	140-150	600	1610
CDS 1015	1950	180-200	700	1610
CDS 1512	2600	220-250	650	1610
CDS 1518	2600	350-400	800	1610
CDS 2018	3400	500-600	900	1610
CDS 2028	3400	800-900	1100	1610
CDS 3018	5000	800-900	900	1610
CDS 3024	5000	1250-1400	1000	1610
CDS 3030	5000	1750-1900	1200	1800

1: Excludes Diversion Chamber except for models 0506, 0708 & 0708M
2: Measured from outlet invert with no tailwater
3: CDS treatment flows are indicative only
4: Model sizing is undertaken independently from the bypass hydraulics of the diversion chamber
5: In most cases minimum DTI is determined by diversion chamber depth

CDS® SEPARATOR PERFORMANCE

Gross Pollutant Removal	98% (>3mm)
Sediments Capture	>80% (>75µm)
TSS Removal	>70% (d_{50} = 106µm)
Total Phosphorous (TP) Removal	>30% (at 70% TSS removal)
Hydrocarbon Capture	80-90% 'at typical stormwater concentrations for free oil

MAINTAINING CDS® SEPARATOR

The CDS® Separator has the lowest life-cycle costs due to its non-blocking functionality, large off-line storage and multiple cleaning options. There are 3 methods of emptying CDS® Separators:

- Removable basket
- Material grab
- Suction method

With no requirement to unblock screens, confined space entry is minimised. Large off-line sump volumes (up to 10m3 available) also minimise cleaning frequency.

CDS® CONTINUOUS DEFLECTIVE SEPARATION

It has long been acknowledged that best management practice for stormwater pollutant traps involves locating the devices off-line.

- GPTs located on-line suffer badly from turbulence and eddies, often resulting in the re-suspension and loss of previously captured pollutants.
- GPTs which store pollution in the screening area suffer decreasing screen area and therefore decreasing flow rates, as they fill up.
- GPTs which function by direct filtration have a treatable flow rate decay that is proportional to the percentage of screen blockage.
- GPTs that utilise a vortex only, without a screen, cannot guarantee neutrally buoyant pollution removal.

Only CDS® Separators combine the advantages of being off-line, having non-blocking functionality, vortex forces and storing pollution outside the screening area. For these reasons, no other device is “equivalent” to a CDS® Separator.

DIVERSION CHAMBER

Precast diversion chambers can be manufactured to suit most typical installations, or chambers can be tailored to meet the hydraulic limitations of the site.

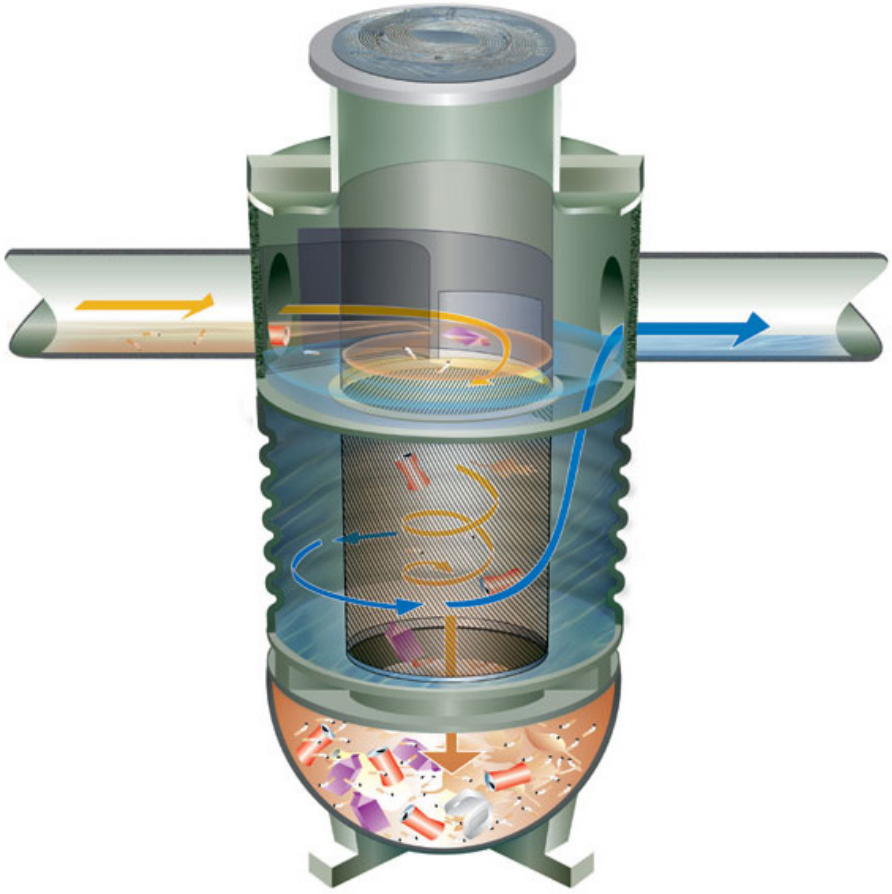
The diversion chamber has the capacity to cater for the highest possible flow in the stormwater system. The chamber is configured on the assumption that the CDS® Separator has not been maintained and there is no flow passing through the unit.

A weir is located within the diversion chamber to create a driving head and direct the majority of flows into the CDS® GPT.

CHAMBER OPTIONS

The CDS® Separator and diversion chamber design depends on the system capacity and site constraints. Rocla will design the most suitable CDS® Separator configuration to meet project requirements.

- Precast diversion chambers
- Semi-precast diversion chambers
- Customised designs for multiple pipes, drops and bends
- In-situ channel designs
- Fixed or collapsible weirs
- Any flow capacity
- No flooding



CDS® 0506 Separator

The PL0506 in-line CDS® Unit, known as the Nipper, is the smallest in the CDS® range of gross pollutant traps. It provides the fully proven performance of CDS® Separators in a pint-sized polymer unit.

The Nipper is ideally suited for installation at the collection source in small catchment areas of less than a hectare and is designed to remove gross pollutants, organic waste, silt, sediment and oils.

Manufactured from strong, lightweight polymer material, the CDS® 0506 is delivered to site in one piece, making it easy to install and cost-effective.

CDS® 0506 PERFORMANCE

Pipe Flows	Treatment 25 L/s Max 150 L/S
Gross Pollutant Removal	98% (>3mm)
Sediments Capture	>80% (>75µm)
TSS Removal	>70% (d_{50} = 106µm)
Total Phosphorous (TP) Removal	>30% (at 70% TSS removal)
Hydrocarbon Capture	80-90% 'at typical stormwater concentrations for free oil
Free Oil Storage Capacity	150 litres

PRODUCT APPLICATION DESIGN (PAD) SERVICES

Rocla offers a full design and drafting service in support of its water quality products, including the CDS® separator.

These service are available to all customers. To see how Rocla can assist you with your water sensitive urban design (WSUD) solutions please visit the Rocla website or call your local sales represenative on 131 004.

SPECIFICATIONS

Storage
- 0.72 cubic metres

Weight
- 140 kilograms

Footprint
- 1050mm diameter

Material
- High density polyethylene

Treatment
- Self-cleaning screens, vortex and gravity

Screens
- 2.4mm stainless steel

Inlet Size
- Up to 375mm diameter

APPLICATIONS

- Small subdivisions
- Bus and train stations
- Pre-screening bio- retention systems
- Pre-screening construction wetlands
- Packaging warehouses
- Roadside drains
- Car parks

For more information call Rocla on **131 004** or visit **rocla.com.au**

CONCRETE PRODUCTS | PIPE | ENGINEERING CAPABILITY

Rocla®

Certified System™
Quality
ISO 9001

spelstormwater
joy in water

SPEL Vortceptor®

Hydrodynamic Vortex Gross Pollutant Trap (GPT)

OVERVIEW

The SPEL Vortceptor® GPT is a non-blocking hydrodynamic separator that has a unique screen and treatment action producing low vortex conditions resulting in excellent pollution removal performance and resulting high water quality outcomes.

BENEFITS

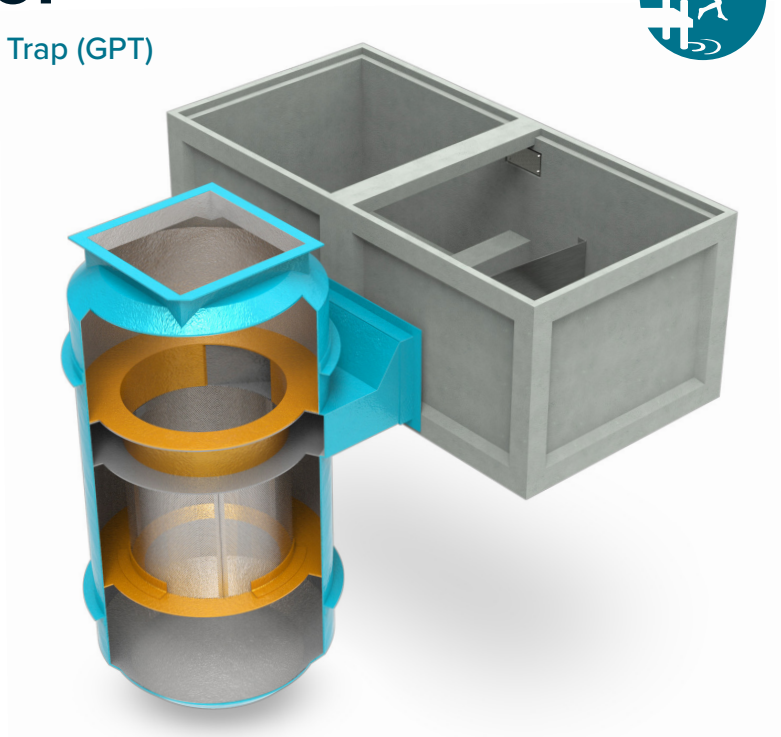
- Vortex Action
- Separates and captures gross pollutants, sediments, silt, total suspended solids, some nutrients and oil and grease.
- Non-blocking hydrodynamic separator.
- Unique screen & treatment action.

APPLICATIONS

- Shopping Precinct
- Commercial Zones
- Recreational Grounds
- Industrial Areas
- Beaches & Parks
- Residential Development

SPEL Vortceptor®

Hydrodynamic Vortex Gross Pollutant Trap (GPT)



Features

- 900 x 900 mm flanged manhole access
- 316 SS VORTCEPTOR Screen
- Additional manhole extensions (if required).
- Reinforced Fibreglass
- Ribbed for structural strength/vertical anchoring
- One piece construction

Specifications

Models	Dimensions (mm)				Capacities			Removal Rates (%)			
	Internal Diameter	Overall Width	Depth below invert	Manhole Size	Sump Capacity (m^3)	Floatables Volume (m^3)	Treatable Flow rate (L/s)	TSS	TP	TN	GP's
OFFLINE SERIES											
SVO.096(L/R)	1500	1670	1725	900x900	2.0	0.35	96	70	30	Variable	99.99
SVO.140(L/R)	1500	1670	2025		2.3	0.35	140				
SVO.180(L/R)	1500	1670	2325		3.0	0.35	180				
SVO.220(L/R)	2200	2350	2800		4.5	1.1	220				
SVO.360(L/R)	2200	2350	3080		6.0	1.1	360				
SVO.530(L/R)	3000	3150	3200		8.5	2.8	530				
SVO.800(L/R)	3000	3150	4200		8.5	2.8	800				
SVO.810(L/R)	4000	4150	3400		19.3	5.65	800				
SVO.1200(L/R)	4000	4150	4000		19.3	5.65	1200				
SVO.1600(L/R)	4000	4150	4600		19.3	5.65	1600				
IN-LINE SERIES											
SVI.025(L/R)	1200	1370	1400	600x600	1.2	0.06	26	70	30	Variable	99.99
SVI.055(L/R)	1800	1970	1650	900x900	2.7	0.22	55				
SVI.055.M(L/R)	2200	2370	1585		3.2	0.22	55				

GENERAL WORKS LEGEND

SITE BOUNDARY	
CONTOUR	100.00
BATTER	
RETAINING WALL	RETAINING WALL
KERB AND GUTTER REFER DRG: C14.01 FOR COUNCIL STANDARD DETAIL	K&G
DISH DRAIN REFER DRG: C14.01 FOR COUNCIL STANDARD DETAIL	DD
KERB RAMP REFER DRG: C14.01 FOR COUNCIL STANDARD DETAIL	
LAYBACK KERB REFER DRG: C14.01 FOR COUNCIL STANDARD DETAIL	LBK
FINISHED LEVEL	F29.00
SWALE DRAIN	>
TEMPORARY DRAINAGE CHANEL	
SURFACE FALL	1.5%
PIPE SIZE STORMWATER DRAINAGE LINE FLOW DIRECTION	375
STORMWATER LINE/PIT NUMBER	A01/01
KERB INLET PIT	
SURFACE INLET PIT/JUNCTION PIT	
HEADWALL	

OLD CASTLEREAGH ROAD

PENRITH LAKES REGIONAL PARK

WETLANDS

SAWCUT EXISTING AC ROAD PAVEMENT (TYP).

MATCH EXISTING ROAD PAVEMENT.

SHARED PATH KERB RAMP CONSTRUCTED TO COUNCIL STANDARDS.

RETAINING WALL 0.8m HIGH

RETAINING WALL 1.25m HIGH

RETAINING WALL 1.70m HIGH

3.0m WIDE SHARED PATH (TYP).

RETAINING WALL 1.80m HIGH

RETAINING WALL 1.55m HIGH

ROCK SCOUR PROTECTION (TYP).

DISCHARGE TO WETLANDS AREA VIA HEADWALL.

SPLITTER PIT TO DIVERT TREATABLE FLOW TO GPT.

GPT ACCESS PAD. PROVIDE REMOVABLE BOLLARDS 900mm BEHIND LBK

RETAINING WALL 0.8m HIGH

EXISTING POWER POLE TO BE RELOCATED (TYP).

120m AUXILIARY DECELERATION LANE

EXISTING 450 SW PIPE TO REMAIN.

EDGE OF NEW PAVEMENT (TYP).

EXISTING HEADWALL TO BE DEMOLISHED.

EXTEND EXISTING SW PIPE AND PROVIDE NEW HEADWALL OUTLET.

PROPOSED BOUNDARY.

PROPOSED RISING MAIN (BY OTHERS).

10.0m WIDE EASEMENT FOR RISING MAIN

BATTER 1:2

BATTER 1:10 TYP

KERB INTEL PIT (ON-GRADE) TO BE CONSTRUCTED OVER PROPOSED RCBC (TYP).

KERB RAMP CONSTRUCTED TO COUNCIL STANDARDS (TYP).

1.5m WIDE FOOTPATH (TYP).

RCBC TRUNK DRAINAGE LINE.

ROAD 3

ROAD 1

25

24

23

71

70

72

73

FOR CONTINUATION REFER DRG: 200044-DA-C05.04

FOR CONTINUATION REFER DRG: 200044-DA-C05.02

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
4	17/12/2020	ISSUED FOR DEVELOPMENT APPLICATION	MDH	ML	MKH	MKH
3	11/12/2020	ISSUED FOR CLIENT REVIEW	MDH	ML	MKH	MKH
2	2/10/2020	ISSUED FOR INFORMATION	MDH	ML	MKH	MKH
1	28/10/2020	ISSUED FOR INFORMATION	MDH	ML	MKH	

Client: NEPEAN BUSINESS PARK

Scale: 0 10 20 30 40 50m — SCALE 1:500 @A1

North

enspire
Enspire Solutions Pty Ltd
205/275 Alfred Street N, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK PENRITH

Title: SITEWORKS AND STORMWATER MANAGEMENT PLAN SHEET 01

Scale: 1:500

Date: 28/10/2020

Size: A1

Datum: AHD

Status: FOR INFORMATION ONLY — NOT TO BE USED FOR CONSTRUCTION

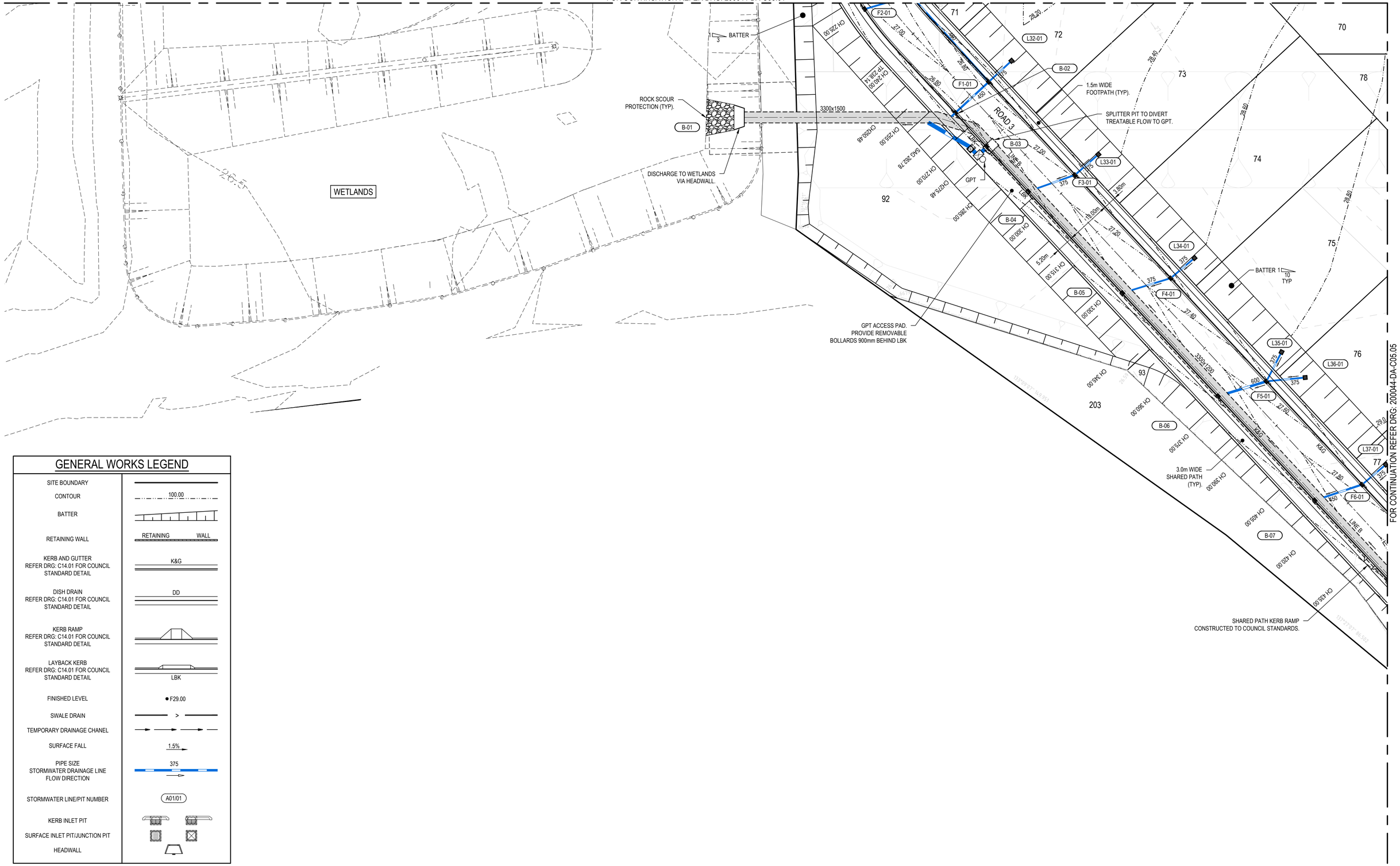
Project Number/Drawing Number: 200044-DA-C05.01

Revision: 4

DATE PLOTTED: 28 September 2021 1:44 PM BY - ANDREW DAVIES

CAD File: P:\200044 NepeanBusinessPark\D-Civil\01-Subdivision\Drawings\6-DACC\3-DA COURT DRAWINGS\200044-DA-C05.01-C05.08 SITEWORKS AND STORMWATER MANAGEMENT PLANS.dwg

FOR CONTINUATION REFER DRG: 200044-DA-C05.01



GENERAL WORKS LEGEND

SITE BOUNDARY	
CONTOUR	100.00
BATTER	
RETAINING WALL	RETAINING WALL
KERB AND GUTTER REFER DRG: C14.01 FOR COUNCIL STANDARD DETAIL	K&G
DISH DRAIN REFER DRG: C14.01 FOR COUNCIL STANDARD DETAIL	DD
KERB RAMP REFER DRG: C14.01 FOR COUNCIL STANDARD DETAIL	
LAYBACK KERB REFER DRG: C14.01 FOR COUNCIL STANDARD DETAIL	LBK
FINISHED LEVEL	F29.00
SWALE DRAIN	>
TEMPORARY DRAINAGE CHANEL	
SURFACE FALL	1.5%
PIPE SIZE STORMWATER DRAINAGE LINE FLOW DIRECTION	375
STORMWATER LINE/PIT NUMBER	A01/01
KERB INLET PIT	
SURFACE INLET PIT/JUNCTION PIT	
HEADWALL	

FOR CONTINUATION REFER DRG: 200044-DA-C05.05

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
4	17/12/2020	ISSUED FOR DEVELOPMENT APPLICATION	MDH	ML	MKH	MKH
3	11/12/2020	ISSUED FOR CLIENT REVIEW	MDH	ML	MKH	MKH
2	2/10/2020	ISSUED FOR INFORMATION	MDH	ML	MKH	MKH
1	28/10/2020	ISSUED FOR INFORMATION	MDH	ML	MKH	

Client: NEPEAN BUSINESS PARK

Scale: 0 10 20 30 40 50m — SCALE 1:500 @A1

North

enspire
Enspire Solutions Pty Ltd
205/275 Alfred Street N, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK
PENRITH

Title: SITEWORKS AND STORMWATER MANAGEMENT PLAN SHEET 04

Scale: 1:500
Date: 28/10/2020
Size: A1
Datum: AHD

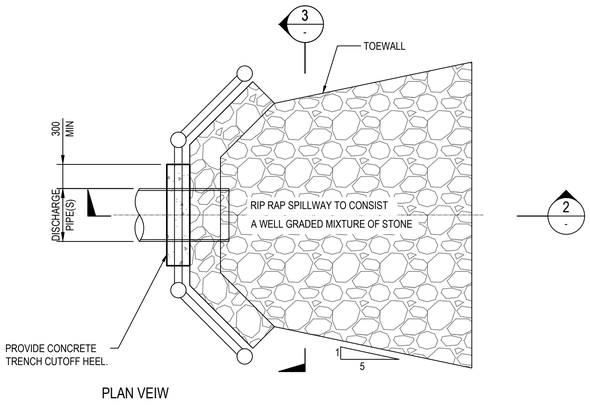
Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-DA-C05.04

Revision: 4

DATE PLOTTED: 28 September 2021 1:44 PM BY : ANDREW DAWES

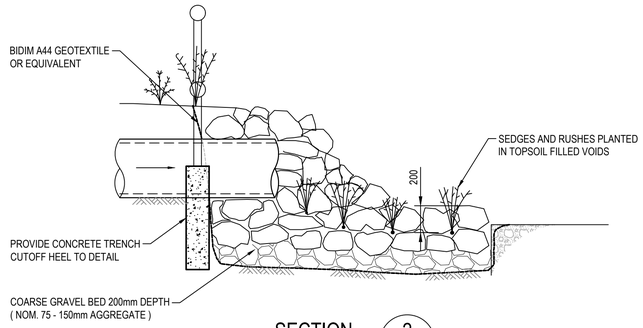
CAD File: P:\200044 NepeanBusinessPark\D-Civil\01-Subdivision\Drawings\6-DACC\3-DA COURT DRAWINGS\200044-DA-C05.01-C05.08 SITEWORKS AND STORMWATER MANAGEMENT PLANS.dwg



PLAN VEIW

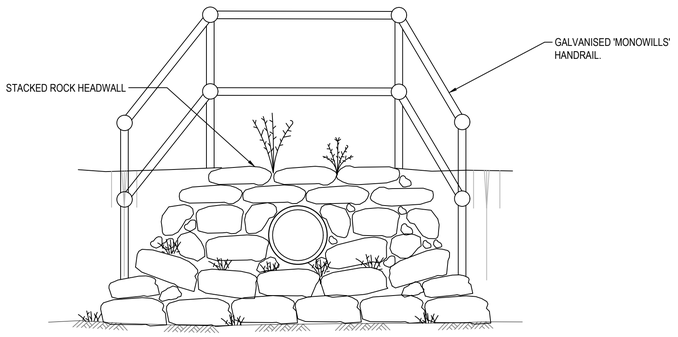
TYPICAL STACKED ROCK HEADWALL OUTLET

SCALE 1:20



SECTION 2 -

SCALE 1:20



SECTION 3 -

SCALE 1:20

RIP-RAP DETAIL

SCALE 1:20

OUTLET HEADWALL RIP-RAP DETAIL

SCALE 1:20

REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF	APPD.
3	29/09/2021	ISSUED FOR INFORMATION	MDH	ML	MKH	MKH
2	17/12/2020	ISSUED FOR DEVELOPMENT APPLICATION	MDH	ML	MKH	MKH
1	11/12/2020	ISSUED FOR CLIENT REVIEW	MDH	ML	MKH	MKH

Client: NEPEAN BUSINESS PARK

Scale: 0 500 1000 1500 2000mm — SCALE 1:20 @A1

North

Enspire Solutions Pty Ltd
205/275 Alfred Street N, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project: NEPEAN BUSINESS PARK
PENRITH

Title: STORMWATER DETAILS
SHEET 03

Scale: AS SHOWN
Date: 11/12/2020
Size: A1
Datum: AHD

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number: 200044-DA-C18.03

Revision: 3

DATE PLOTTED: 29 September 2021 4:28 PM BY : MARK HENNESSEY

CAD File: P:\200044 NepeanBusinessPark\D-Civil\01-Subdivision\Drawings\6-DACC\3-DA COURT DRAWINGS\200044-DA-C18.01-C18.03 STORMWATER DETAILS.dwg

10 September 2021

ENSPIRE SOLUTIONS
ABN 71 624 801 690

ENGINEERING
LAND DEVELOPMENT
PROJECT MANAGEMENT

1302/83 Mount Street
North Sydney
NSW 2060
Australia

Ms Clare Collett
Special Council
Mills Oakley
Level 7, 151 Clarence Street Sydney
NSW 2000

By email: ccollett@millsoakley.com.au

CC: dylan@precinctgroup.com.au

Dear Clare,

RE: Nepean Business Park, Penrith – Response to SOFC

This letter has been prepared by Enspire Solutions in response to the Civil Engineering related items within the associated Statement of Facts and Contentions (2021/204069), dated 1/9/21.

PART B1 – CONTENTIONS THAT THE APPLICATION BE REFUSED

Particulars

1.4 – Plans has been compiled from survey information provided by CitiSurv Pty Ltd dated 15 October 2018 and the 2 year approved site levels prepared by GCA Engineering Solutions dated 29 May 2020. The 2 year site levels have been adopted as existing levels within the site as construction has commenced. The compiled drawing has been added to the Civil Engineering drawing set (drawing numbers 200044-DA-C19.01 to C19.04) identifying the following:

- 1.4.1 – the location, boundary dimensions, site area and north point of the land;
- 1.4.2 – existing vegetation and trees on the land outside the 2 year earthworks extents;
- 1.4.3 – existing and 2 year levels of the land in relation to buildings and roads; and
- 1.4.4 – the location and uses of buildings on sites adjoining the land.

8.1 – A concept services Infrastructure Coordination Plan has been added to the Civil Engineering drawing set (drawing number 200044-DA-C12.01) identifying the following:

- In-ground and above ground services;
- A description of how infrastructure requirements would be coordinated, funded and delivered.

8.2 – Final design of infrastructure services will be undertaken in conjunction with each of the service authorities once their requirements are provided as part of the future construction documentation process which is the normal process for any development.

9.3 – A zoning overlay plan has been added to the Civil Engineering drawing set (drawing number 200044-DA-C01.42)

11.1 – The stormwater design achieves the requirements of Stage 2 Penrith Lakes Water Management Plan (WMP) including the stormwater and water quality objectives. Section 4 of the WMP outlines the design requirements for the Employment Land which are as follows: *"Specifically, the Employment Land located to the east of the Southern Wetlands will ultimately discharge its stormwater into the wetland treatment system once the site is developed. These inflows have been accounted for in the revised wetlands layout as well as the Hydrological Modelling (Appendix 2) and Water Quality Modelling (Appendix 4) of the Scheme. The Employment Land development will be required to treat any stormwater with gross pollutant traps in accordance with WSUD guidelines prior to discharge into the wetland system. The Southern Wetlands will provide all further water quality treatment and on-site detention required to service the proposed Employment Land development in accordance with WSUD guidelines."*

Gross pollutant traps have been incorporated into the design in accordance with the WMP as demonstrated in the Civil Engineering Report (REPT001-200044-01-Enspire-R02-201222Nepean Business Park DA Engineering Report) prepared by Enspire Solutions, Revision 2, dated 22nd December 2020. This confirms it meets the requirements of the WMP.

Water quality modelling and design has been undertaken in line with the following:

- Water quality treatment measures implemented into the design include Gross Pollutant Traps (GPT's) in accordance with the draft Penrith Lakes Development Control Plan – Stage 1 dated April 2021 prepared by the NSW Department of Planning, Industry and Environment (DPIE), Section 3.2.1;
- All tertiary water quality treatment is to be provided by the proposed Southern Wetlands associated with the Penrith Lakes Scheme, as documented and verified by J. Wyndham Prince report (110088-8-OSD and WQ Certification Letter_C) which is appendix D our report (REPT001-200044-01-Enspire-R02-201222-Nepean Business Park DA Engineering Report);
- The overarching stormwater management and road gradients were endorsed in principle by Penrith City Council. Refer email dated 24 November 2020 which is also attached to our report as Appendix C.

11.2 – It is proposed to include a GPT to each individual lot as documents in the WMP. This is outlined Section 6.5.1 of our report. It is noted that a Spill Management Plan will be established in line with normal practice for areas draining to sensitive receiving stormwater systems for each individual lot as part individual development applications to the consent authority.

11.3 – Information in relation to the specification and performance of the GPT's is outlined in the Engineering Report prepared by Enspire Solutions, Section 6.5.1. All GPT's will be a vortex type meeting the DCP requirements Clause 3.2.1 (1) of the Draft DCP. The overarching stormwater management and road gradients were endorsed in principle by Penrith City Council. Refer email dated 24 November 2020.

A detailed assessment of proprietary GPT's was undertaken by Enspire Solutions to determine to availability of appropriate devices that would meet the requirements. It was determined that there are multiple manufacturers of suitable continuously deflecting vortex type devices on the marked that will achieve compliance with the Draft DCP and WMP requirements.

The endorsed WMP provides the full details on how stormwater is treated in the Southern Wetlands.

11.4 – It is proposed that the two GPTs within the road corridors will be dedicated as part of the road and stormwater drainage infrastructure and maintained by Penrith City. The overarching stormwater management and road gradients were endorsed in principle by Penrith City Council. Refer email dated 24 November 2020.

11.5 – The stormwater design meets the objectives of the Stage 2 Penrith Lakes Water Management Plan. Please refer to my comments in section 11.1 above. The draft Penrith Lakes Development Control Plan – Stage 1 dated April 2021 prepared by the NSW Department of Planning, Industry and Environment (DPIE) Section 3.2.1 specifies stormwater controls for employment lands. The Water Quality objectives are clearly defined and have been complied with as outlined in our design and the JWP assessment letter dated 3 July 2020.

11.6 – The JWP OSD assessment letter outlines that the southern wetland Cell A will provide adequate storage to comply with OSD requirements. As documented in Section 4 of the WMP, the Southern Wetlands have been designed on the basis that the site does not incorporate OSD and caters for the unrestricted site runoff. The modelling by JWP demonstrates the required reduction in pre to post discharge from the Southern Wetlands into the Lake system. In addition, A review and assessment of the OSD was undertaken by JWP who concluded *"the discharge flow rates from the site would be negligible by comparison to the significant capacity available in the Penrith Lakes Scheme and the capacity of the Nepean River".*

11.7 – Refer item 11.6

11.8 – The Development Application documentation prepared by Enspire Solutions provides longitudinal sections of the proposed inground pipe network including velocities. The outlet headwall rip-rap detail is shown on drawing 200044-DA-C18.03 which is appropriate scour protection for the proposed flow rates.

11.9 – It is proposed that should the building works occur prior to the construction of the downstream Southern Wetlands, temporary OSD and WQ treatment would be required within each proposed lot.

PART B2 – INSUFFICIENT INFORMATION CONTENTIONS

Particulars

2.1 – The earthworks strategy has been developed in consultation with Penrith City Council to achieve the objectives of the Stage 2 Water Management Plan and stormwater management system. The overarching stormwater management and road gradients were endorsed in principle by Penrith City Council. Refer email dated 24 November 2020.

Planning considerations to be addressed by other**.**

2.3 – Bulk earthworks plans and sections have been amended to remove the discrepancy. Refer to the Civil Engineering drawing set (drawing number 200044-DA-C04.01, 200044-DA-C04.21, 200044-DA-C04.22 and 200044-DA-C04.23).

2.4 – Additional bulk earthworks sections have been added to demonstrate impacts of the works on the land zoned environmental adjoining the Nepean River and adjoining sites. Refer Sections on plan (200044-DA-C04.26).

2.5 – The extent of batters and their relationship to site boundaries provide sufficient space (varies between 9m and 18m) to provide landscaping.

2.8 - There are no earthworks taking place within the safety clearance zone of the electrical lines. Electrical lines are located within the road corridor. Any future built form will be clear of the boundary and environmental zone fronting Old Castlereagh Road and therefore have sufficient clearance**.**

Enspire believes the above adequately address the items identified in the SOFC.

Sincerely

Andrew Dawes
Director
For Enspire
andrew.dawes@enspiresolutions.com.au
+61 413 723 171