Civil Engineering and Infrastructure Report

16 Chapman Street, Werrington

80219053

Prepared for
Lendlease

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Cardno

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1 Introduction

Cardno has been engaged by Lendlease Communities to prepare documentation in support of a Development Application (DA) for 16 Chapman St, Werrington, legally described as Lot 1 in DP 1226122. . 16 Chapman St, Werrington is wholly located within the suburb of Werrington in the Penrith City Council (Council) Local Government Area (LGA) and is hereby referred to as the Subject Site. This site has been the subject of many previous development applications.

The works to which this report relates are broadly defined below:

- Earthworks
  - Significant cut and fill across the site
  - Boxing out of Roads
  - Lot grading
  - The shaping of future landscape elements
  - Boundary interfaces including batters and retaining walls
- Roads
  - The construction of the Internal road network connecting to Chapman Street and Walker Street
  - The construction of the East-West Link Road providing future connection to Werrington Road together with the construction of the associated roundabout
- Drainage
  - The construction of a piped drainage network
- Stormwater Quality/OSD
  - The construction of three bioretention basins co-located with the proposed detention basins
  - Installation of gross pollutant traps
- Utility servicing
  - Reticulation of utility services (i.e. potable water, wastewater, electricity, telecommunications, gas)
  - Construction of lead-in mains for electricity, water, gas and sewer.

1.1 South Werrington Urban Village Overview

Chapman St, Werrington is located within the South Werrington Urban Village (SWUV). The SWUV comprises approximately 48 hectares of land identified for urban development generating residential and employment uses. The SWUV will assist with the delivery of housing and employment opportunities in Penrith and integrate with the existing Werrington community north and south of the Great Western Railway (Penrith City Council, 2014).

Planning for the SWUV has been undertaken by Penrith City Council and is detailed in Council's Development Control Plan (DCP) for the SWUV (Penrith City Council, 2014).

The design of proposed development has been informed by the following:

- Penrith Development Control Plan 2014 Volume 2 – Part C – South Werrington Urban Village (Penrith City Council) 2014; and
- Werrington Enterprise Living and Learning (WELL) Precinct Development Contributions Plan (Penrith City Council) 2008.
- Design Guidelines for Engineering Works for Subdivision and Developments (Penrith City Council) 1997 (amended 2013)
- Stormwater drainage specification for Building Developments 2013 (amended 2018)

- WSUD Technical Guidelines (Penrith City Council) 2015

2 The Development Site

16 Chapman St, Werrington forms part of the overall SWUV urban development site and covers an area of approximately 27.7 hectares. The Subject Site is located to the west of Werrington Road and Claremont Creek, south west of Werrington Train Station, east of the Western Sydney University campus, and north of the Great Western Highway and the Cobham Juvenile Justice Centre. A site locality plan for the Subject Site is provided in Figure 2-1.

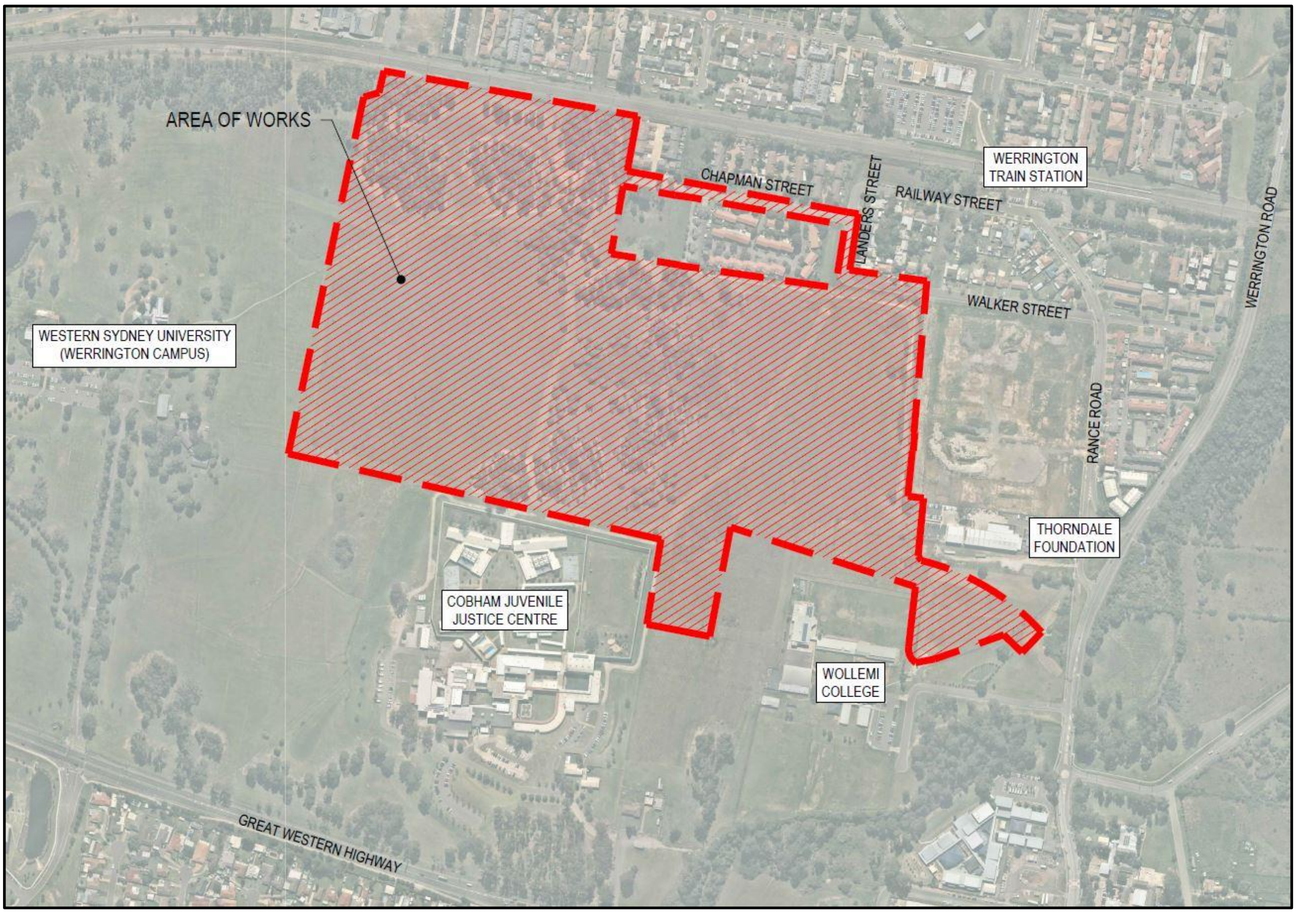


Figure 2-1 Site location

The development of the Site will be staged to provide 265 residential lots, 14 industrial Lots, 10 Residue Lots for future Torrens subdivisions, 1 residue Lot for a future apartment development and one residue Lot for future Road.

An indicative staging plan for the delivery of civil works and lots is shown in Figure 2-2. Other works involved for the proposed development includes:

1. New connector roads to service the proposed development as well as the adjacent properties including:
    a. North South Link Road, connecting Werrington Railway Station and Werrington Road; and
    b. East West Collector Road, connecting University of Western Sydney,the proposed industrial area and Werrington Road.
2. Stormwater detention and bio-retention basins; and
3. A new roundabout at Werrington Road to improve the existing intersection at Rance Road and the East West Collector Road mentioned above.

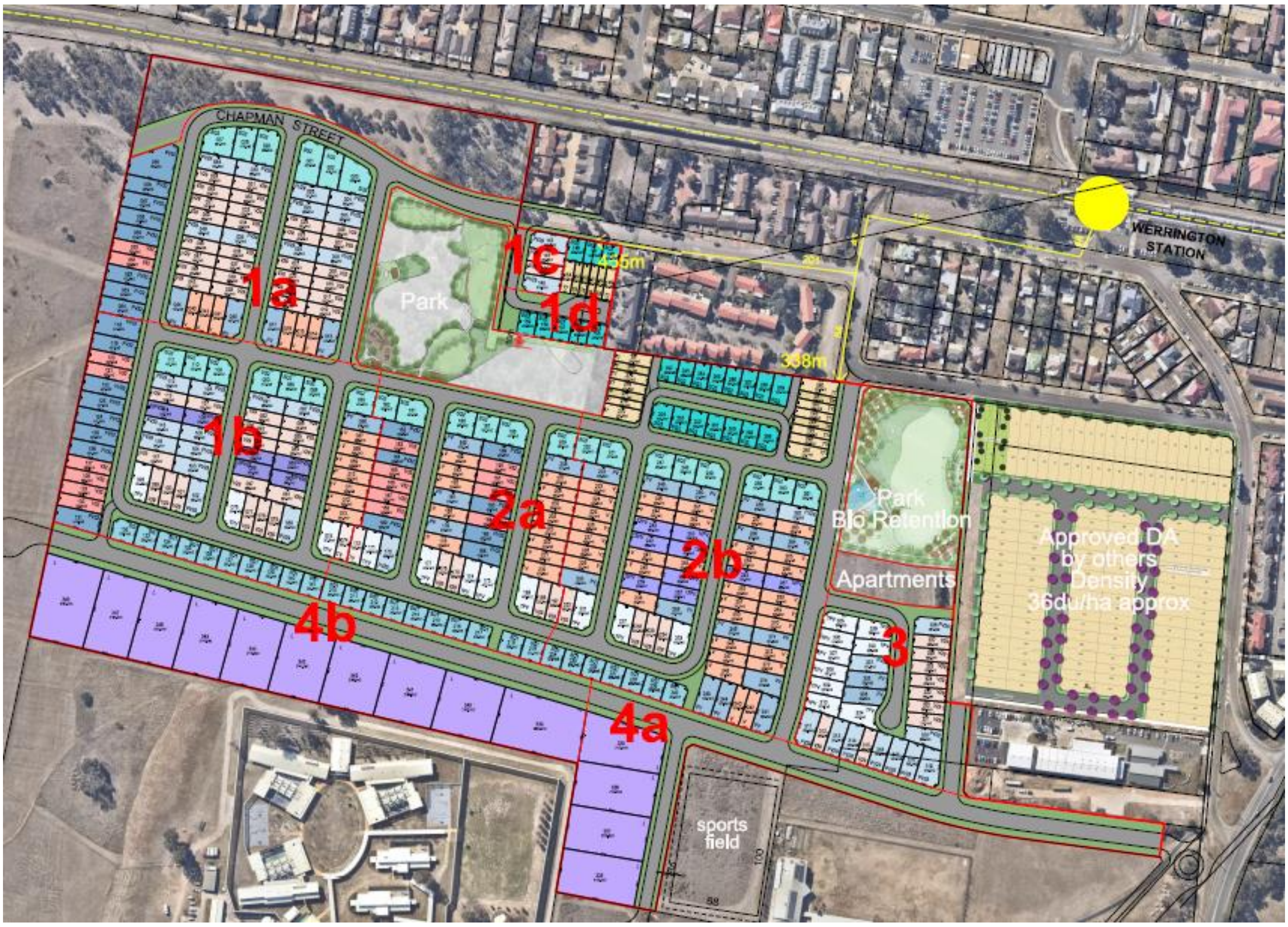


Figure 2-2 Masterplan of the proposed development

The Subject Site is categorised by flat grades to the eastern portion of the site (ranging between 0.5% and 4%) moderate grades to the west (up to 8%). The Subject Site generally grades from the south-west to the north-east.

3 Earthworks & Grading

It is proposed to undertake bulk earthworks for the Subject Site in accordance with Penrith City Council *Engineering Construction Specification for Civil Works* (2017) Section 4.

3.1 Site Grading

The site grading is largely dictated by the existing topography, the proposed road network, and the need to satisfy drainage requirements. The site generally falls from the south-west to the north-east. The design grading of the Lots generally ranges from 1% to 3%. The Subject Site is not affected by regional flooding hence road levels are not constrained by this factor.

3.2 Earthworks Quantities

Approximate earthworks volumes for the Subject Site are as follows:

- Cut - 45650m3
- Fill +301790m3
- Balance (sourced from off-site) +256141m3
-

These volumes are indicative and are subject to change during detailed design. The following provisions are included in quantifying the volumes:

- 300mm topsoil stripping;
- Bulking factor of 20% for material excavated on-site
- Nominal 400mm deep road boxing for pavement; and
- Nominal 150mm deep boxing for footpaths and cyclepaths.

3.3 Retaining Walls

Approximate retaining wall requirements on the Subject Site are as follows:

- Along the southern boundary of the site there is approximately 455m of retaining wall with a maximum height of 2.8m.
- Along the western boundary of the site there is approximately 345m of retaining wall with a maximum height of 1.7m.
- To the north of the site, there is retaining wall running along the interface between the central parkland and the east west minor local road (Road 05). This retaining wall is approximately 205m in length and has a maximum height of 2.0m. This wall joins with retaining wall running along the northern site boundary in Stage 2B which is approximately 195m in length with a maximum height of 1.2m.
- Within the site, there is a retaining wall approximately 475m in length and maximum height of 1.2m separating the industrial land with residential lots.
- Throughout the residential stages, there is approximately 1,100m of retaining wall along various lot boundaries of a height range of 0.45m to 1.5m.

3.4 General

The proposed road design is based on the masterplan as shown in Figure 2-2 and the road hierarchy as shown in Figure 3-1.

Figure 3-1 Road Hierarchy Plan (Drawing CI 1041)

The road corridors have been designed generally in accordance with Section 12.8.3.3.3 of Penrith DCP 2014. Note however that the location of the footpath has been adjusted so as to provide additional space for the planting of mature street tress. The footpaths have been set not less than 600mm from the Road reserve boundary.

3.5 Design Vehicles

The road layout for the Subject Site has considered three design vehicles as follows:

- A 12.5m long SU truck along all other internal roads.
- A 20m long B-Double truck and trailers
- A 19m long semi-trailer
- A standard passenger vehicle

Parameters for the design vehicles were adopted from *Guide to Road Design*, Austroads, 2006.

Design turning paths were used to determine where local increases in pavement width were required to ensure that the design vehicle could satisfactorily negotiate turns within striking or mounting the kerb or other obstructions. Where necessary, ‘no stopping’ signs, ‘one way’ signs and kerb blisters will be provided to ensure that turning areas are free from parked vehicles and to control traffic directions. Turning path plans are provided on drawings 3001-3005 of the *16 Chapman Street Werrington - Civil Works Development Application, Cardno, August 2019* drawing set (refer **Appendix A**).

3.6 Road Geometry and Width

Road geometry has generally been undertaken in accordance with the Penrith Development Control Plan 2014 Volume 2 – Part C – South Werrington Urban Village (Penrith City Council, 2014). There are five proposed road cross-sections within the Subject Site, summarised in Table 3-1 below.

Table 3-1 Road Reserve Widths

Road Type	Road Reserve Width (m)	Pavement Width (m)
East-West Link Road (Collector)	24.0m	12.0m
North-South Link Road (Collector)	19.6m	12.0m
Local Road	18.1m	10.5m
Minor Local Road	16.6m	9.0m
Laneway	12.5m	6.5m

Kerb and gutter will be constructed to contain the proposed carriageways for all road types.

3.7 Road Grading

Roads have generally been graded to ensure that parameters presented in Penrith City Council Design Guidelines for Engineering Works for Subdivisions and Development, Penrith City Council, 2013 are met. **Table 3-2** presents the minimum, maximum and typical road grades proposed within the Subject site. All roads have generally been designed with 3% cross-fall.

Table 3-2 Summary of Minimum, Maximum and Typical Road Grades

Road Type	Minimum Road Grade	Maximum Road Grade
All roads	0.7%	10%

3.8 Intersection

The proposed roundabout at the intersection between Werrington Road and East West Collector Road has been designed to improve the current congestion issue at Rance Road. It is proposed to have a 4 leg roundabout to provide access to East West Connector Road, Rance Road and the through traffic at Werrington Road. Traffic studies and concept sketches have been prepared in support of this arrangement.

4 Stormwater Drainage

4.1 Design Standards

The stormwater drainage network has been designed to comply with *Design Guidelines for Engineering Works for Subdivisions and Developments* (Penrith City Council, 2013), *Stormwater Drainage Specification for Building Development* (Penrith City Council, 2016) and *Australian Rainfall and Runoff, 2016*, Institution of Engineers.

The proposed drainage network has been designed to safely convey major and minor flows to basins before discharging into downstream drainage infrastructure. Design rainfall events have been adopted as follows:

- Minor System 20% AEP
- Major System 1% AEP

Stormwater pits have been positioned to suit the proposed road geometry and generally maintain a maximum flow width of 2.5 metres from the face of kerb during the design storm event.

Where practical, overland flow paths have been subject to preliminary design to accommodate the 1% AEP storm event by maintaining a velocity-depth product of 0.4 m^2/s or less and a maximum flow depth equal to or less than 300 millimetres. In instances where these parameters are exceeded, appropriate risk management strategies will need to be developed through the preparation of detailed design documentation.

4.2 Existing Site Drainage and catchments

The following description of the existing site drainage is based on first-hand site inspections, survey and consultant reports prepared by Aurecon (*South Werrington Urban Village Precinct Stormwater Management Strategy for Universal Property Group,* 2016), Patterson Britton & Partners (*South Werrington Sub Precinct Masterplan Servicing and Stormwater Management, 2006)* and Catchment Simulations Solutions (*College, Orth and Werrington Creeks Catchment Overland Flow Flood Study Final Report for Penrith City Council*, 2017).

The majority of the development site is divided into 2 main catchments:

The southern portion of the site currently falls towards a low point located along the north eastern boundary near Walker Street, where surface runoff is detained by an existing earth berm up to 1.6m in height. This berm is approximately 250m long where situated along the northern boundary of the site and is approximately 210m long along the eastern boundary of the site. This naturally-flat portion of the site, in conjunction with the berm, acts as an existing detention basin detaining runoff from the Subject Site and its external catchments before discharging through an existing 825mm headwall and pipe towards the corner of Chapman Street and Landers Street.

The remainder of the Subject Site drains towards the Werrington railway embankment and ultimately into Chapman Street and its existing drainage network.

These two sources of runoff converge at a pit located north of the corner of Chapman Street and Lander Street before being conveyed through 1150mm, 900mm and 850mm diameter pipes into a grassed channel and detention basin located along Railway Street, south of the railway line. A 1200 mm culvert conveys flows north beneath the railway line at Werrington Station. It is understood that flows in excess of the system result in backwater into a grassed swale located parallel to Landers Street and adjacent to existing townhouses, which functions as a surcharge basin. Catchment Simulation Solution’s flood study indicates that the area to the north of the site is inundated up to a water level of RL24.0m in a 1% AEP storm event.

The existing site drainage infrastructure described above is shown on the Engineering Plans to which this report relates.

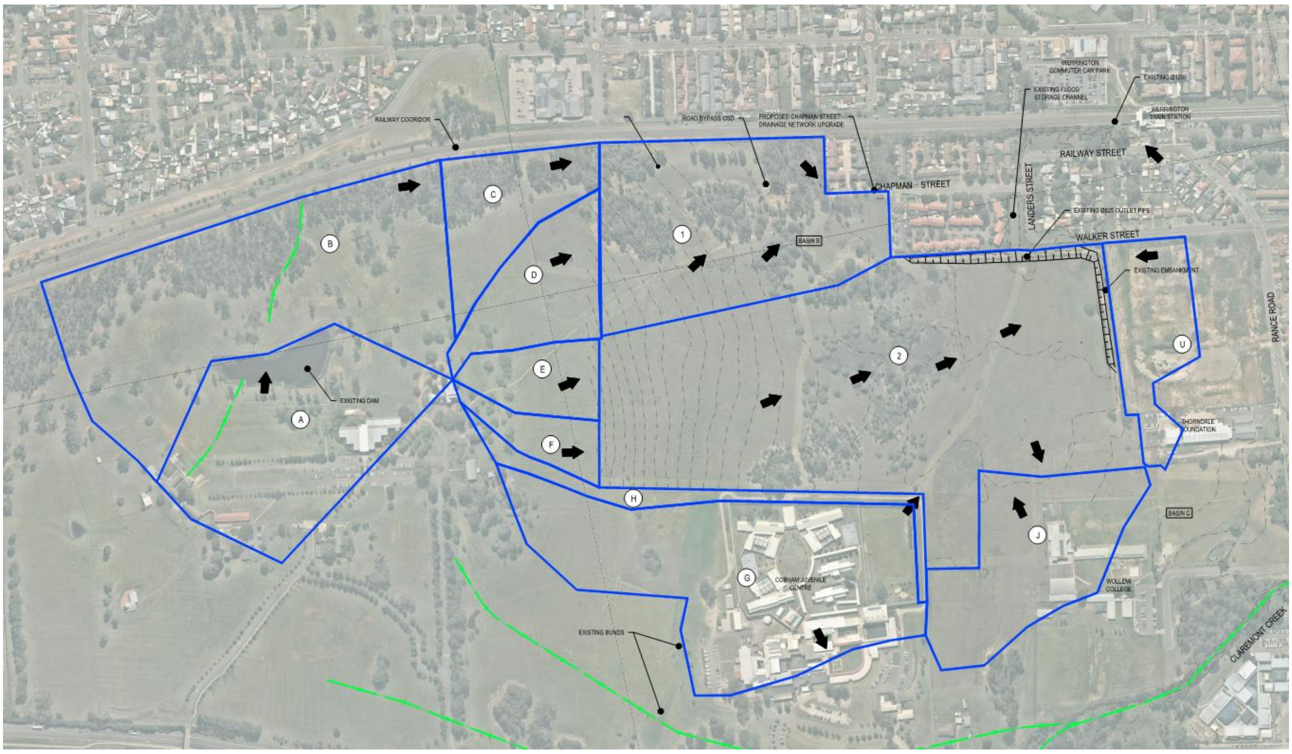


Figure 4-1 Pre-development Catchment Plan

4.2.2 External Catchments

As shown in Figure 4-1 above, the site is subject to stormwater flows from the external catchments, which are located to the west and south of the site. Western Sydney University (WSU) is located to the west with a catchment area of approximately 26ha. External catchments from the south includes part of the Cobham Juvenile Justice Centre, northern half of the existing land owned by Hillsong and the western section of Wollemi College.

External catchments to the south of the development site will drain to Road 10, where flows will be conveyed to the east towards Claremont Creek. The characteristics of the external catchments are summarised in Table 5-1.

Table 4-1 External Catchment Characteristics

Name	Area (ha)	Description
A	6.98	University of Western Sydney (UWS) Werrington North Campus drains to the existing dam with overflow draining to Catchment B and towards the railway corridor.
B	11.4	UWS land, mixture of grassland and woodland. Stormwater runoff ponds at the low point than flows parallel with the railway corridor towards the east.
C	3.96	UWS land, mixture of grassland and woodland. Stormwater runoff sheet flows across the site boundary to Catchment 8, then flows parallel with the railway corridor towards the east.
D	2.05	UWS land, predominantly grassland with steep slope up to 8% grade. Existing runoff flows north-east towards Chapman Street.
E	2.1	UWS land with well-maintained lawn. The site has steep slope up to 9% grade. Existing runoff flows east towards the existing low point at Walker Street.
F	1.05	UWS land with well-maintained lawns. The site has a steep slope up to 9% grade. Existing runoff flows east towards the existing low point at Walker Street.
G	9.55	The site has a grade of approximately 5% with well-maintained lawns. Cobham Juvenile Centre is located to the eastern side of the catchment, an existing OSD basin is located to the south eastern corner of the Centre and drains stormwater runoff to the unnamed

		watercourse south of the catchment. There are bunds to the west of the Centre which divert stormwater runoff from the centre.
H	1.32	Catchment with well-maintained lawns drains to the existing low point to the north-eastern corner of Cobham Juvenile Justice Centre. Existing runoff flows east towards the existing low point at Walker Street.
J	5.02	Existing catchment drains to the low point in Walker Street. Existing runoff flows east towards the existing low point at Walker Street. Post-development modelling of this catchment is used to size Basin C.

4.2.3 Post-development stormwater management strategy

The stormwater management strategy has been designed based on the following documents and correspondences:

- Part E12 – South Werrington Urban Village, Penrith City Council DCP 2014;
- South Werrington Sub-Precinct Masterplan Servicing and Stormwater Management prepared for University of Western Sydney by Patterson and Partners Pty Ltd, 2006; and
- Discussions during the Pre-DA meeting with Penrith City Council and Lend Lease, and subsequent email correspondences.

The proposed stormwater drainage network generally consisting of gross pollutant traps, onsite detention (OSD) basins and bio-retention (WSUD) basins to ensure the design complies with Penrith City Council's stormwater management objectives. There are 2 combined OSD/WSUD basins and 1 bio-retention basin for the proposed development.

Basin A is located to the north eastern development site and has been designed to attenuate the peak flow from the proposed development (Catchment 2). The bio-retention area will be provided to remove pollutants from the stormwater runoff. As the development adjoins an established residential area, its configuration will provide a smooth interface with the surrounding environment along Walker Street.

The area known as Catchment 8 (refer to Figure 5-2) drains to Walker Street. Basin A has been designed to compensate the free draining component of the development site (Catchment 8).

Basin B is located at the centre of the development site, at the end of Chapman Street. The upper part of Basin B is a bio-retention basin and the lower part provides OSD storage for the proposed development site.

Basin C is located near the intersection Werrington Road and the proposed East West Collector Road, which will provide stormwater treatment for the road runoff and a small portion of residential development that will be drained to the road. Discussions with Penrith City Council during the pre-DA phase were to the effect that Council have agreed in principal (and subject to detailed assessment) to Basin C being a bio-retention basin only, treating the stormwater runoff from Catchment 6.

The justification for this arrangement is that Basin A has been designed to detain all of the stormwater runoff from the approved development of 25 Rance Road, Werrington (DA15/0207) (refer to Catchment U in Figure 4-1). The existing scenario is that the eastern half of the 25 Rance Road development is currently draining to Claremont Creek.

It is proposed that the 14 industrial lots will be burdened with a restriction requiring the future built form over those Lots to incorporate separate private OSD and WSUD measures.

The Post-development catchments are illustrated in **Figure 4-2** below**,** which shows the catchment boundaries and the locations of the proposed basins.

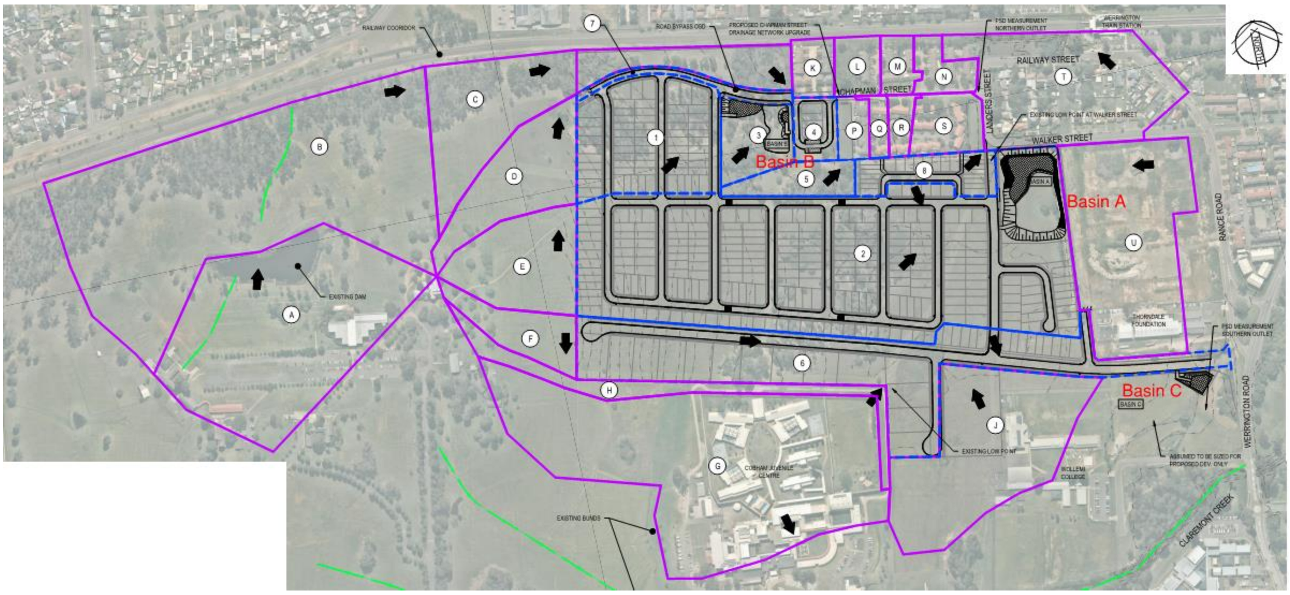


Figure 4-2 Post development catchment plan (Refer to Drawing CI 2301)

The internal catchment properties are shown in Table 5-2.

Table 4-2 Post Development Catchment Characteristics

Name	Area (ha)	Description
1	3.29	Proposed residential development, stormwater runoff will be treated by Basin B.
2	13.6	Proposed residential development, stormwater runoff will be treated by Basin A.
3	1.01	Proposed Park drains to Basin B, majority of the area will remain to match existing condition to ensure minimal disturbance to the existing trees.
4	0.65	Proposed residential development, stormwater runoff will be treated by Basin B.
5	0.73	Proposed Park drains to Chapman Street bypasses OSD/WSUD basins. Majority of the area will remain to match existing condition to ensure minimal disturbance to the existing trees.
6	6.15	Proposed industrial lots will have individual OSD tanks and stormwater treatment devices, these measures will be designed and part of separate development application. The road runoff and an approximate 0.6ha of residential area will be drained to Basin C for stormwater quality treatment, then discharge to Claremont Creek.
7	0.36	Half of Road 13 Catchment bypasses proposed Basin B and drains to Chapman Street.
8	0.96	Proposed residential development drains to proposed gross pollutant trap prior discharges to Walker Street. This catchment bypasses Basin A.

The proposed stormwater drainage network has been designed to convey the stormwater runoff from the external catchment through the development site. These measures are shown in Table 5-3.

Table 4-3 Stormwater drainage strategy for the external catchment in post development scenario

Name	Area (ha)	Description
D	2.05	Stormwater runoff will be collected by a drainage swale along the site boundary and conveyed to the proposed Chapman Street stormwater drainage network upgrade.
E	2.1	Stormwater runoff will be collected by a drainage swale along the site boundary and conveyed to the proposed Road 5 stormwater drainage network.

F	1.05	Stormwater runoff will be collected by a drainage swale along the site boundary and conveyed to Catchment H.
H	1.32	Stormwater flows will be conveyed to Claremont Creek via a new stormwater drainage network in East West Collector Road.
J	4.5	Stormwater flows will be conveyed to Claremont Creek via a new stormwater drainage network in East West Collector Road.
U	4.61	Based on the approved DA plans of the proposed development at 25 Rance Road, the majority of the development will be drained to Basin A for detention and water quality treatment.

4.3 Hydrology Calculations

Detailed catchment modelling was conducted to calculate flows generated by the site within the DRAINS software package. This software package uses the industry standard for hydrology calculation ILSAX. The following parameters were used in the model:

- Bureau of Meteorology IFD design rainfall depth 2016 data based on the geographical location of the Subject Site
- Australian Rainfall and Runoff 2016 Data Hub areal and temporal patterns based on the geographical location of the Subject Site
- Depression storage:
  - 1 mm for paved (i.e. impervious) areas
  - 5 mm for grassed (i.e. pervious) areas
- Antecedent moisture condition 3
- Time of Concentration has been calculated by the kinematic wave equation, which is based on the catchment slope, flowpath length and roughness values (as shown below). For small urban catchments, the minimum Time of Concentration of 5 minutes and 10 minutes for impervious and pervious areas respectively has been adopted..
- Surface roughness parameter Mannings n:
  - 0.15 - 0.3 for pervious areas
  - 0.015 - 0.018 for impervious areas

The fraction of imperviousness for different land use is shown in Table 4-4 below.

Table 4-4 Fraction of imperviousness of different land use

Catchment	% Impervious	Comment
Local Roads	95	Based on Penrith City Council Engineering Design Guidelines
Collector Roads	75-85	Based on typical road cross-sections
Residential	85	Based on Penrith City Council Engineering Guidelines for medium density residential developments
Industrial	90	Based on Penrith City Council Engineering Guidelines
Open Space incl. Basins	5-20%	Based on proposed land uses
External Catchments	0-30%	Based on aerial imagery

Two DRAINS models have been developed:

1. A pre-development model was established to assess the permissible site discharge (PSD). The PSD is measured at location where the stormwater runoff from the development site converges, which is located at the intersection of Chapman Street and Launder Street. The pre-development model has included:

- The existing basin within the development site and the 825mm diameter outlet pipe; and
- The downstream catchments, which is controlled by the existing 1200mm diameter outlet pipe under the railway corridor, which would allow the model to calculate the tailwater condition at the existing basin outlet.

2. A post development model was established to estimate the OSD volume required for the proposed development. The storage volume in the existing basin and the area to the downstream of the site were calculated by 12d with data from the 2m contours and the detailed site survey.

4.4 Hydraulic Calculations

The hydraulic calculation was conducted using DRAINS software.

The model represents all lumped catchments collected via a pit and pipe network designed to cater for the minor flows with consideration of major design storms. All areas are gravity drained with overland flows.

Hydraulic calculations are preliminary only and have principally been used to determine the appropriate pipe sizes for the trunk drainage and to size the proposed detention basins in order to attenuate flows off-site to pre-development conditions.

4.5 Chapman Street Drainage Upgrade

There will be stormwater drainage upgrade work in Chapman Street to provide a connection to the proposed stormwater drainage network in Road 14 and Basin B. It is proposed to construct a new 750mm diameter drainage line to convey stormwater on the northern side of Chapman Street and connect to the existing stormwater pit and pipe network in Lander Street.

The stormwater drainage network will provide an improvement to the existing flow conditions within Chapman Street as the proposed stormwater drainage network will reduce the amount of surface runoff on the road.

4.6 Basin design

The proposed OSD basins are designed to ensure adequate storage can be provided and minimise the loss of natural vegetation. The basins generally consist of:

1. Landscaped vegetated batters up to 1:3 slope;
2. Sandstone retaining walls;
3. A maintenance access ramp at 1:10 slope; and
4. Minimum 1% fall at the base.

The proposed basins as shown in the civil engineering drawings provides a conceptual footprint of the basin to ensure adequate storage can be provided. The basins will be designed in consultation with the landscape architect to improve the aesthetic and provide a better transition with the surrounding open space design.

The modelling results for the OSD basins are shown in Table 5-5

Table 4-5 OSD Modelling Results

AEP (%)	Pre-development Flow (m^3/s)	Post-development Flow (m^3/s)	Basin A Storage (m^3)	Basin B Storage (m^3)
50%	0.66	0.66	6900	1050
20%	1.81	1.27	7800	1650
5%	3.20	2.50	8500	2100
1%	4.80	3.65	12000	3500

The total OSD storage for the proposed development is 15,500m^3, which is approximately 560m^3/ha. The OSD storage rate is slightly higher than the typical OSD storage rate of 400m^3/ha, this may be caused by the submerged outlet condition at the catchment outlet point.

5 Stormwater Quality

As the development of the Subject Site is expected to produce additional pollutants compared to existing conditions, stormwater quality treatment will be required to treat stormwater drainage prior to discharge off-site.

Stormwater quality management has been generally assessed and designed in accordance with the following guidelines:

- *Stormwater Drainage Specification for Building Development*, Penrith City Council, 2016
- *WSUD Technical Guidelines Volume 3*, Penrith City Council, 2015
- *WSUD Technical Guidelines Deemed to Comply Toolkit*, Penrith City Council, 2015
- *NSW MUSIC Modelling Guidelines,* BMT WBM Pty Ltd*, 2015*

5.1 Water Quality Objectives

Stormwater quality pollutant load reduction requirements for all development types are:

- 90% reduction in the post-development mean annual load total Gross Pollutants (greater than 5mm);
- 85% reduction in the post-development mean annual load Total Suspended Solids (TSS);
- 60% reduction in the post-development mean annual load Total Phosphorus (TP); and
- 45% reduction in the post-development mean annual load Total Nitrogen (TN).

5.2 Water Quality Strategy

The majority of the site will consist of residential lots, with the remainder being open space and residue industrial lots. A small portion of the site and some external catchments will bypass the water quality treatment system due to site grading, with the remainder diverted to a treatment train of bioretention basins and gross pollutant trap (GPT) units. Water quality treatment catchments are based on post-development catchments described in **Section 4.2.3**.

The stormwater quality management strategy for the Subject Site includes the following water quality improvement devices:

- Three bioretention basins;
- Four gross pollutant traps (GPTs); and
- Rainwater tanks on residential lots.

Rainwater tanks are to be provided as part of dwelling construction with sizing to be determined through a BASIX assessment. For the purposes of the water quality modelling, it has been assumed that each dwelling will provide a 2,500L rainwater tank, modelled at 80% capacity (2,000L).

The neighbouring 25 Rance Road Development Application proposes a permanent GPT and a temporary bioretention basin to be provided on-site until the proposed Basin A is constructed (*Proposed Residential Subdivision 25 Rance Road, Werrrington NSW 2747 Civil and Stormwater Engineering Works*, SGC, 2017). Water quality modelling for the Subject Site has reflected the ultimate case at 25 Rance Road, specifically that the adjacent site is treated with its own GPT before discharging into the proposed Basin A. It is noted that this GPT will not form part of the Subject Site works and has been modelled only to reflect the ultimate treatment case proposed at 25 Rance Road.

It is assumed that the residue industrial lots and the proposed apartment site will provide their own water quality treatment, and this has been reflected in the modelling.

5.3 MUSIC Modelling

Water quality treatment effectiveness has been modelled using the MUSIC software package (v6.3.0) incorporating Penrith City Council MUSIC link data for hydrology and node parameters. **Figure 5-1** provides a MUSIC node diagram reflective of the stormwater quality management strategy.

Treatment and pollutant source node parameters are generally adopted from Council guidelines and NSW MUSIC Modelling Guidelines, with some exception. Treatment node parameters are provided in tables below and further details are shown on drawing number 2201 of the *Chapman Street Werrington - Civil Works Development Application, Cardno, August 2019* drawing set. The MUSIC link report for the modelling is provided in **Appendix A**.

5.3.1 Gross Pollutant Traps

Rocla CDS units have been adopted within the Subject Site for the MUSIC modelling however this is subject to Council preferences. Gross pollutant trap parameters have been adopted as given in **Table 5-1**. Parameters are subject to change during detailed design.

Table 5-1 Gross Pollutant Trap MUSIC Node Parameters

MUSIC Model Parameter Input	Value	Comment
Gross Pollutant	98% removal efficiency	Council WSUD guidelines
Total Suspended Solids	70% removal efficiency for inflow concentrations greater than 75 mg/L	Council WSUD guidelines
Total Phosphorus	30% removal efficiency for inflow concentrations greater than 0.5 mg/L	Council WSUD guidelines
Total Nitrogen	0% removal efficiency	Council WSUD guidelines

5.3.2 Bioretention Basins

Bioretention node parameters are based on Council guidelines and are given in **Table 5-2**. Parameters are subject to change during detailed design.

Table 5-2 Bioretention Basin MUSIC Node Parameters

MUSIC Model Parameter Input	Value	Comment
Extended Detention Depth (m)	0.3	0.3m maximum depth specified in Council WSUD guidelines
Filter Media Depth (m)	0.5	0.5m minimum depth specified in Council WSUD guidelines
TN Content of Filter Media (mg/kg)	800	Council WSUD guidelines
Orthophosphate Content of Filter Media (mg/kg)	40	Council WSUD guidelines

5.3.3 Rainwater Tanks

Rainwater tank node parameters are based on Council guidelines and are given in **Table 5-3**. Parameters are subject to change during detailed design.

Table 5-3 Rainwater Tank MUSIC Node Parameters

MUSIC Model Parameter Input	Value	Comment
Tank Volume (m^3)	2,000	80% of 2,500L rainwater tank volume available (NSW MUSIC Modelling Guidelines)
Tank Surface Area (m^2)	1.5	1.5m high tank with 0.2m above overflow pipe
Annual demand (kL/year)	50	Non-potable reuse rates as per Council WSUD guidelines for lots > 320m^2 and < 520m^2.
Daily Demand (kL/day)	0.1	Non-potable reuse rates as per Council WSUD guidelines for lots > 320m^2 and < 520m^2.
Portion of Lot Roof Area Draining to Tank	50%	Council WSUD guidelines

5.3.4 Generic Treatment Nodes

Areas assumed to have internal treatment measures (the apartment site and industrial lots) are routed through generic treatment nodes which match the target removal efficiencies for Penrith City Council specified in **Section 5.1**.

5.3.5 Pollutant Generation Nodes

Pollutant generation node parameters were generally based on Council guidelines, with impervious percentage areas matching values given in **Section 4.2**. The central parkland and undeveloped southern external catchment parameters are based on 'clay loam' rainfall-runoff parameters specified in the *NSW MUSIC Modelling Guidelines* (2015) and geotechnical borehole results from *Land Capability Assessment South Werrington Urban Village Precinct* (Douglas Partners, 2014).

5.4 Results

The treatment efficiencies modelled in MUSIC are given in the tables below. **Table 5-4** and **Table 5-5** show treatment efficiencies for the Northern and Eastern measurement points respectively. **Figure 5-1** shows the MUSIC Modelling Diagram.

Table 5-4 Stormwater Quality Treatment Train Effectiveness – Catchment Outlet at intersection of Landers Street and Chapman Street

Pollutants	Sources	Residual Load	Percentage Reduction (%)	Council DCP Reduction Target (%)
Gross Pollutants (kg/year)	3610	167	95	90
Total Suspended Solids (kg/year)	18900	2930	85	85
Total Phosphorus (kg/year)	32.9	12.2	63	60
Total Nitrogen (kg/year)	267	121	55	45

Table 5-5 Stormwater Quality Treatment Train Effectiveness – Basin C outlet

Pollutants	Sources	Residual Load	Percentage Reduction (%)	Council DCP Reduction Target (%)
Gross Pollutants (kg/year)	866	43	95	90
Total Suspended Solids (kg/year)	7360	945	87	85
Total Phosphorus (kg/year)	12.2	3.65	70	60
Total Nitrogen (kg/year)	66.1	30.7	53	45

The Water quality infrastructure nominated at this stage is given in the table below. Sizes and unit models are preliminary only and are subject to change in detailed design of the Stormwater Quality Treatment Infrastructure

Table 5-6 Water quality infrastructure

Location	Bioretention Filter Media (m^2)	Filter depth (m)
Basin A	2000	0.5
Basin B	800 (Upper) and 100 (Lower)	0.5
Basin C	450	0.5

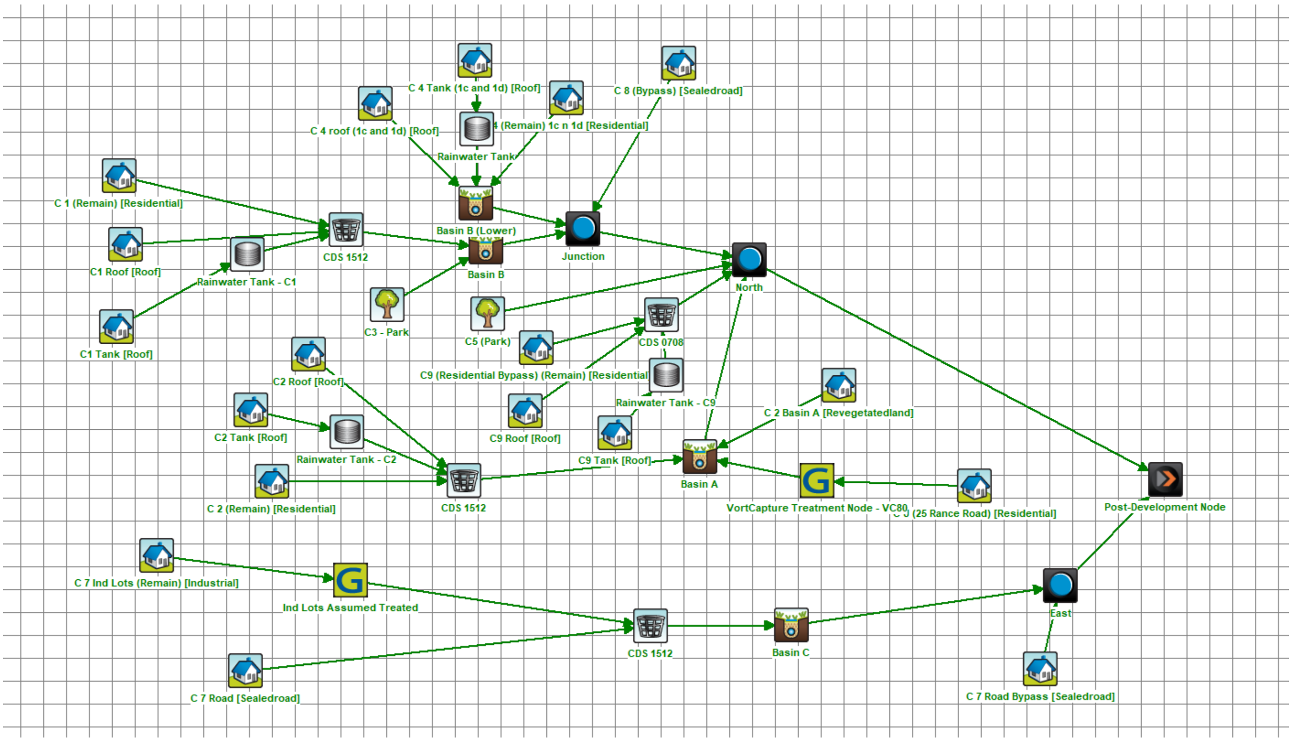


Figure 5-1 MUSIC Modelling Diagram

6 Overland Flowpath Assessment

The catchment plan as shown in Figure 6-1 and Figure 6-2 shows the existing development site is subject to overland flow from the external catchment.

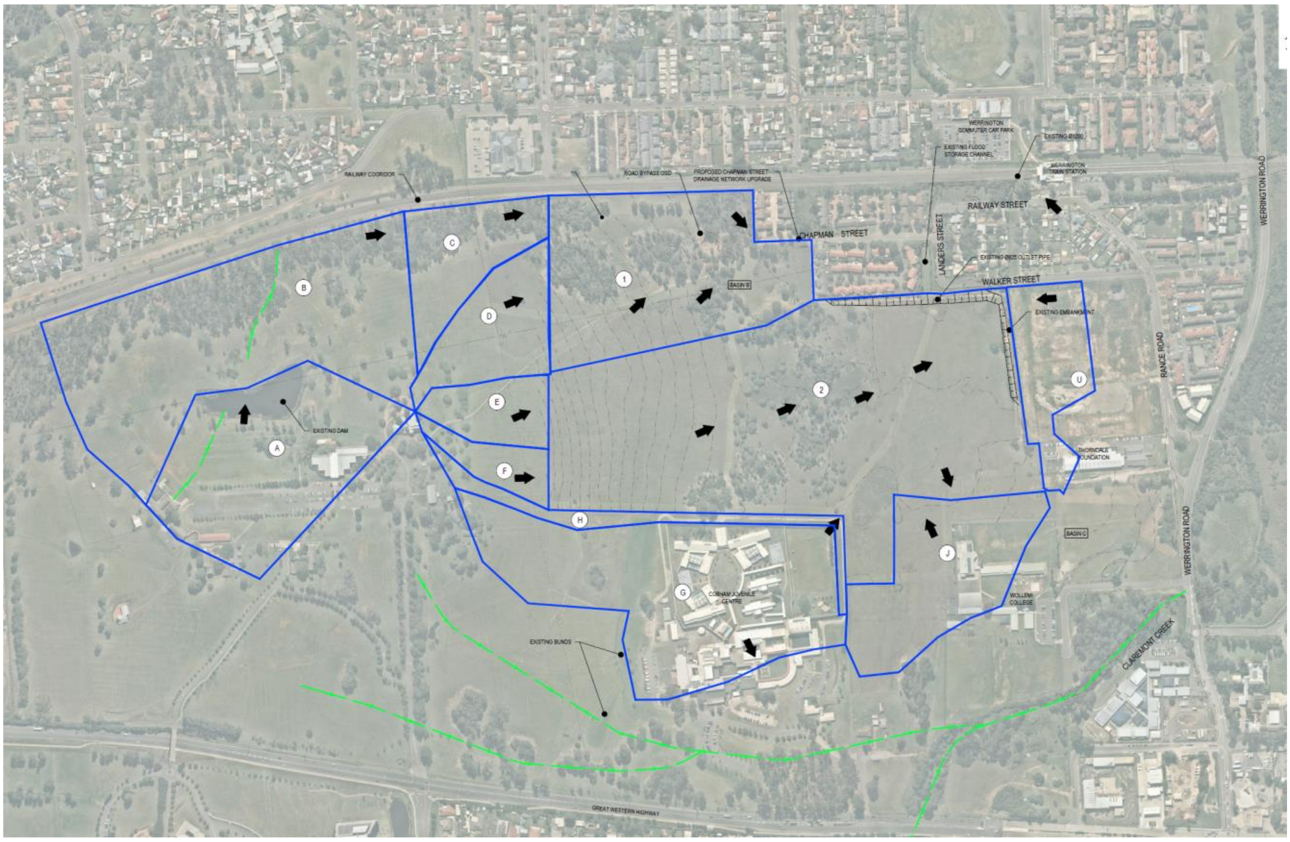
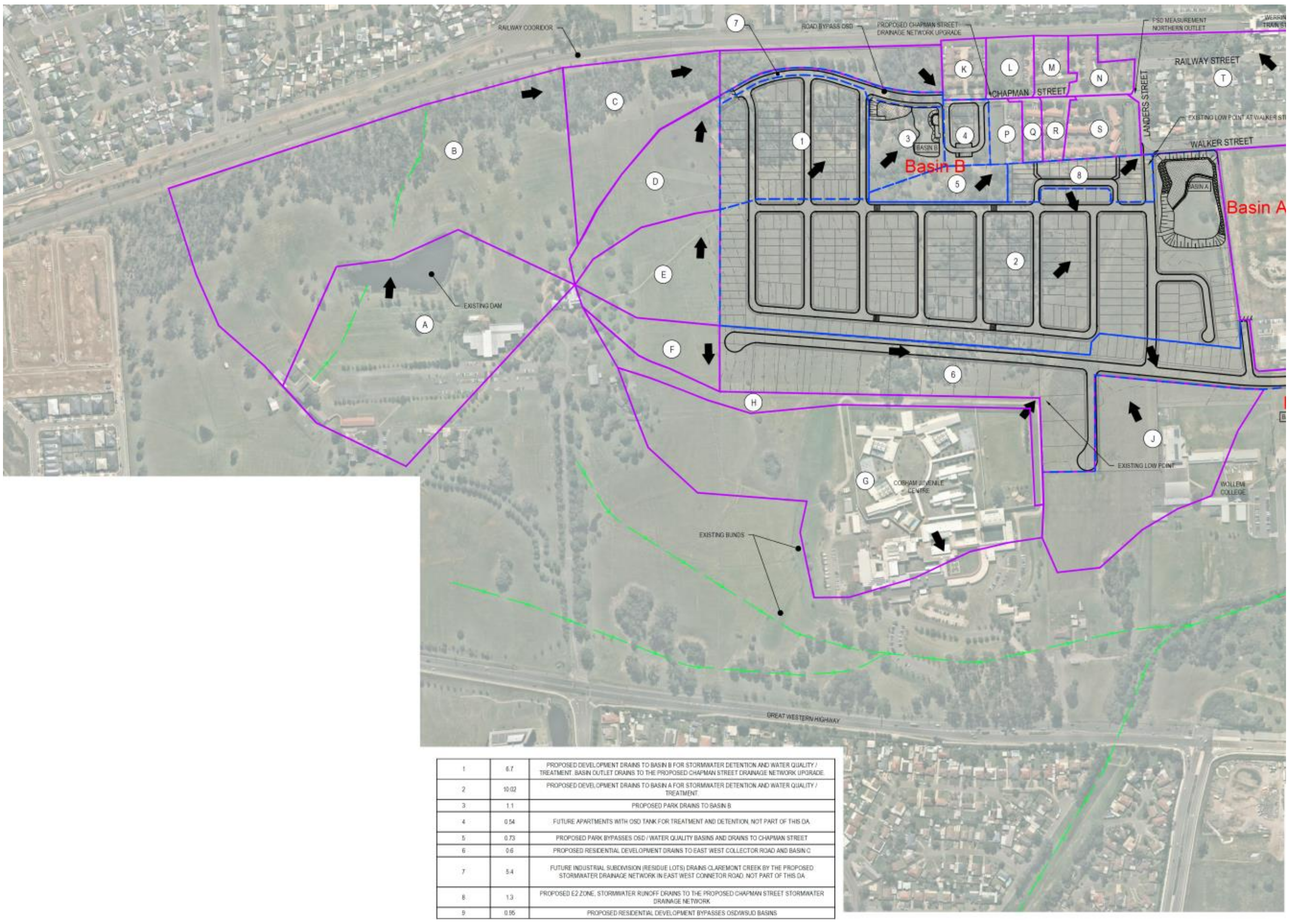


Figure 6-1 Existing Catchment Plan



1	6.7	PROPOSED DEVELOPMENT DRAINS TO BASIN B FOR STORMWATER DETENTION AND WATER QUALITY / TREATMENT. BASIN OUTLET DRAINS TO THE PROPOSED CHAPMAN STREET DRAINAGE NETWORK UPGRADE
2	10.02	PROPOSED DEVELOPMENT DRAINS TO BASIN A FOR STORMWATER DETENTION AND WATER QUALITY / TREATMENT
3	1.1	PROPOSED PARK DRAINS TO BASIN B
4	0.54	FUTURE APARTMENTS WITH OSD TANK FOR TREATMENT AND DETENTION. NOT PART OF THIS DA
5	0.73	PROPOSED PARK BYPASSES OSD / WATER QUALITY BASINS AND DRAINS TO CHAPMAN STREET
6	0.6	PROPOSED RESIDENTIAL DEVELOPMENT DRAINS TO EAST WEST COLLECTOR ROAD AND BASIN C
7	5.4	FUTURE INDUSTRIAL SUBDIVISION (RESIDUE LOTS) DRAINS CLAREMONT CREEK BY THE PROPOSED STORMWATER DRAINAGE NETWORK IN EAST WEST CONNETOR ROAD. NOT PART OF THIS DA
8	1.3	PROPOSED E2 ZONE, STORMWATER RUNOFF DRAINS TO THE PROPOSED CHAPMAN STREET STORMWATER DRAINAGE NETWORK
9	0.95	PROPOSED RESIDENTIAL DEVELOPMENT BYPASSES OSD/WSUD BASINS

Figure 6-2 Post Development Catchment Plan

A Flood Study prepared by Catchment Simulation Solutions for Penrith City Council has indicated there are 2 overland flowpaths which run through the proposed development site. Flowpath A runs along the railway corridor through the proposed E2 zone and then flows to Chapman Street towards the railway station.

Flowpath B starts within Cobham Juvenile Centre and traverses through the site to Walker Street. **Figure 6-3** shows the locations of the flowpath,

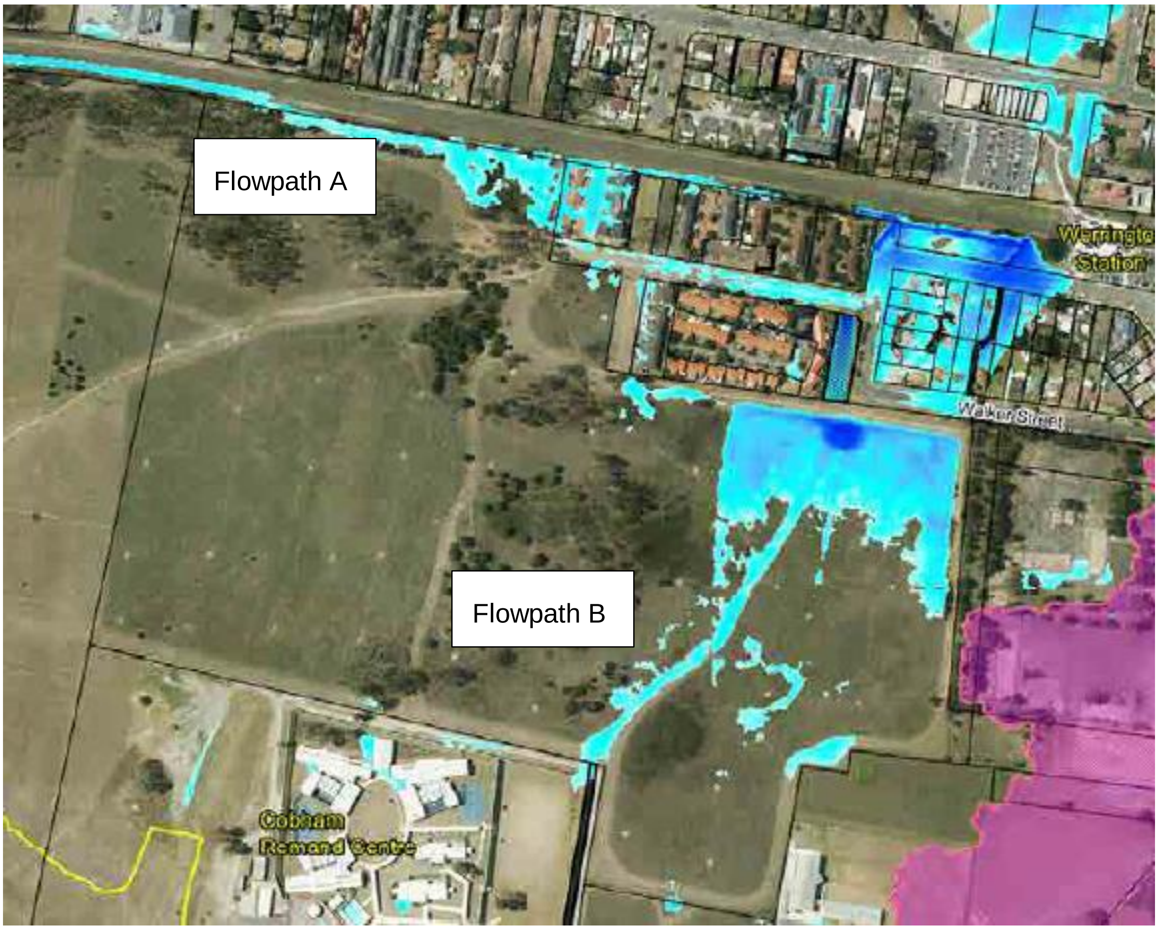


Figure 6-3 Existing flow condition – 1% AEP (Figure 16-6 of the College, Orth and Werrington Creek Flood Study)

6.2 Flowpath A

Since the work extent of the proposed development will not extend beyond Road 14, it is unlikely that there will be any changes to the flow conditions adjacent to the railway corridor. Stormwater pits will be located at the site boundary at Chapman Street to will capture some of the surface runoff into the pipe network, hence reducing the flow depth in Chapman Street.

6.3 Flowpath B

Overland flowpath B will be replaced by the stormwater drainage network in East West Collector Road, which will convey stormwater to the east to Claremont Creek. The stormwater drainage network consists a series of pit and pipe network ranges between 750mm diameter pipe to 1050mm pipes. The 1% AEP flood level at Cobham Juvenile Centre is approximately 300mm, similar to the findings in the flood study as shown in **Figure 6-3.**

The stormwater drainage network in the East West Collector Road has been modelled in DRAINS to confirm the feasibility to divert the stormwater flow to the east, **Figure 6-4** shows the maximum ponding at the low point near Cobham Juvenile Centre is approximately 312mm, similar to the flood study results as shown in **Figure 6-3.**

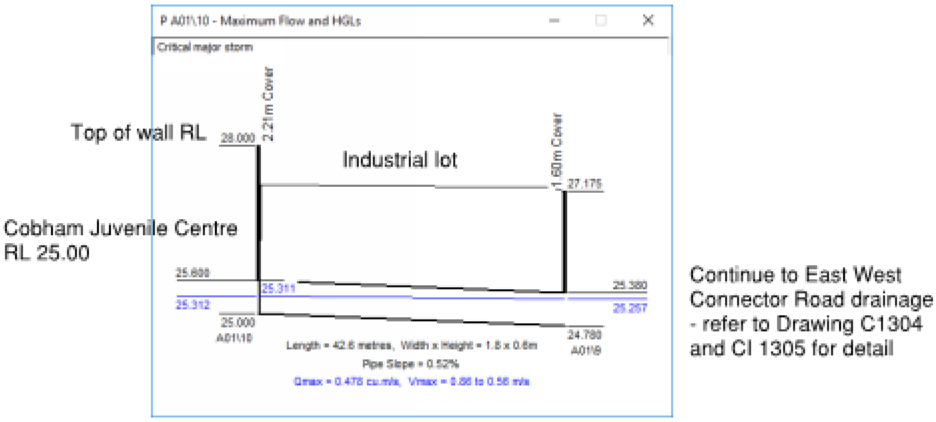


Figure 6-4 DRAINS modelling results – 1% AEP

7 Sediment & Erosion Control

Sediment and erosion control measures will be installed and maintained in accordance with Council's requirements and Landcom's *Managing Urban Stormwater, Soils and Construction* (2004). General erosion and sediment control measures include:

- Erection of temporary perimeter security fencing and sediment control fencing;
- Installation of sediment traps and barriers along stormwater flowpaths and inlet pits;
- Appropriate treatment of construction vehicles to control and minimise sediment and debris affecting areas external to the development site;
- Formation of material delivery stockpiles near areas of minimal cut or fill, including provision of appropriate covers and containment to prevent sediment runoff; and
- Provision of sediment basins at the locations of the proposed detention basins.

The full sedimentation and erosion control strategy is presented on drawing numbers 1101-1104 within the Cardno drawing set *Chapman Street Werrington - Civil Works Development Application, Cardno, August 2019.*

8 Waste Management

8.1 Construction Waste Management

Prior to the construction of Chapman St, Werrington the development team is to produce a Construction Environment Management Plan which will include details of construction waste management that contractors will be made to comply with.

8.2 Occupation Waste Management

The Subject site road and lot layout has been designed generally in accordance with Penrith City Council's *Waste Management Guidelines for Residential Subdivisions*. In particular, road and property boundary geometries have been adjusted to suit the 12.5m Penrith City Council waste pickup vehicle, including the provision of traffic control signage and design measures.

9 Utilities

New utility servicing infrastructure will be provided to service the lots created within 16 Chapman Street, Werrington. These services will be placed in typical shared trench arrangements in accordance with the NSW Streets Opening Conference Guide to Codes and Practices for Streets Opening (2018) or equivalent alternative guidelines approved by the relevant authority.

The services to be provided include:

1. Potable water;
2. Wastewater;
3. High and low-voltage electrical services and street lighting;
4. Telecommunications; and
5. Gas.

Detailed services plan will be provided as part of Construction Certificate works and are subject to approval from the relevant service authority.

9.1 Potable Water

Potable water in the Subject Site is intended to be serviced by Sydney Water.

It is currently anticipated that initial stages of the developed may be serviced by an existing DN100 potable water connection in Chapman Street, subject to Sydney Water application and approval. It is expected that the ultimate yield of the subdivision will require upgrade to the existing network or lead-in off a DN150 main along Werrington Road, some 300m east of the site.

A detailed potable water plan will be prepared as part of the Construction Certificate design process and is subject to Sydney Water application and approval.

9.2 Wastewater

Wastewater in the Subject Site is intended to be serviced by Sydney Water.

Site investigations and survey revealed the presence of existing wastewater lines within the Subject Site, including a private DN225 sewer asset running through the north-west portion of the development believed to be providing a service to the Western Sydney University campus. As part of this development this sewer line will be modified in accordance with the reticulation design and ownership transferred to Sydney Water once infrastructure is available in the area. In addition, there is an existing sewer line running north-east towards Chapman Street from the corner of the Cobham Juvenile Justice Centre. The ownership and status of this line will need to be ascertained prior to development and appropriate measures taken to incorporate it into the design.

A large 1500mm diameter sewer carrier exists within Claremont Creek, some 500m east of the site and is the planned point of connection for the sewer reticulation within the development. It is expected that all wastewater will be gravity sewer

Detailed wastewater design will be prepared as part of the Construction Certificate design process and is subject to Sydney Water application and approval.

9.3 Electricity

The primary electricity supplier to the Subject Site will be Endeavour Energy.

It is currently anticipated that electrical lead-in will be required. The site benefits from an existing easement for services which runs from the site to the south (through the Cobham Juvenile Justice Centre) to where it joins Water Street.

It is envisaged that this easement may be utilised for the installation of lead-in electrical services.

Existing HV feeders are located around the Subject Site, all of which originate from the Claremont Meadows Zone Substation. Endeavour Energy had advised that this zone substation has sufficient capacity to service the development.

The proposed electrical servicing strategy may involve extending approximately 1.2km of 11kV HV feeder from CS1210, located south the Great Western Highway in Sunflower Drive.

A Level 3 Endeavour Energy Accredited Service Provider will undertake the design and documentation of the electrical reticulation network. Street lighting will be installed in accordance with Endeavour Energy and Penrith City Council standards.

9.4 Telecommunications

Opticomm is Lendlease's designated telecommunications service provider.

Telecommunications pits and pipes in the Subject Site will be designed by OptiComm personnel and will be installed by certified contractors. The design of the network will be undertaken as part of the Construction Certificate design process.

An existing easement for services running parallel to the Subject Site boundary within the Cobham Juvenile Justice Centre benefits the Subject Site and the adjacent Western Sydney University site. It is envisaged that this easement may be utilised for the installation of lead-in telecommunications services.

9.5 Gas

The primary natural gas supplier to the Subject Site is expected to be Jemena.

The closest gas line is located along the Great Western Highway (210 kPa distributor and a 3500 kPa primary service). Jemena have advised that the site is capable of being serviced.

The site benefits from an existing easement for services which runs from the site to the south (through the Cobham Juvenile Justice Centre) to where it joins Water Street. It is envisaged that this easement may be utilised for the installation of lead-in gas services.

Detailed gas design will be prepared as part of the Construction Certificate design process and is subject to Jemena application and approval.

10 Conclusion

This report has detailed the proposed civil, drainage and utilities strategies for the 16 Chapman Street, Werrington development. In particular, this report has demonstrated that minimum requirements to support the proposed development can generally be achieved and it is the intention of Lendlease to proceed in accordance with the strategies provided in this report.

11 References

- Penrith Development Control Plan 2014 Volume 2 – Part C – South Werrington Urban Village (Penrith City Council) 2014; and
- Werrington Enterprise Living and Learning (WELL) Precinct Development Contributions Plan (Penrith City Council) 2008.
- Design Guidelines for Engineering Works for Subdivision and Developments (Penrith City Council) 1997 (amended 2013)
- Stormwater drainage specification for Building Developments 2013 (amended 2018)
- WSUD Technical Guidelines (Penrith City Council) 2015
- Aurecon (*South Werrington Urban Village Precinct Stormwater Management Strategy for Universal Property Group,* 2016)
- Patterson Britton & Partners (*South Werrington Sub Precinct Masterplan Servicing and Stormwater Management, 2006)*
- Landcom's *Managing Urban Stormwater, Soils and Construction* (2004)

A

MUSIC LINK REPORT

PENRITH CITY COUNCIL

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MUSIC-*link* Report

Project Details		**Company Details**	
Project:	Proposed Residential/Industrial Subdivision. Chapman Street, Werrington	**Company:**	Cardno (NSW/ACT) Pty Ltd
Report Export Date:	1/10/2019	**Contact:**	Pak Lau
Catchment Name:	190910 Werrington DA v18	**Address:**	Level 9, The Forum, 203 Pacific Highway, St Leonards, 2065, NSW
Catchment Area:	32.878ha	**Phone:**	9496 7846
Impervious Area*:	78.12%	**Email:**	pak.lau@cardno.com.au
Rainfall Station:	67113 PENRITH		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1999 - 31/12/2008 11:54:00 PM		
Mean Annual Rainfall:	691mm		
Evapotranspiration:	1158mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.32		
Study Area:	Penrith		
Scenario:	Penrith Development		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness		**Treatment Nodes**		**Source Nodes**	
Node: Post-Development Node	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	9%	Bio Retention Node	4	Urban Source Node	21
TSS	85.2%	Rain Water Tank Node	5	Forest Source Node	2
TP	64.9%	GPT Node	6		
TN	53.6%	Generic Node	3		
GP	95.3%				

Comments

The rainwater tank size for each lot is 2kL and will be designed in detailed during CC design to comply with BASIX requirements

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Basin A	Hi-flow bypass rate (cum/sec)	None	99	0.96
Bio	Basin A	PET Scaling Factor	2.1	2.1	2.1
Bio	Basin B	Hi-flow bypass rate (cum/sec)	None	99	0.23
Bio	Basin B	PET Scaling Factor	2.1	2.1	2.1
Bio	Basin B (Lower)	Hi-flow bypass rate (cum/sec)	None	99	0.05
Bio	Basin B (Lower)	PET Scaling Factor	2.1	2.1	2.1
Bio	Basin C	Hi-flow bypass rate (cum/sec)	None	99	0.25
Bio	Basin C	PET Scaling Factor	2.1	2.1	2.1
Forest	C3 - Park	Area Impervious (ha)	None	None	0.056
Forest	C3 - Park	Area Pervious (ha)	None	None	1.044
Forest	C3 - Park	Total Area (ha)	None	None	1.101
Forest	C5 (Park)	Area Impervious (ha)	None	None	0.037
Forest	C5 (Park)	Area Pervious (ha)	None	None	0.690
Forest	C5 (Park)	Total Area (ha)	None	None	0.728
GPT	CDS 0708	Hi-flow bypass rate (cum/sec)	None	99	0.054
GPT	CDS 1009	Hi-flow bypass rate (cum/sec)	None	99	0.1
GPT	CDS 1512	Hi-flow bypass rate (cum/sec)	None	99	0.22
GPT	CDS 1512	Hi-flow bypass rate (cum/sec)	None	99	0.22
GPT	CDS 1512	Hi-flow bypass rate (cum/sec)	None	99	0.22
GPT	CDS 2018	Hi-flow bypass rate (cum/sec)	None	99	0.55
Post	Post-Development Node	% Load Reduction	None	None	9
Post	Post-Development Node	GP % Load Reduction	90	None	95.3
Post	Post-Development Node	TN % Load Reduction	45	None	53.6
Post	Post-Development Node	TP % Load Reduction	60	None	64.9
Post	Post-Development Node	TSS % Load Reduction	85	None	85.2
Urban	C 1 (Remain)	Area Impervious (ha)	None	None	2.105
Urban	C 1 (Remain)	Area Pervious (ha)	None	None	0.484
Urban	C 1 (Remain)	Total Area (ha)	None	None	2.59
Urban	C 2 (Remain)	Area Impervious (ha)	None	None	8.696
Urban	C 2 (Remain)	Area Pervious (ha)	None	None	2.103
Urban	C 2 (Remain)	Total Area (ha)	None	None	10.8
Urban	C 2 Basin A	Area Impervious (ha)	None	None	0.242
Urban	C 2 Basin A	Area Pervious (ha)	None	None	0.957
Urban	C 2 Basin A	Total Area (ha)	None	None	1.2
Urban	C 4 roof (1c and 1d)	Area Impervious (ha)	None	None	0.161
Urban	C 4 roof (1c and 1d)	Area Pervious (ha)	None	None	0.018
Urban	C 4 roof (1c and 1d)	Total Area (ha)	None	None	0.18
Urban	C 4 Tank (1c and 1d)	Area Impervious (ha)	None	None	0.161
Urban	C 4 Tank (1c and 1d)	Area Pervious (ha)	None	None	0.018
Urban	C 4 Tank (1c and 1d)	Total Area (ha)	None	None	0.18

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	C 6 (Remain)	Area Impervious (ha)	None	None	0.358
Urban	C 6 (Remain)	Area Pervious (ha)	None	None	0.091
Urban	C 6 (Remain)	Total Area (ha)	None	None	0.45
Urban	C 7 Ind Lots (Remain)	Area Impervious (ha)	None	None	2.784
Urban	C 7 Ind Lots (Remain)	Area Pervious (ha)	None	None	0.311
Urban	C 7 Ind Lots (Remain)	Total Area (ha)	None	None	3.096
Urban	C 7 Road	Area Impervious (ha)	None	None	1.790
Urban	C 7 Road	Area Pervious (ha)	None	None	0.453
Urban	C 7 Road	Total Area (ha)	None	None	2.244
Urban	C 7 Road Bypass	Area Impervious (ha)	None	None	0.128
Urban	C 7 Road Bypass	Area Pervious (ha)	None	None	0.031
Urban	C 7 Road Bypass	Total Area (ha)	None	None	0.16
Urban	C 8 (Bypass)	Area Impervious (ha)	None	None	0.297
Urban	C 8 (Bypass)	Area Pervious (ha)	None	None	0.052
Urban	C 8 (Bypass)	Total Area (ha)	None	None	0.35
Urban	C U (25 Rance Road)	Area Impervious (ha)	None	None	3.938
Urban	C U (25 Rance Road)	Area Pervious (ha)	None	None	0.671
Urban	C U (25 Rance Road)	Total Area (ha)	None	None	4.61
Urban	C1 Roof	Area Impervious (ha)	None	None	0.32
Urban	C1 Roof	Area Pervious (ha)	None	None	0
Urban	C1 Roof	Total Area (ha)	None	None	0.32
Urban	C1 Tank	Area Impervious (ha)	None	None	0.32
Urban	C1 Tank	Area Pervious (ha)	None	None	0
Urban	C1 Tank	Total Area (ha)	None	None	0.32
Urban	C2 Roof	Area Impervious (ha)	None	None	1.4
Urban	C2 Roof	Area Pervious (ha)	None	None	0
Urban	C2 Roof	Total Area (ha)	None	None	1.4
Urban	C2 Tank	Area Impervious (ha)	None	None	1.4
Urban	C2 Tank	Area Pervious (ha)	None	None	0
Urban	C2 Tank	Total Area (ha)	None	None	1.4
Urban	C4 (Remain) 1c n 1d	Area Impervious (ha)	None	None	0.373
Urban	C4 (Remain) 1c n 1d	Area Pervious (ha)	None	None	0.096
Urban	C4 (Remain) 1c n 1d	Total Area (ha)	None	None	0.47
Urban	C6 Bypass	Area Impervious (ha)	None	None	0.075
Urban	C6 Bypass	Area Pervious (ha)	None	None	0
Urban	C6 Bypass	Total Area (ha)	None	None	0.075
Urban	C6 Tank	Area Impervious (ha)	None	None	0.075
Urban	C6 Tank	Area Pervious (ha)	None	None	0
Urban	C6 Tank	Total Area (ha)	None	None	0.075
Urban	C9 (Residential Bypass) (Remain)	Area Impervious (ha)	None	None	0.672

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Node Type	Node Name	Parameter	Min	Max	Actual
Urban	C9 (Residential Bypass) (Remain)	Area Pervious (ha)	None	None	0.166
Urban	C9 (Residential Bypass) (Remain)	Total Area (ha)	None	None	0.839
Urban	C9 Roof	Area Impervious (ha)	None	None	0.145
Urban	C9 Roof	Area Pervious (ha)	None	None	0
Urban	C9 Roof	Total Area (ha)	None	None	0.145
Urban	C9 Tank	Area Impervious (ha)	None	None	0.145
Urban	C9 Tank	Area Pervious (ha)	None	None	0
Urban	C9 Tank	Total Area (ha)	None	None	0.145

Only certain parameters are reported when they pass validation

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Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Forest	C5 (Park)	Field Capacity (mm)	70	70	99
Forest	C5 (Park)	Groundwater Daily Baseflow Rate (%)	10	10	25
Forest	C5 (Park)	Pervious Area Infiltration Capacity coefficient - a	150	150	180
Forest	C5 (Park)	Pervious Area Infiltration Capacity exponent - b	3.5	3.5	3
Forest	C5 (Park)	Pervious Area Soil Storage Capacity (mm)	105	105	119
Rain	Rainwater Tank	% Reuse Demand Met	80	None	37.49
Rain	Rainwater Tank - C1	% Reuse Demand Met	80	None	37.30
Rain	Rainwater Tank - C1	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Rain	Rainwater Tank - C1	Total Nitrogen - C** (mg/L)	0	0	1.4
Rain	Rainwater Tank - C1	Total Phosphorus - C** (mg/L)	0	0	0.13
Rain	Rainwater Tank - C1	Total Suspended Solids - C** (mg/L)	0	0	12
Rain	Rainwater Tank - C2	% Reuse Demand Met	80	None	33.69
Rain	Rainwater Tank - C2	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Rain	Rainwater Tank - C2	Total Nitrogen - C** (mg/L)	0	0	1.4
Rain	Rainwater Tank - C2	Total Phosphorus - C** (mg/L)	0	0	0.13
Rain	Rainwater Tank - C2	Total Suspended Solids - C** (mg/L)	0	0	12
Rain	Rainwater Tank - C6	% Reuse Demand Met	80	None	25.411
Rain	Rainwater Tank - C6	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Rain	Rainwater Tank - C6	Total Nitrogen - C** (mg/L)	0	0	1.4
Rain	Rainwater Tank - C6	Total Phosphorus - C** (mg/L)	0	0	0.13
Rain	Rainwater Tank - C6	Total Suspended Solids - C** (mg/L)	0	0	12
Rain	Rainwater Tank - C9	% Reuse Demand Met	80	None	0.012
Rain	Rainwater Tank - C9	Threshold Hydraulic Loading for C** (m/yr)	0	0	3500
Rain	Rainwater Tank - C9	Total Nitrogen - C** (mg/L)	0	0	1.4
Rain	Rainwater Tank - C9	Total Phosphorus - C** (mg/L)	0	0	0.13
Rain	Rainwater Tank - C9	Total Suspended Solids - C** (mg/L)	0	0	12

Only certain parameters are reported when they pass validation