1 WATER ST WERRINGTON

STORMWATER MANAGEMENT STRATEGY REPORT

Hillsong C/- Calibre Consulting Pty Ltd

June 2017

SUSTAINABLE CERTIFICATION
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Integrated Management System

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CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

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1 INTRODUCTION

Calibre Consulting on behalf of Hillsong Church has engaged J. Wyndham Prince to prepared a Stormwater Management Strategy Report is to support a development application for Church auditorium and associated facilities for 1 Water Street, Werrington.

The key objectives of this study are to:

- Review Section 149 Certificates for the lots within site and provide advice regarding existing flood constraints.
- Review with Penrith City Council's guidelines to determine requirements for on-site detention.
- Develop a MUSIC model to assess the water quality impacts of the proposed development. Identify and make recommendations for water quality measures devices to ensure compliance with Council's water quality guidelines.
- Recommend strategies that will enable development of the site in a way that meets water quality and quantity standards outlined in Penrith Cities' *Water Sensitive Urban Design* (WSUD) guidelines.
- Prepare engineering concept plans for the site and the Lander Road extension suitable for submission to Penrith City Council.

2 PROPOSED DEVELOPMENT

The subject site is located within the Penrith City Council Local Government Area, between Werrington Station and the Great Western Highway. The site currently drains into Claremont Creek, which is a tributary of South Creek. The proposed development includes a three-stage development for a Hillsong Church Complex, comprised of an auditorium with ancillary buildings, car parking areas and an extension of Landers Street. Refer to Plate 2.1.

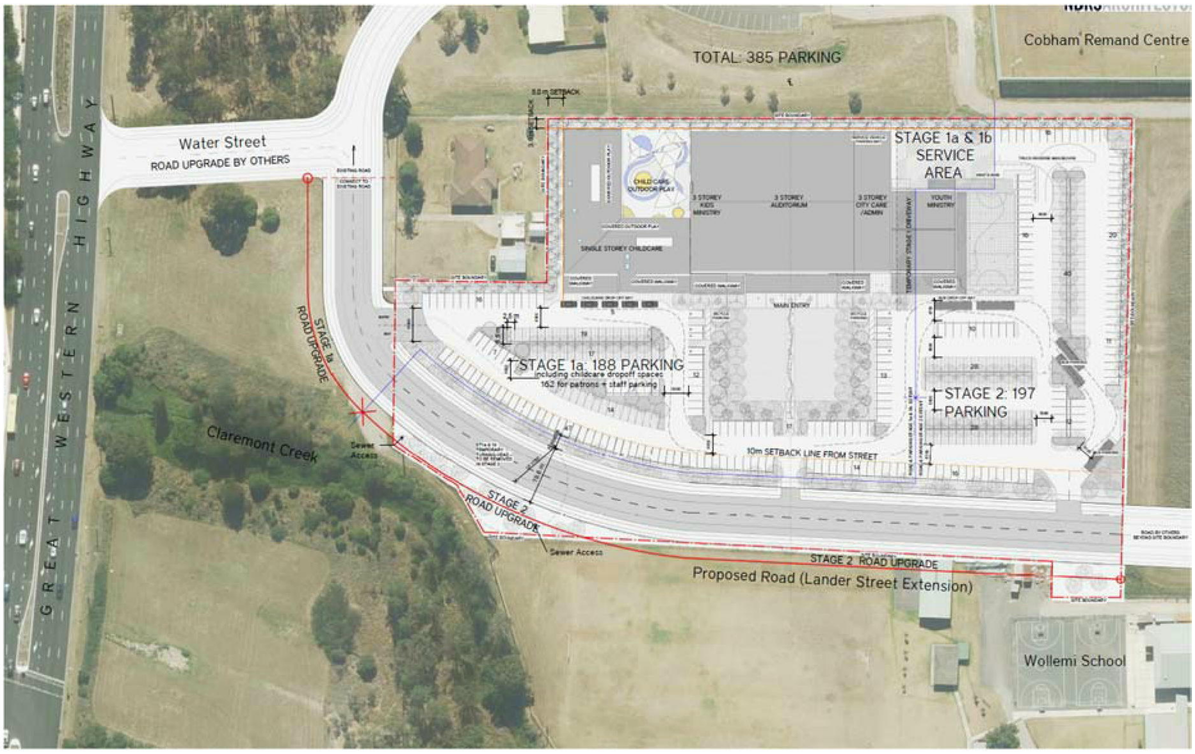


Plate 2.1 – Proposed Development

3 RELAVENT GUIDELINES AND POLICIES

3.1 Penrith City Council Development Control Plan (DCP) (2014)

Review of the Penrith City Council Development Control Plan (DCP) (2014) indicates that the site is located in South Werrington Urban Village (SWUV). SWUV is an area of land that comprises approximately 48 hectares of land that have been identified for urban development comprising residential and employment generating uses. SWUV will assist the delivery of housing and employment opportunities in Penrith and integrate with the existing Werrington community north and south of the Great Western Railway. Refer to Plate 3.1:

Plate 3.1 – South Werrington Urban Village

The DCP (PCC, 2014) provides the following objectives for flood planning, which have been considered as part of the planning process:

Water Management

- To maintain the stability and integrity of the finished creek profile.
- To ensure the quality of water leaving the urban areas does not adversely impact upon the health of Claremont Creek.
- To provide for stormwater detention.
- Reduce the peak flow rate of stormwater run-off from the site for all storms up to the 100 year ARI.

Flood Management

- To manage the risk to life and property assets from flooding events up to PMF.
- To allow the riparian corridor to function as a naturally occurring waterway.
- To manage flood waters within the site in a safe manner

3.2 South Werrington Sub-Precinct Masterplan Report

This report was written by Worley Parsons to advise the SWUV Precinct of the PCC DCP in 2007. As part of this report, a water quantity assessment was undertaken in XP-RAFTS model, which determined pre development flows for the catchment and set post development detention requirements to ensure that the pre development flow conditions had been met.

The subject site is located within Catchment P-B of this model. This model indicated that to reach pre-development flows, "On Site Detention (OSD) tanks/systems on all employment zoned land of Catchment P-B totalling 4,000m³ or 484m³/ha"

3.3 Penrith City Council Water Sensitive Urban Design Guidelines (WSUD) (2015)

The Penrith City WSUD (PCC, 2015) sets guidelines for stormwater quality from urban developments within the Council Local Government Area. The WSUD nominates quantitative post construction phase stormwater management objectives for the reduction of various pollutants for a range of new developments. The pollutant reduction criteria for the site are nominated in Table 3.1 below:

Table 3.1 – Stormwater Pollutant Reduction Targets

Pollutant	Post Development Average Annual Load Reduction Required
Total Suspended Solids (TSS)	85%
Total Phospherous (TP)	60%
Total Nitrogen (TN)	45%
Gross Pollutants (GP)	90%

4 WATER QUALITY ANALYSIS

The stormwater quality analysis for this study 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 6.2 was released in 2016 and has been adopted for this study.

The model provides a number of features relevant for the development:

- It is able to model the potential nutrient reduction benefits of gross pollutant traps, constructed wetlands, grass swales, bio-retention systems, sedimentation basins, infiltration systems, ponds and it incorporates mechanisms to model stormwater re-use as a treatment technique
- It provides mechanisms to evaluate the attainment of water quality objectives

MUSIC modelling was undertaken to demonstrate that the stormwater management system proposed for the proposed development will result in reductions in overall post-development pollutant loads in accordance with the designated target objectives.

PCC have established default parameters for use in *MUSIC* models to represent the generation of various pollutants by different land uses. A *MUSIC* model representing the proposed development was prepared to demonstrate compliance with the required post development annual load reductions (PCC, 2015).

4.1 Proposed Stormwater Management Strategy

4.1.1 Potential Water Sensitive Urban Design Measures

A critical consideration for the Stormwater Management Strategy is the long term ecological sustainability of the development and the Claremont Creek corridor. To maintain stormwater quality at the required levels, a 'treatment train' approach is proposed where various types of pollutants are removed by a number of devices acting in series. The strategy focuses on mitigating the impacts of the development on the total water cycle and maximising the environmental, social and economic benefits achievable by utilising responsible and sustainable stormwater management practices.

A range of water sensitive urban design measures may be adopted as part of the proposed development for the management of stormwater runoff. Each of these management measures were evaluated and compared with consideration of a range of environmental, social/amenity, economic, maintenance and engineering criteria.

4.1.2 Vegetated Swales and Buffers

Swales are formed, vegetated depressions that are used for the conveyance of stormwater runoff from impervious areas. They provide a number of functions including:

- Removing sediments by filtration through the vegetated surface.
- Reducing runoff volumes (by promoting some infiltration to the sub-soils).
- Delaying runoff peaks by reducing flow velocities.

Swales are typically linear, shallow, wide, vegetation lined channels. They are often used as an alternative to kerb and gutter along roadways but can also be used to convey stormwater flows in recreation areas and car parks. For an example of a typical vegetated swale arrangement, refer to Plate 4.1.

Comment: Swales and buffers within urban residential streets are not recommended due to the large number of culvert crossings required for driveways, safety concerns and significant maintenance requirements. The site is too small and too urbanised to use swales effectively, since they are most effective in a semi-rural environment.

Plate 4.1 - Typical Vegetated Swale Arrangement

4.1.3 Sand Filters

Sand filters typically include a bed of filter media through which stormwater is passed prior to discharging to the downstream stormwater system. The filter media is usually sand, but can also contain gravel and peat/organic mixtures. Sand filters provide functions such as:

- Removing fine to coarse sediments and attached pollutants by infiltration through a sand media layer.
- Delaying runoff peaks by providing retention capacity and reducing flow velocities.

Sand filters can be constructed as either small or large scale devices. Small scale units are usually located in below ground concrete pits (at residential/lot level) comprising of a preliminary sediment trap chamber with a secondary filtration chamber. Larger scale units may comprise of a preliminary sedimentation basin with a downstream sand filter basin-type arrangement. For an example of a typical sand filter, refer to Plate 4.2.

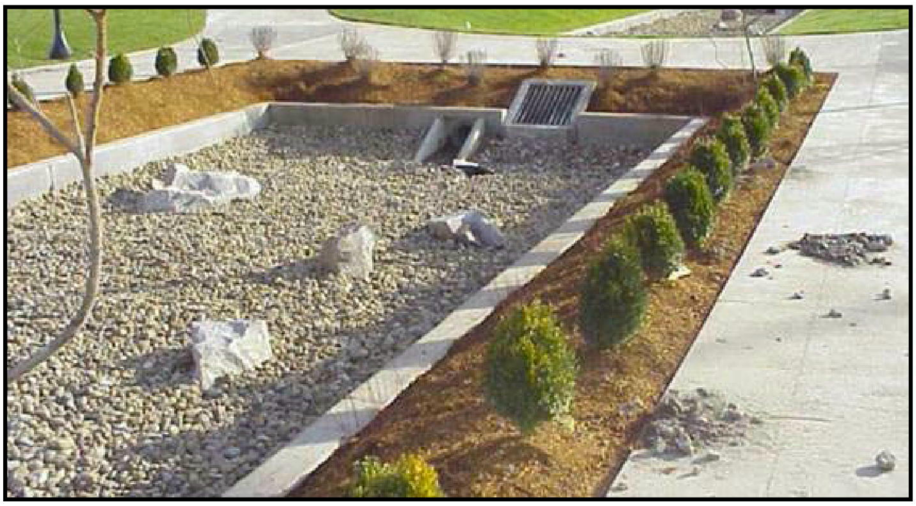


Plate 4.2 - Typical Sand Filter Arrangement

Comment: Sand filters are suited to confined spaces and where vegetation cannot be sustained (such as underground) and are particularly useful in heavily built-up areas. However, they are inefficient when compared to bio-retention systems and require frequent maintenance.

4.1.4 Permeable Pavement

Permeable pavements, which are an alternative to typical impermeable pavements, allow runoff to percolate through hard surfaces to an underlying granular sub-base reservoir for temporary storage until the water either infiltrates into the ground or discharges to a stormwater outlet. They provide a number of functions including:

- Removing some sediments and attached pollutants by infiltration through an underlying sand/gravel media layer.
- Reducing runoff volumes (by infiltration to the sub-soils).
- Delaying runoff peaks by providing retention/detention storage capacity and reducing flow velocities.

Commercially available permeable pavements include pervious/open-graded asphalt, no fines concrete, modular concrete blocks and modular flexible block pavements. There are two (2) main functional types of permeable pavements:

- Infiltration (or retention) systems – temporarily holding surface water for a sufficient period to allow percolation into the underlying soils.
- Detention systems – temporarily holding surface water for short periods to reduce peak flows and later releasing into the stormwater system.

For an example of a permeable pavement, refer to Plate 4.3.

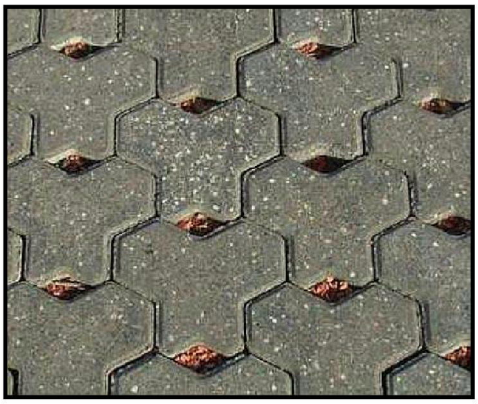


Plate 4.3 - Typical Permeable Pavement Arrangement

Comment: Permeable pavements are generally a more 'at source' solution and best suited as an 'on lot' approach or for small roadway catchments. Permeable pavers may possibly be considered at the development application stage for on lot treatment or for areas draining small catchment areas with low sediment loads and low vehicle weights. These systems are also prone to clogging and are not suitable in saline soils similar to those located close to the site and therefore not recommended for the Water St Development.

4.1.5 Infiltration Trenches

Infiltration trenches temporarily hold stormwater runoff in a sub-surface trench prior to infiltrating into the surrounding soils. Infiltration trenches provide the following main functions:

- Removing sediments and attached pollutants by infiltration through the sub-soils.
- Reducing runoff volumes (by infiltration to the sub-soils).
- Delaying runoff peaks by providing detention storage capacity and reducing flow velocities.

Infiltration trenches typically comprise of a shallow, excavated trench filled with reservoir storage aggregate. The aggregate is typically gravel or cobbles but can also comprise modular plastic cells (similar to a milk crate). Runoff entering the system is stored in the void space of the aggregate material or modular cells prior to percolating into the surrounding soils. Overflow from the trench is usually to downstream drainage system. Infiltration trenches are similar in concept to infiltration basins; however, trenches store runoff water below ground in a pit and tank system, whereas basins utilise above ground storage. For an example of an infiltration trench, refer to Plate 4.4.

Plate 4.4 - Typical Infiltration Trench Arrangement

Comment: Infiltration trenches and basins are not appropriate for small sites or where there is potential for salinity issues, so they will not be used for this site.

4.1.6 Ponds

Ponds are usually deep (>1.5 m) artificial bodies of open water. Many ponds have a small range of water level fluctuation because they are formed by a simple dam wall with a weir outlet structure. Newer systems may have riser-style outlets allowing for extended detention and temporary storage of inflows. Emergent aquatic macrophytes are normally restricted to the pond surrounds because of water depth, although submerged plants may occur in the open water zone.

Water quality improvement in ponds are promoted by a complex array of physical, chemical and biological actions. Whilst not as effective in the removal of pollutants as wetlands, they do still provide benefit an effective means of intercepting pollutants from stored sediments. For an example of a pond arrangement, refer to Plate 4.5.

Comment: Ponds and Wetlands are effective in removing sediment and nutrient loads typically generated from urban development. However, ponds generally require large landtake to ensure the pollutant treatment capacity of the pond achieves the requires water quality objectives.

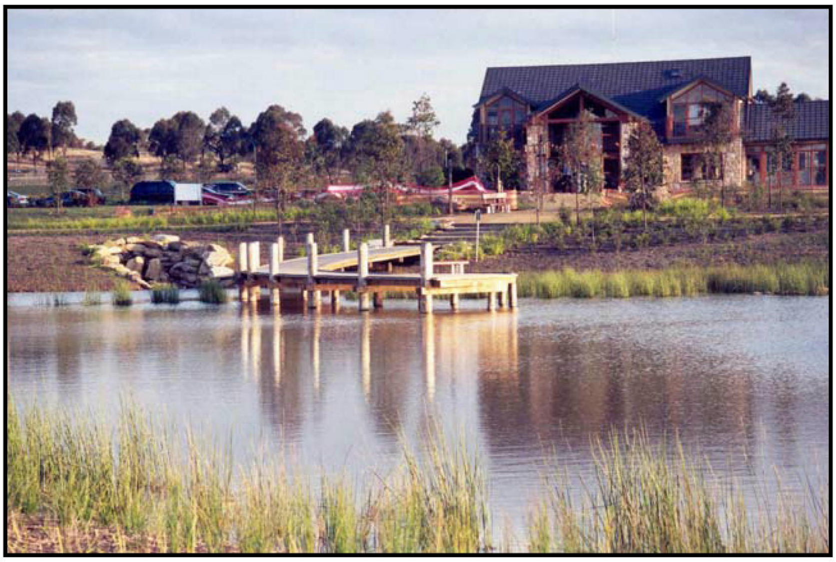


Plate 4.5 - Typical Pond Arrangement

4.1.7 Bio-retention Raingarden Systems

Bio-retention raingarden systems consist of a filtration bed with either gravel or sandy loam media and an extended detention zone typically from 100-300 mm deep designed to detain and treat first flush flows from the upstream catchment. They typically take the form of an irregular bed (raingarden) or a linear swale (bio-swale) and are located within the verge area of a road reserve or extend within the bushland corridors or other open space areas. The surface of the bio-retention system can be grassed or mass planted with water tolerant species. Filtration beds of bio-retention systems are typically 0.4 to 0.6 metres deep. For an example of an established bio-retention raingarden, refer to Plate 4.6.

Plate 4.6 - Typical Raingarden After Plant Establishment

Comment: Bio-retention systems are an effective and efficient means of treating pollutants from urban development when part of an overall treatment train. However, bio-retention systems do require reasonably high maintenance during the vegetation establishment phase. They will not be used for this site.

4.1.8 Cartridge Filter Systems

Cartridge filtration systems are underground pollution control devices that treat first flush flows. The unit consists of a vault containing a number of cartridges each loaded with media that targets specific pollutants. Each cartridge has a maximum treatable flowrate of approximately 1 - 1.5 litres per second. For an example of a typical cartridge filter system arrangement, refer to Plate 4.7.

Plate 4.7 - Typical Cartridge Filter System (During Construction)

Comment: Cartridge filtration systems are an efficient means of treating pollutants from urban development, as they are typically located underground and therefore do not require additional land take. As cartridge systems have a low treatable flow rate, additional 'buffer' storage is usually provided to keep the capital costs down. Cartridge filtration systems also need to be supplemented with additional treatment devices to achieve pollutant reduction targets. There is a need to provide significant height differences between the inlet to the filtration system and the discharge point from the supplementary system.

Because of the benefits of reduced land take, and the planned underground detention basin, Cartridge Filter systems are well suited for this site. They work well in small to medium scale developments and as such, will be included as part of the proposed Stormwater Management Strategy.

4.1.9 Inlet Pit Filter Inserts and Gross Pollutant Traps (GPTs)

GPT devices are typically provided at the outlet of stormwater drainage lines. These systems operate as a primary treatment to remove litter, vegetative matter, free oils and grease and coarse sediments prior to discharge to downstream (Secondary and Tertiary) treatment devices. They can take the form of trash screens or litter control pits, pit filter inserts and wet sump gross pollutant traps.

Inlet pit filter inserts have several advantages over end of pipe GPT's, such as providing a dry, at source collection of litter, vegetative matter and sediment as well as allowing for staged construction works without having to provide additional / temporary GPT units. Pit filter inserts will provide an at source mechanism for treatment of gross pollutants as development proceeds throughout the site. For an example of an inlet pit filter insert, refer to Plate 4.8.

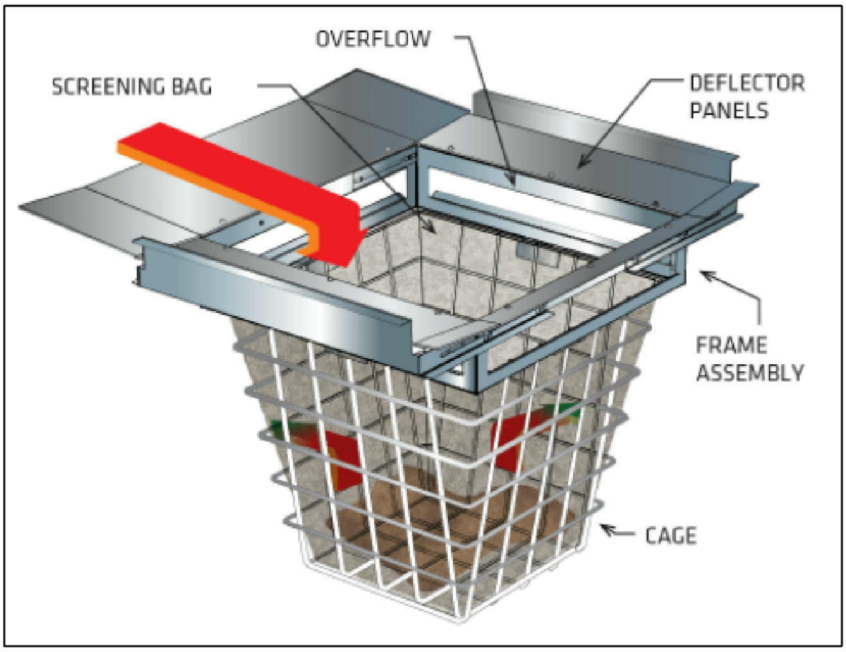


Plate 4.8 – Inlet Pit Filter Insert

Comment: Gross Pollutant Traps are effective in removing gross pollutants from stormwater runoff generated from large urbanised catchments. They provide a single point of maintenance, which is beneficial to the long-term viability and cost effectiveness of the water quality treatment system. However, Inlet Pit Filter Inserts capture and retains litter, debris and other pollutants more effectively than GPTs. Because of this increased effectiveness, they will provide a more effective solution, as the number of cartridges will be able to be reduced.

As they remove a greater portion of pollutants, inlet pit filters will be used for this site. They work well in small to medium scale developments, and the number of cartridges in the cartridge filter system will be reduced because of their high pollutant removal efficiency.

4.1.10 Rainwater Tanks

Rainwater tanks are sealed tanks designed to contain rainwater collected from roofs.

Rainwater tanks provide the following main functions:

- Allow the reuse of collected rainwater as a substitute for mains water supply, for use for toilet flushing, laundry, or garden watering.
- When designed with additional storage capacity above the overflow, provide some on-site detention, thus reducing peak flows and reducing downstream velocities.

The water collected can be reused as a substitute for mains water supply either indoors (toilet flushing) or outdoors (garden watering). Rainwater tanks can be either above ground or underground. Above ground tanks can be placed on stands to prevent the need of installing a pump to distribute the water. Such systems are referred to as gravity systems. Pressure systems require a pump and can be either above or below ground tanks.

Tanks can be constructed of various materials such as Colorbond™, galvanised iron, polymer or concrete.

Comment: Rainwater tanks are effective in removing suspended solids and a small amount of nutrient pollutants. They are also effective in reducing overall runoff volumes. The effectiveness of rainwater tanks is also increased when plumbed in for internal use. Rainwater Tanks will be used as part of the development.

4.2 Catchments

A MUSIC model was established to represent the proposed development. The model layout is shown on Plate 4.1 with the catchments considered for the MUSIC model included in Appendix C.

Plate 4.1 – MUSIC Model Layout
(110422_MU4.sqz)

4.3 Modelling Inputs and Assumptions

The following assumptions and parameters were adopted in the MUSIC model:

- "Penrith City Council WSUD Technical Guidelines", Version 1 (Dec 2013)
- SF Chamber node modelled with 'k' values set to 1
- Rainfall Station 67113 Penrith Lakes Aws, 6 Minute Time Step From 1999 To 2008
- Penrith City Council Source Node(s) utilising modified % impervious area, rainfall threshold, soil properties & pollutant concentrations
- No drainage routing between nodes.

4.4 Pollutant Load Estimates

Total annual pollutant load estimates were derived from the results of the *MUSIC* model The water quality assessment undertaken for the catchment incorporating Stages 1 to 3 demonstrated that a buffer tanks with 35 filter cartridges Penrith City Council's water quality targets. The results of the assessment are shown in Tables 1 to 3:

Table 5.1 – Summary of Pollutant Load Reductions

Pollutant	Total Developed Source Nodes (kg/yr)	Minimum Reduction Required (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Target Reduction Required (%)	Total Reduction Achieved (%)
TSS	11500	9775	1690	9810	85.0%	85.3%
TP	19.8	12	6.47	13.33	60.0%	67.3%
TN	91.6	41	48.0	43.6	45.0%	47.6%
GP	904	814	0.0	904	90.0%	100.0%

4.5 Proposed Water Quality Treatment System

At this stage in the planning process, a water quality treatment system has been determined for the site. The proposed water quality treatment system for site includes the following:

Water Efficient / On-Lot Treatment

- Implementation of water efficient fittings and appliances in all buildings (dual flush toilet, AAA showerheads, water efficient taps and plumbing).
- Provision of a 10KL rainwater tank to the development, to provide at-source water quality treatment and the ability to re-use stormwater runoff generated on site for irrigation purposes and/ or internal use.

Inlet Pit Filter Inserts

- Inlet pit filter inserts will be proposed at strategic locations throughout the Development, to remove all gross pollutants from stormwater runoff generated on the site. Inlet pit filter inserts will be provided at all major discharge points. In total, there will be ten (10) pit filter inserts across the site. Refer to Appendix B.
- For this design, we have used Stormwater360 Enviropods. An equivalent inlet pit filter insert could be used.

Cartridge Filter System

To meet treatment demands, a cartridge filter system is proposed to provide the bulk of the water quality treatment for the site. They will be located underground, in a combined tank, which will provide both detention and water quality treatment.

- The buffer storage portion of the tank, which houses the cartridges, will be **100 m²**. This will be located adjacent to the detention portion of the tank. The combined tank is shown in the site layout plan in Appendix B
- The cartridges used in the MUSIC model are Stormwater360 690 mm StormFilter Phosphosorb (Psorb) media cartridges. This current design includes **35 cartridges**. This is the recommended quantity not only to achieve the targets in MUSIC but also based on mass load from the catchment area. All filters have been sized in a way which results in a filtration system suitable for the estimated pollutant loads relative to the catchment.
- An equivalent cartridge filter system could also be used.

5 WATER QUANTITY MANAGEMENT SYSTEM

Water quantity management is typically adopted for proposed developments, to ensure peak flows discharging from the site are less than or equal to existing conditions. This attempts to minimise the potential impact of increased stormwater runoff from a proposed development on the capacity of downstream drainage systems and flood related impacts.

The water quality management referred to in Section 1.2 determined the required OSD to be 484m³/ha. We have used the target of 484m³/ha and applied the area to our site of 3.1 hectares to give a total OSD amount of 1500 m³ We have achieved this using an underground detention tank.

The South Werrington Sub-Precinct Masterplan Report demonstrated that the proposed OSD will attenuate flows to pre-development levels for all sub catchments, in accordance with PCC's guidelines. Further refinement of this will take place during the CC Design process.

5.1 Additional Stormwater Management Considerations

5.1.1 Construction Stage

Erosion and sediment control measures are to be implemented during the construction phase in accordance with the requirements of Penrith City Council and the guidelines set out by Landcom (the "Blue Book" 2004).

As the operation of cartridge water quality treatment systems are sensitive to the impact of sedimentation, construction phase controls should generally be maintained until the majority of Stage 1 site building works (approximately 80%) are complete.

5.1.2 Long Term Management

Regular maintenance of the stormwater quality treatment devices is required to remove rubbish and maintain filtration cartridges. Some sediment build-up may occur within the sediment tank and may require removal to maintain the high standard of stormwater treatment.

Proper management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. It is strongly recommended that a site-specific Operation and Maintenance (O & M) Manual is prepared for the system. The O & M manual will provide information on the Best Management Practices (BMP's) for the long-term operation of the treatment devices. The manual will provide site-specific management procedures for:

- Maintenance of the inlet pit filter inserts including rubbish and sediment removal.
- Management of the sediment tank and filter cartridges, including maintenance and cleaning requirements.
- Indicative costing of maintenance over the life of the device.

6 SUMMARY/CONCLUSION

The *Stormwater Management Strategy* has been prepared to support development applications for bulk earthworks and development of the site. The strategy has been prepared to conform with the statutory requirements and industry best practice for stormwater management in this catchment.

The water quality management comprises a “treatment train” that consists of pit inlet filters and a cartridge filter system. Results demonstrate that this strategy will ensure that the post-development stormwater discharges will meet PCC’s water quality pollutant removal targets.

The On Site Detention will also ensure that peak post development discharges do not exceed pre-development levels for the 50% and 1% AEP at the discharge points from the site.

Therefore, the proposed stormwater management strategy as outlined in the report is consistent with Penrith City Council’s requirements, and as such, development consent should be granted.

Yours faithfully
J. WYNDHAM PRINCE

DAVID CROMPTON
Manager – Stormwater and Environment Group

7 REFERENCES

Penrith City Council, 2014, *WSUD Guidelines*

Penrith City Council, 2014, *Development Control Plan*

Worley Parsons & the University of Western Sydney, 2007, *South Werrington Sub-Precinct Masterplan Servicing and Stormwater Management*

APPENDIX A

APPENDIX A – MUSIC Modelling Parameters

C1 Catchment Information

The sub-catchment breakup for the site was developed based on available contour and surface information of the site and adjacent properties (refer Plate C.1).

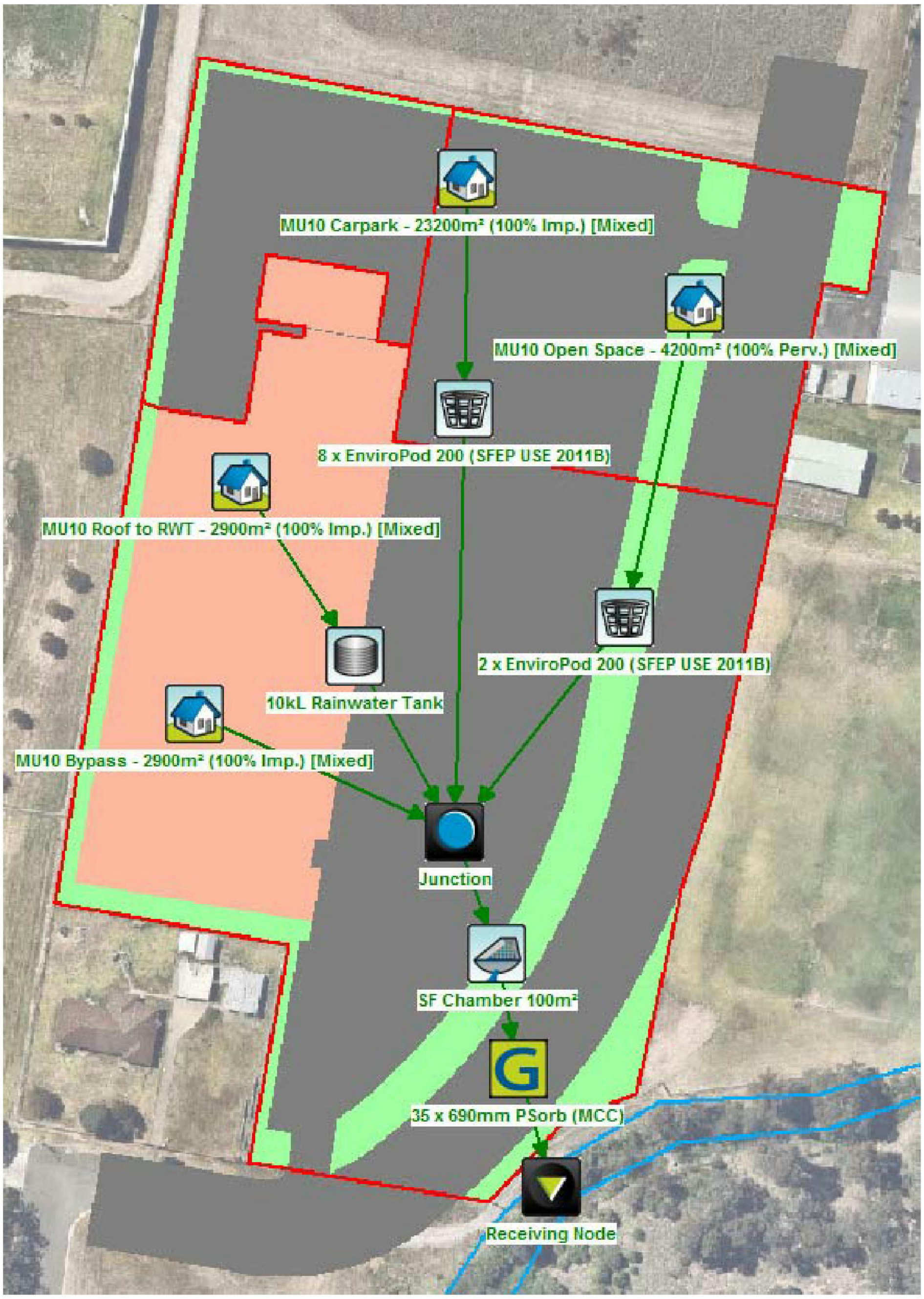


Plate C.1 – MUSIC Model Catchments

C2 Rainfall Data

The *MUSIC* model is able to utilise rainfall data based on 6 minute, hourly, 6 hourly and daily time steps. A six (6) minute time step was used in the analysis which was chosen in accordance with the recommendations for selecting a time step within the *MUSIC* User's Manual.

The rainfall data adopted in the *MUSIC* model was kept consistent with Penrith City Councils MUSIC-Link dataset. The rainfall and potential evapotranspiration data for the period analysed is shown on the graph which is provided in Plate A.2.

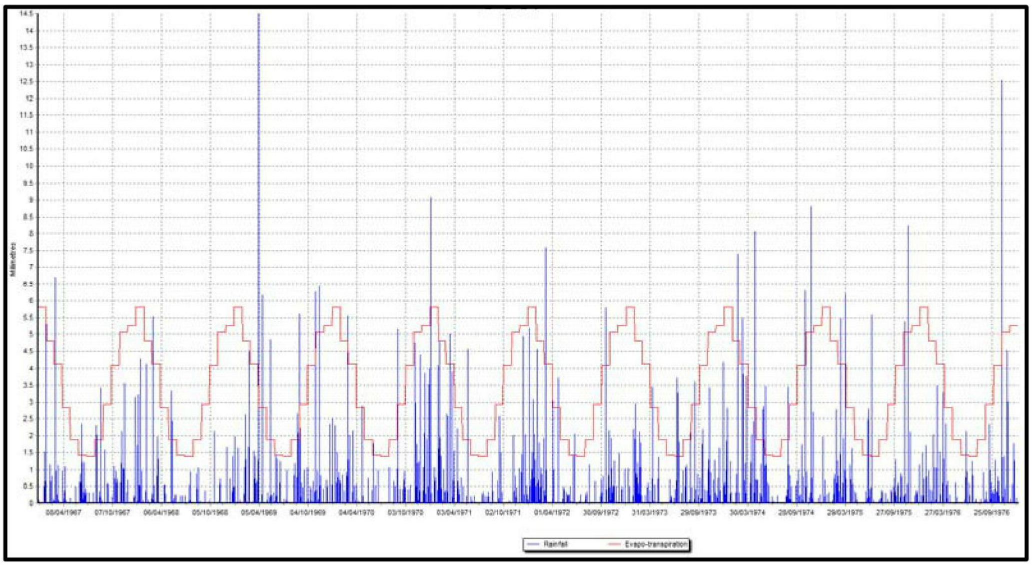


Plate C.2 – Rainfall & Evapo-Transpiration Data Adopted

C3 Soil / Groundwater Parameters and Pollutant Loading Rates

In the absence of site specific data, the soil / groundwater parameters and pollutant loading rates adopted for the natural and urban catchments, were kept consistent with PCC's *Development Handbook for Water Sensitive Urban Design* (2013). The adopted parameters are presented in Tables C.1 and C.2.

TABLE C.3 – ADOPTED SOIL / GROUNDWATER PARAMETERS

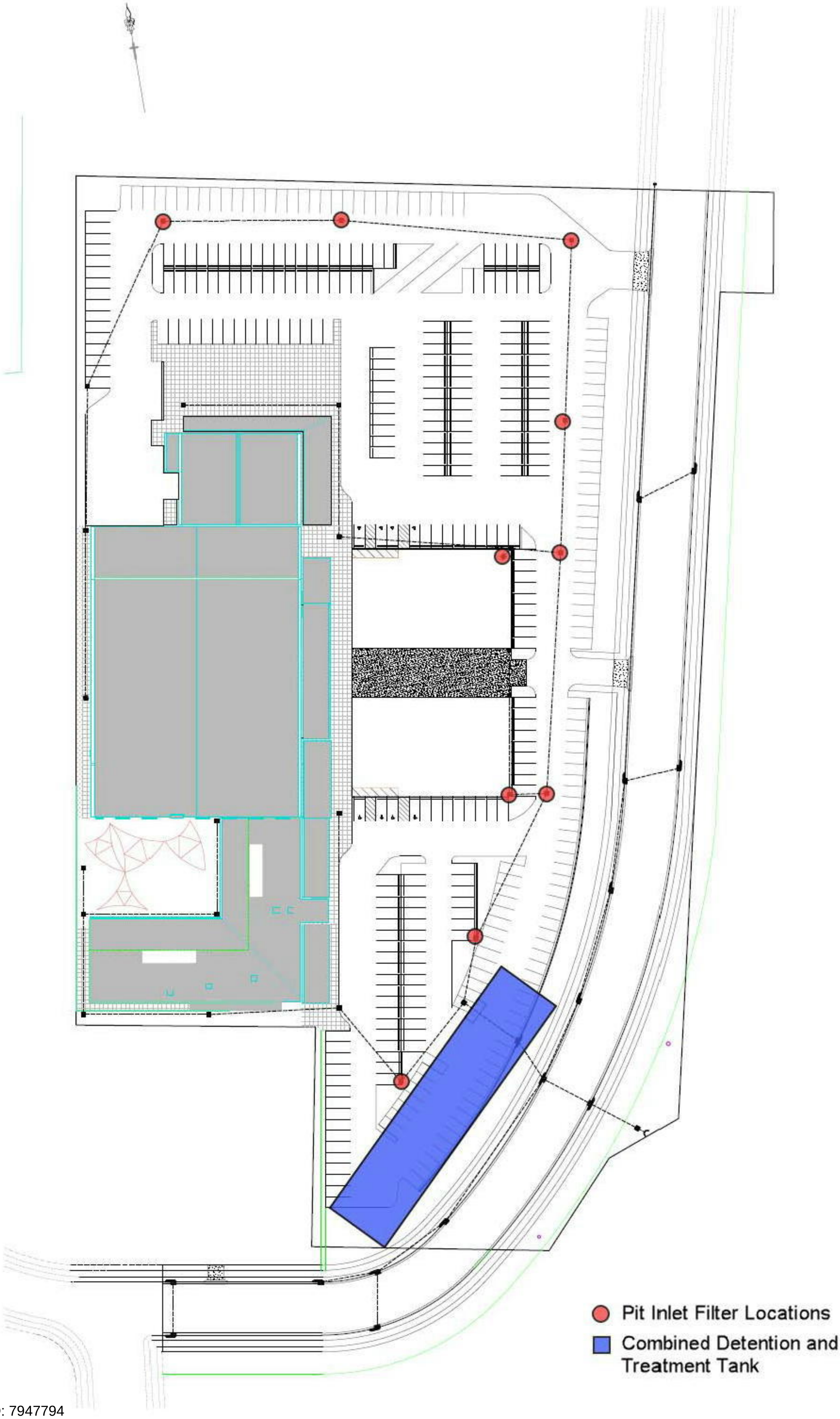
Property	Units	Value
Rainfall Threshold - (mm/day)	mm/day	1.4
Pervious Area Properties		
Soil Storage Capacity	mm	170
Initial Storage*	% of Capacity	30
Field Capacity	mm	70
Inifiltration Capacity Coefficient - a		210
Inifiltration Capacity Coefficient - b		4.7
Groundwater Properties		
Initial Depth*	mm	10
Daily Recharge Rate	%	50
Daily Baseflow Rate	%	4
Daily Deep Seepage Rate	%	0

TABLE C.2 – ADOPTED POLLUTANT CONCENTRATION PARAMETERS

Surface Type	TSS		TP		TN	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Storm Flow						
Roof	1.3	0.32	-0.89	0.25	0.3	0.19
Road	2.43	0.32	-0.3	0.25	0.34	0.19
Impervious	2.15	0.32	-0.6	0.25	0.3	0.19
Pervious	2.15	0.32	-0.6	0.25	0.3	0.19
Natural (Forest)	2.15	0.32	-0.85	0.19	0.11	0.12
Base Flow						
All Surfaces	1.2	0.17	-0.85	0.19	0.11	0.12

APPENDIX B

APPENDIX B – Site Layout Plan



Pit Inlet Filter Locations
Combined Detention and Treatment Tank