New Ultimo Pyrmont Public School

State Significant Development DA

Prepared for DesignInc & Lacoste+Stevenson / 25 / October / 2017 / Rev F

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Revision Control

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1.0 Introduction

1.1 Preface

This State Significant Development DA report has been prepared in accordance with Sydney City Council's Development Control Plan to support the New Ultimo Pyrmont Public School.

A detailed assessment of the environmental factors expected to be encountered during the state significant development as well details of the final stormwater management strategy have been explored throughout this report by discussing the following segments; sediment and erosion control measures, earthworks operations, construction, maintenance, environmental site management issues, the primary components of the pit/piped drainage network, the permanent water quality/quantity systems and lastly a flood impact assessment.

Temporary measures outlined in this report must be implemented prior to and maintained during the construction phase until the permanent measures are implemented. Ultimately this document forms a guide to the minimum controls to be installed and as such the final design, implementation and maintenance of all measures is the sole responsibility of the contractor. Furthermore, the permanent stormwater measures outlined in this report are required to be assessed and as such the final system may need to be revised during the detailed tender design period.

The following information and documents were utilised in this investigation:

- Concept Civil Engineering Drawings by TTW;
- Concept Architectural Plans by DesignInc & Lacoste+Stevenson
- "Managing Urban Stormwater – Soils and Construction, 4th Edition (2004)" by Landcom;
- EPA – Pollution control manual for urban stormwater.
- Geotechnical Investigation by JK Geotechnics Report Ref No: 30361SBrpt
- Preliminary Environmental Site Assessment by Environmental Investigation Services Report Ref No: E30361KHrpt
- City of Sydney Development Control Plan December 2012;
- City of Sydney Stormwater Drainage Manual February 2017;
- City of Sydney Decentralised Water Master Plan; WSUD & Stormwater Infrastructure Report June 2012;
- "Australian Runoff Quality – A Guide to Water Sensitive Urban Design", Engineers Australia (2006);
- "Australian Rainfall and Runoff – A Guide to Flood Estimation", Institute of Engineers, Australia (2016);
- "Draft NSW MUSIC Modelling Guidelines", Sydney Catchment Management Authority (August 2010)
- NSW Floodplain Development Manual (2005)
- Draft Blackwattle Bay Catchment Floodplain Risk Management Plan by WMA
- Draft Blackwattle Bay Catchment Floodplain Risk Management Study by WMA
- Draft Blackwattle Bay Catchment Flood Study by WMA
- Flood Certificate for Ultimo Public School by WMA
- City of Sydney Interim Floodplain Management Policy

The increases in impervious areas, disturbance of existing topography and alteration of the natural terrain associated with land development has a potential to increase surface run off and subsequently concentrate peak storm flow rates. Consequently existing flow regimes are adversely affected resulting in excessive flows and velocities through the downstream drainage network which may cause erosion of the associated waterways.

To mitigate any negative impacts to the downstream drainage network, the site stormwater management system has been designed to safely convey flows through the site and within the capacity of the downstream trunk drainage systems whilst also managing post development pollutants on site via a water quality treatment train.

The results of this assessment is an ecological sustainable development that ensures the safe discharge of stormwater whilst maintaining the existing flow regimes in a healthy environmental state.

1.2 SEAR General Requirements

This report addresses the relevant SEAR requirements as follows:

- **13. Drainage**
  Detailed drainage associated with the proposal, including stormwater and drainage infrastructure.

- **14. Flooding**
  Assess any flood risk on site (detailing the most recent flood studies for the project area) and consideration of any relevant provisions of:
  - The NSW Floodplain Development Manual (2005), including the potential effects of climate change, sea level rise and an increase in rainfall intensity; and
  - Council's Draft Blackwattle Bay Catchment Floodplain Risk Management Plan, Draft Blackwattle Bay Catchment Floodplain Risk Management Study and Draft Blackwattle Bay Catchment Flood Study.

- **Plans and Documents:**
  - Stormwater Concept Plan;
  - Sediment and Erosion Control Plan

1.3 General Instructions

This report is to be read in conjunction with the concept engineering plans, and any other plans or specifications that may be issued in relation to the Project.

Contractors shall ensure that all soil, sediment, erosion and water management works are undertaken as instructed in this report and constructed as per the guidelines stated in "Managing Urban Stormwater – Soils and Construction, 4th Edition (2004)" by Landcom.

The Contractor shall ensure that all subcontractors are informed of their responsibilities in minimising the potential for soil erosion and pollution to downslope areas, Council's stormwater network and the receiving waterways.

2.0 Site Background

2.1 Locality

The site is located at Ultimo/Pyrmont Public School (Lot 101 DP1105527). It is bound by roads on three sides; Jones Street to the East, Quarry Street to the North and Wattle Street to the West. The site currently exists as a public school and would be considered fully developed.

Figure 1 - Aerial Photo of Existing Site (Source: SIX Maps)

The land falls East to West from Jones Street towards Wattle Street with an approximate elevation change of up to 15m from the carriageways. The proposed development includes the redevelopment of the existing school including construction of a new driveway entrance off Wattle Street, stormwater infrastructure and associated utility services. The New Ultimo Pyrmont Public School will support up to 800 students and 33 staff as well as provide a shell space for a 40-space child care centre.

2.2 Key Issues

The key issues to be addressed in this report include:

- Sedimentation and erosion control
- Earthworks
- Construction sequencing
- Site maintenance
- Air quality and dust management
- Stormwater Quantity Control
- Stormwater Quality Control
- Flood Risk Assessment

3.0 Sedimentation and Erosion Control

3.1 Strategies

The proposed sedimentation and erosion control measures to manage runoff and ensure no detriment to the receiving environments have been divided into temporary and permanent strategies as summarised below.

STRATEGY	DESCRIPTION
Temporary	Temporary strategies generally refer to the control of sediment erosion and water pollution during the construction phase. The primary risks occur when soil is excavated and exposed to the elements during construction works. It is at this stage that suspended solids and other construction activity associated pollutants can be washed into the receiving stormwater network and subsequently the downstream waterways. The strategies that are implemented to prevent potential soil degradation and pollution of waterways include the adequate provision of sedimentation and erosion control measures. Generally the measures outlined in this report form a minimum basis that should be considered and further documented by the contractor prior to commencement of the works through a Soil and Water Management Plan (SWMP). The temporary controls that are proposed in the concept plans by TTW will limit the displacement of sediment caused by runoff from disturbed areas, and are designed to remove sediment prior to discharging from site.
Permanent	For the permanent water quantity and quality measures refer to Section 8 of the report.

Table 1 - Temporary & Permanent Strategies

This section of the report addresses the temporary strategies and outlines the minimum short term measures required to reduce the impacts of the construction activities. For permanent strategies and long term measures (i.e. post construction phase) water quality control is achieved by implementing the recommendations outlined in Section 8.

3.2 Proposed Measures

The proposed measures are documented on the concept Erosion and Sediment Control Plan attached to this report under Appendix A Drawing No's C001.

3.3 Installation of Measures

The measures are to be installed as per the requirements outlined below:

- Clearly visible barrier, site fencing and hoarding shall be installed at the discretion of the Superintendent to ensure site security, safety of the public, manage traffic control and prohibit any unnecessary site disturbance. Vehicular access to the site shall be

limited to only what is essential for the construction activities and shall enter the site only through the stabilised access points.

- All disturbed areas are to be stabilised within 14 working days of the completion of earthworks. All disturbed areas are to be protected so that the land is permanently stabilised within six months.
- Proprietary silt fencing shall be installed by the Contractor in accordance with the final approved Sedimentation and Erosion Control Plan and elsewhere at the discretion of the site superintendent to contain sedimentation to as near as possible to the original source.
- Sediment removed from any sediment trapping device shall be relocated where further pollution to downslope lands and waterways cannot occur.
- Stockpiles shall be located by the Contractor in accordance with the final approved Sedimentation and Erosion Control Plan and elsewhere at the discretion of the Project Manager and/or Superintendent. Where stockpiles are to be in place longer than 30 days they shall be stabilised.
- Water shall be prevented from entering the permanent drainage system unless it is sediment free. Drainage pits are to be protected in accordance with the final approved Sedimentation and Erosion Control Plan.
- Temporary sediment traps located at pits shall be retained throughout the early works stage and until the appropriate replacement measures for the subsequent stages are installed.

3.4 Land Disturbance

Where practicable, the soil erosion hazard shall be kept as low as possible. Limitations to access are to be in accordance with the following table:

Land Use	**Limitation**
Access areas	Access is to be limited to the designated work zones via the stabilised site access.
Truck cleaning areas	Any truck exiting out of the site shall be thoroughly cleaned and limit the exportation of soil and sediment on public roads.
Remaining undisturbed areas.	Access to any undisturbed areas and remaining lands is only permitted with permission from the Project Manager and/or Superintendent.

Table 2 - Limitations to Access

4.0 Earthworks

The below earthworks review and recommendations is to be read in conjunction with the full geotechnical report by JK Geotechnics Ref No: 30361SBrpt and TTW's Civil Specifications.

4.1 Subsurface Conditions

JK Geotechnics were engaged to undertake a geotechnical investigation and prepare an assessment which included the following:

- 8 new borehole locations spread throughout the site.
- Review of previous geotechnical investigation by NSW Public Works 2001
- Review of previous geotechnical investigation by NSW Public Works 2015

The results of the investigation indicated that the school is underlain by uncontrolled fill and alluvial soils (predominantly composed of a silty sand) over Hawkesbury Sandstone

4.2 Groundwater and Seepage

Whilst groundwater seepage was encountered in two boreholes (1 and 3) it was recorded below the depth of the finished floor levels. As a result designing for hydrostatic pressures and dewatering due to water table will not be a requirement during excavation. Although groundwater table is not an issue for excavation an allowance for seepage from the surrounding areas has been made.

The short term treatment of seepage is indicated on Drawing No. C001 (Appendix A) by the catch drains running parallel to the base of all retaining walls. Seepage behind these walls can be collected by a combination of vertical and spitter drains detailed by the structural engineer which will discharge into the catch drains at the base of the full depth retaining structures. These temporary catch drains can then be converted to formalised drainage measures such as a spoon drain or gravel drain connected into the future piped drainage system to prevent the build-up of any hydrostatic pressure due to seepage.

4.3 Earthworks Recommendations

4.3.1 Support of Adjacent Public Infrastructure:

Due to the steep sloping nature of the site it is vital that due diligence and care is taken during the demolition of existing buildings and subsequent excavation of the site down to the proposed bulk earthworks levels that all infrastructure adjacent to the property boundary is adequately supported.

4.3.2 Batter Slopes & Retaining

As the bulk of the excavation is into a silty sandy fill vertical faces are not possible. As such temporary batter slopes and full depth retaining systems are advised to be installed prior to excavation of the fill down to bulk earthworks levels. As the silty sandy fill is uncontrolled temporary batters are to be a maximum of 3m high and no steeper than 1 Vertical to 1.5 Horizontal provided that all loads (surcharge, construction etc) all kept clear of the batter crests. To reduce the creation of temporary batters, stockpiling of materials and subsequent backfilling it is recommended to leave the existing retaining walls in place until the new full depth retaining structures are installed. Permanent batters of up to 1 Vertical to 2 Horizontal are possible with adequate stabilisation however 1 Vertical to 4 Horizontal is preferable to

reduce the possibility of erosion, enable maintenance access and allow planting/landscaping.

4.3.3 Treatment of Fill

The silty sandy fill is considered as uncontrolled fill and as such is unsuitable to support footings or slabs on ground. As a result, foundations will be composed of piles driven down into the underlying Hawkesbury sandstone bedrock and the majority of slabs will be fully suspended.

Excavated material is to only be reused on site as 'form fill' with nominal compaction (95% standard maximum dry density) to support the floor slabs whilst they are being poured. Prior to backfilling with the silty sandy fill, all vegetation and root affected soil is to be removed and the based rolled to ensure adequate surface compaction. The remainder of the excavated material is to be exported offsite as general solid waste.

4.3.4 Subgrade Strength

Pavements within the courtyard areas are proposed to be cast on grade and shall incorporate a 300-500mm bridging layer as per the recommendations of the geotechnical report by JK Geotechnics. The subgrade improvement works shall include:

- A bridging layer of good quality granular fill at least 300mm thick;
- Subgrade proof roll with at least 7 passes of a 8 tonne dead weight smooth drum vibratory roller (final pass in the presence of a geotechnical engineer);
- Be comprised of good quality granular material such as ripped or crushed sandstone or recycled road base compacted to 98% maximum modified dry density in maximum 200mm layers.
- In the event that subgrade movement is observed during the final pass of the smooth drum roller a geogrid is to be installed at the base of the granular bridging layer.

4.3.5 Backfill Requirements

In locations where temporary batters are proposed, the void between the batter and the permanent retaining wall will need to be backfilled and compacted to reduce the likelihood of settlement. The geotechnical report specifies backfill to be placed in 100mm loose thickness layers with light compaction equipment to reduce excessive lateral forces on the walls.

5.0 Construction Sequence

The works covered in this report shall be undertaken in the following sequence:

1. A dilapidation report detailing the existing condition of the properties and public infrastructure shall be undertaken.

2. Install site security/hoarding and sediment fencing to requirements of the final approved sedimentation and erosion control plan. Waste collection bins shall be installed adjacent to the site office.

3. Construct stabilised site access in the location nominated by the Contractor and in accordance with the specification.

4. Full depth retaining structures are to be installed prior to excavation as per the geotechnical recommendations outlined by JK Geotechnics Report Ref No: 30361Sbrpt. Refer to structural plans for the detail on pile/shoring layouts and retaining structures required.

5. Install sediment control protection measures at all natural and man-made drainage structures. Maintain until all the disturbed areas are stabilised.

6. Excavation of the site, management of earthworks, backfilling and exportation of fill is to comply the geotechnical recommendations outlined by JK Geotechnics Report Ref No: 30361Sbrpt, the preliminary environmental site assessment by Environmental Investigation Services Report Ref No: E30361KHrpt and any recommendations outlined in subsequent Remediation Action Plans as a result of further contamination investigations.

7. Clean water is to be redirected around the construction site and earthworks areas.

8. Sedimentation traps for disturbed areas will be installed in accordance with the final approved Sedimentation and Erosion Control Plan. It is to be ensured that the sedimentation traps are cleared of sediment once the capacity is reached.

9. Clear and strip the work areas. Minimise the damage to the grass and low ground cover of non-disturbed areas.

10. Any disturbed areas, other than grading areas, shall immediately be covered with site topsoil within 7 days of clearing. Re-graded areas shall be covered with bitumen emulsion as specified.

11. Permanent stabilisation measures shall be installed on the site if necessary.

6.0 Site Maintenance

At a minimum the following site maintenance procedures shall be adhered to:

- The site manager shall inspect the site at least weekly to review all measures;
- Waste bins are to be provided for all construction refuse. They are to be emptied at least weekly and refuse is to be disposed in accordance with the site manager's recommendations;
- It is to be ensured that all drains are operating effectively. If required, the necessary repairs shall be undertaken to restore any damaged or inefficiently operating device;
- Any spilled material shall be immediately removed from areas subject to runoff or concentrated flow;
- Trapped sediment shall be removed where the capacity of the sedimentation trapping device falls below 60%;
- Sedimentation traps are to be inspected after each rainfall event and/or weekly to;
    - Ensure that all sediment is removed once the sediment storage zone is full;
    - Ensure that outlet and emergency spillway works are maintained in a fully operational condition at all times;
    - Ensure rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate;
- Additional erosion or sediment control works may be required to be constructed as appropriate to ensure the protection of downslope lands and waterways;
- Erosion and sediment control measures are to be maintained in a fully functioning condition at all times until the site is rehabilitated or secondary stage measures are installed;
- Revegetation schemes are to be adhered to and that any grass coverings are kept healthy, including watering and mowing;
- The removal of the temporary soil conservation and sedimentation control structures is to be the last activity in the rehabilitation program.

7.0 Air Quality & Dust Management

Prior to construction, the Contractor shall prepare a Construction Environmental Management Plan (CEMP), which will include a section on Air Quality and/or Dust Management). The CEMP will distinguish include but not be limited to:

- Plant and equipment emissions shall be as per the relevant regulations and standards;
- Areas of exposed soil shall be minimised and long term stockpiles shall be stabilized with vegetation or covered;
- A water cart shall be available at all times for surface spraying exposed soil surfaces to reduce dust generation;
- The site compound and haul roads are to be covered with gravel or kept moist (by spraying with water cart) to reduce dust generation;
- Materials transported in open trucks shall be covered to prevent possible dust generation;
- Tailgates of all vehicles transporting soil materials to and from the construction site shall be securely fixed so as to prevent soil spilling which in turn could generate dust;
- The burning of materials is not permitted on site at any time.

8.0 Stormwater Design

8.1 Local Authority Requirements

The proposed stormwater elements have been designed in accordance with the following:

Water Quantity Guidelines: City of Sydney; DCP 2012; Clause 3.7.2

City of Sydney; Stormwater Drainage Manual; Clause 5

A desirable outcome in the redevelopment of the school is to increase useable space. Generally increases in useable space result in an increase in the total site impervious area. The consequence associated with increases in imperviousness is the potential to increase stormwater flows due to the reduction in available pervious and landscaped areas to absorb initial rainfall runoff. To mitigate the impact of increased site discharge on downstream properties it is essential to design the site stormwater system to attenuate the increased runoff and safely convey storm flows through the site and within the capacity of the receiving drainage network.

Water Quality Guidelines: City of Sydney; DCP 2012; Clause 3.7.3

City of Sydney; Stormwater Drainage Manual; Clause 7

Increases to impervious area often results in the increase of gross pollutants, total suspended solids, and phosphorus and nitrogen nutrients. These pollutants are washed away into the stormwater network during rainfall events and transported from their site of origin into downstream waterways. To limit the impact on the receiving water body, quality control measures have been designed within the site stormwater management system in the form of a treatment train that reduces pollutant loads prior to discharging into the drainage network.

8.2 Stormwater Design Objectives

The objective is to provide stormwater controls that ensure that the proposed development does not adversely impact on the quantity or quality of stormwater flows within, adjacent and downstream of the site. The table below outlines the objectives and targets compatible with the relevant authority legislations, policies and requirements:

DESIGN ELEMENT	OBJECTIVES
STORMWATER QUANTITY	• The existing flow regimes and discharge for the full range of storm events should be maintained. • A safe stormwater conveyance system should be provided for the major storm events. • Any existing flows from external catchments will be safely mitigated through the site. • The existing runoff from the development should be maintained. • Safe mitigation measures should be provided to minimise any potential flooding impact on the site. • Downstream properties are not to be adversely affected by the development.

STORMWATER QUALITY	• Stormwater leaving the site should meet the full range of pollutant reduction targets of the relevant authority. • Site discharge should achieve natural dry and wet weather concentrations for the given catchment.

Table 3 - Objectives of the Stormwater System

8.3 Strategies

The proposed stormwater measures to manage runoff and ensure no detriment to the receiving environments have been divided into temporary and permanent strategies as summarised below:

STRATEGY	DESCRIPTION
Temporary	For the temporary sediment and erosion control details refer to Section 3 of the report.
Permanent	Permanent strategies generally refer to the installation of a number of permanent treatment measures to remove gross pollutants, total suspended solids, and phosphorus/nitrogen nutrients effectively in order to maintain stormwater quality discharged from the site.

Table 4 - Temporary & Permanent Strategies

This section of the report addresses the permanent strategies and outlines the long term measures required to reduce the impacts of development. For temporary strategies and short term measures (i.e. excavation and construction stage) water quality control is achieved by implementing the recommendations outlined in Section 3.

9.0 Stormwater Quantity Control

9.1 Introduction

The main goal for the stormwater quantity control measures is to ensure that the post-developed peak storm flows do not exacerbate flow regimes within Council's receiving drainage network and cause detriment to the downstream waterways.

9.2 Proposed Drainage System

The site stormwater system for the development has been designed to capture flows from impermeable surfaces including courtyards open to the sky. The proposed stormwater management system for the development includes:

- Pit and pipe drainage network to collect runoff from areas;
- Stormwater flows up to the 5% annual exceedance probability event are conveyed by a minor drainage system; and
- Stormwater flows above the 5% annual exceedance probability event are conveyed by a major drainage system;

As the site is completely contained there are no overland flow paths available, the pit and pipe drainage network has been sized to convey the full 1% Annual Exceedance Probability flow. Emergency high level overflow arrangements have been provided via rectangular hollow section connections to Quarry Street. These overflows have been provided so that water is able to leave the site before inundating the ground floor courtyards in the event of a downstream pipe blockage.

It is to be noted that the flowrates generated to size the internal pit and pipe network are based off Australian Rainfall and Runoff – A Guide to Flood Estimation 2016.

A reduced set of the concept stormwater management plans are included in Appendix B.

9.3 On-Site Stormwater Detention Requirements

Sydney Water is the responsible body for determining the onsite stormwater detention (OSD) permissible site discharges and site storage required. OSD is not required for any development at Lot 101 DP1105527, Ultimo (Ultimo Public School) as per the email correspondence attached to this report as Appendix C.

10.0 Stormwater Quality Control

10.1 Introduction

The quality of site stormwater runoff depends upon a number of factors including land use, degree of imperviousness, population size, sanitation and waste collection methods, topography, geotechnical characteristics of the soil and the amount of rainfall based on climate. Litter, garbage, sediment, soils, nutrients, oils, hydrocarbons, grease, and heavy metals are all examples of pollutants that are typically transported off site by runoff. Whilst these pollutants have an adverse impact on the overall quality of the receiving water body it is gross pollutants, suspended solids and the nutrients phosphorus/nitrogen which are the most detrimental to the environment. Litter, garbage, oils, hydrocarbons and other pollutants that typically float on the surface generally have a bigger aesthetic impact to water quality.

Activities associated with development and urbanisation include the disturbance of vegetation/topsoil, earthworks, construction, services, and building works. It is during the earthworks and construction phase that sediment transportation is greatest with loadings up to six times higher than the pre development state. At the cessation of construction activities sediment loading may eventually return to pre development levels or remain slightly higher depending on land management practices and maintenance strategy.

As with every development, sediment erosion during the excavation and construction phase represents the largest potential risk to water quality levels. It is during this period that exposed earthworks are highly susceptible to being washed downstream by site runoff, carrying suspended solids and associated construction related pollutants.

This report addresses the permenent water quality measures to be implemented. For the temporary measures and short term effects (i.e. during the construction phase) water quality is managed by implementing the measures covered in the Sedimentation & Erosion Control Plan.

The site specific water quality targets specified by the City of Sydney Council are outlined in the table below:

Pollutant Type	Pollutant Reduction Target (Average Annual Load)
Gross Pollutants (GP)	90%
Total Suspended Solids (TSS)	85%
Total Phosphorus (TP)	65%
Total Nitrogen (TN)	45%

Table 5 - Reduction Targets

10.2 Stormwater Quality Control Measures

There are a number of measures that can reduce pollutant loadings with their effectiveness varying depending on the targetted pollutant, land use type, maintenance access or

requirements and site topography. The proposed combination of measures aims to provide the most efficient and manageable measures suited to the site.

The individual elements of the proposed treatment train for the redevelopment of the school are summarised in the table below:

Element	Description
Gross Pollutant Trap: EnviroPod.	• An EnviroPod is a filter basket insert that is installed within grated service inlet pits. It is an effective preliminary measure for removing trash, debris and other larger pollutants from runoff. • EnviroPods proposed for the treatment train utilise a 200 micron filter system. • These filter baskets will be installed in all grated inlet pits servicing the open to sky courtyard areas.
Rainwater Tank: Refer to hydraulic plans for details.	• Rainwater tanks are an effective measure as they can remove pollutant loads at source. • The pollutant removal process occurs through harvesting roof runoff for reuse, thereby reducing the nutrients that are discharged into the stormwater network. • It is proposed to provide a rainwater reuse tank plumbed for landscape irrigation as detailed on the hydraulic engineer's plans. We have been advised that the average daily demand for landscape irrigation will be 1,370 litres. • The rainwater tank shall receive a mains top up from a potable water source.
Filter Cartridges: StormFilter.	• StormFilter by Stormwater360 is a proprietary device made up of multiple cartridge units that operate as a single system. • The number of filter cartridges is generally based on the size of the catchment or proposed land use. As cartridges can be added or removed from the system it is an appropriate water quality measure for usage in any size catchment. • One of the advantages of using StormFilter is that the cartridges come with various filtration media available to target site-specific pollutants. • There will be a number of standard 460mm height phosphosorb cartridges within a precast chamber as detailed in the engineering drawings

Table 6 - Proposed Water Quality Measures

10.3 MUSIC Modelling

The effectiveness of the combination of treatment train measures has been assessed using numerical modelling within MUSIC (Model for Urban Stormwater Improvement Conceptualisation version 6). The results of the modelling were compared against the

Council's pollutant reduction targets to determine the effectiveness of the proposed measures.

MUSIC simulates the performance of a group of stormwater management measures, configured in series or in parallel to form a "treatment train" against historic rainfall event data sets. It is the industry standard water quality modelling software developed by the MUSIC Development Team of the Cooperative Research Centre for Catchment Hydrology (CRCCH).

The MUSIC User Manual suggests that the time-step should not exceed the time of concentration of the smallest sub-catchment however due consideration must also be made regarding the shortest detention time of nodes within the treatment train.

The historical 6-minute rainfall and monthly evapotranspiration data used in the model was:

- Rainfall Station 66062 Sydney Observatory Hill;
- 6 Minute Time Step 1962 To 1966;

10.4 Event Mean Concentration

MUSIC uses different event mean concentrations (EMC) to determine the pollutant loads generated by different land uses. The standard EMCs adopted within MUSIC were based on research undertaken by Duncan (1999) through the CRCCH and the results are reproduced in Australian Runoff Quality – A Guide to Water Sensitive Urban Design (ARQ). The EMC values used in the MUSIC models for this project were based on the Sydney Catchment Management Authority (CMA) Source Node(s) utilising modified % impervious area, rainfall threshold, soil properties & pollutant concentrations. The table below summarises the parameters used for the development site;

NODE TYPE	MEAN BASE FLOW CONCENTRATIONS Log_{10} (mg/L)			MEAN STORM FLOW CONCENTRATIONS Log_{10} (mg/L)		
	TSS	TP	TN	TSS	TP	TN
Roof	Not Applicable*Note			1.300	-0.890	0.300
Impervious	Not Applicable*Note			2.150	-0.600	0.300
Pervious	1.200	-0.850	0.110	2.150	-0.600	0.300

Table 7 - EMC Inputs for MUSIC

*Note – Impervious areas do not have base flows.

10.5 Catchment Breakdown

The catchments were split into roof and non-roof catchments with varying imperviousness ratios to replicate the development condition. The catchment breakdown is attached to this report as Appendix D.

The table on the following page provides a breakdown of the catchment areas and the respective impervious percentages used in the MUSIC model:

CATCHMENT	AREA (m2)	IMPERVIOUSNESS RATIO (%)	PERCENTAGE OF SITE (%)
Roof to RWT	1,450	100	27%
Roof	555	100	10%
Planter Courtyards	100	0	2%
Courtyard 1	570	100	11%
Courtyard 2	385	80	7%
Other Impervious	2,340	100	43%
Sub Total	5,400	97%	100%

Table 8 - Catchment Breakdown

10.6 Treatment Train Devices

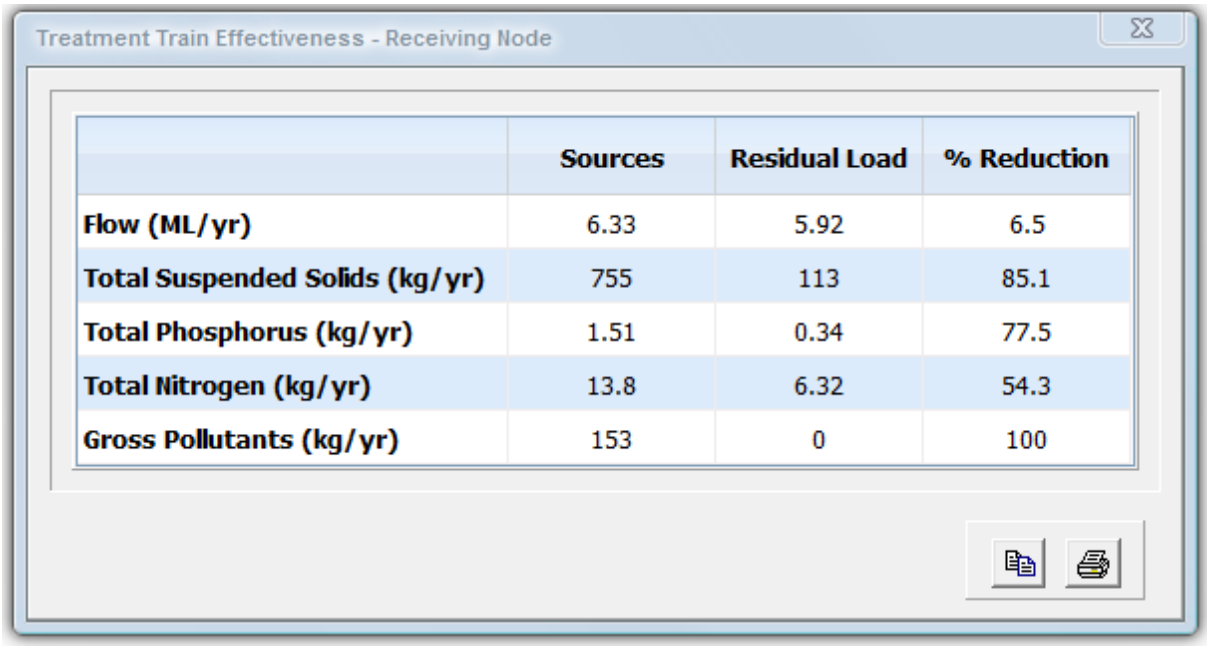
The final number of Stormwater Quality Improvement Devices (SQID) within the treatment train are listed in the following table:

DEVICE	NO. OF UNITS
Filter Cartridges	25 x 460mm Phosphosorb Stormfilter
Rainwater Tanks	1x20kL
Gross Pollutant Traps	Enviropods in nominated pits (min 5)

Table 9 - Stormwater Quality Improvement Devices (SQID)

10.7 Results

The results of the modelling are summarised below with the pollutant loads expressed in kilograms per year. The reduction rate is expressed as a percentage and compares the pollution from the post developed site to that of the existing developed state of the site to determine whether the reduction targets have been achieved.



	Sources	Residual Load	% Reduction
Flow (ML/yr)	6.33	5.92	6.5
Total Suspended Solids (kg/yr)	755	113	85.1
Total Phosphorus (kg/yr)	1.51	0.34	77.5
Total Nitrogen (kg/yr)	13.8	6.32	54.3
Gross Pollutants (kg/yr)	153	0	100

Table 10 - MUSIC Results

GP	=	Gross Pollutants	TSS	=	Total Suspended Solids
TP	=	Total Phosphorus	TN	=	Total Nitrogen

The final MUSIC model layout is attached to this report as Appendix E.

From the above results table it can be seen that the proposed treatment train will achieve the reduction targets for the full range of pollutants. Through the implementation of the proposed water quality measures stormwater discharge from the site can be effectively managed to ensure that there is no detrimental effect to the water quality downstream of the subject site.

10.8 Alternative Measures for Water Quality

Although the modelled treatment train includes the use of Stormwater360's proprietary product 'StormFilter', alternative products and Water Sensitive Urban Design measures are able to be explored during the detailed design phase. The possibility of incorporating raingardens into the landscape planter bed design or the provision of alternative proprietary products (e.g. Stormwater360's Jellyfish) is possible depending on the final layout of the stormwater drainage design and subject to additional MUSIC modelling to confirm that the pollutant percentage reduction targets set by Council are still achievable.

11.0 Permanent Stormwater Recommendations

The key strategies to be adopted for this development include the following:

1. A pit and pipe network to collect all stormwater runoff up to the 1% AEP event with emergency high level overflows to Quarry Street via several rectangular hollow section kerb connections;

2. EnviroPods at nominated inlet pits will form part of the water quality treatment train, removing pollutants and nutrients that are detrimental to downstream waterways;

3. A 20kL total rainwater harvesting and retention system to reduce the reliance on potable water whilst providing an improvement to the quality of stormwater discharge and a level of stormwater detention. The harvested rainwater will be plumbed for landscaping use as per the hydraulic engineer's details.

4. 25x460mm Stormwater360 phosphosorb StormFilter cartridges to treat stormwater prior to discharge to the downstream drainage network.

The results from the investigations and modelling summarised in this report indicate that the development can provide a safe and ecologically sustainable environment with the proposed stormwater network and water sensitive urban design management strategy.

12.0 Flood Impact Assessment

A review of the following flood related documentation available at Council's website was undertaken in the preparation of this desktop flood impact assessment:

- Draft Blackwattle Bay Catchment Floodplain Risk Management Plan
- Draft Blackwattle Bay Catchment Floodplain Risk Management Study
- Draft Blackwattle Bay Catchment Flood Study
- Flood Certificate for Ultimo Public School by WMA
- City of Sydney Interim Floodplain Management Policy

12.1 Existing Flood Behaviour

The draft documents assessing flood behaviour by WMA make specific mention to a number of hotspots throughout the Blackwattle Bay catchment. The hotspot relevant to the proposed redevelopment of Ultimo/Pyrmont School is the major overland flow path that exists along Wattle Street. Wattle Street conveys upstream water towards the downstream outlet to the North of the site during significant flood events. Although Wattle Street acts as a major overland flow path, inundation over the existing finished floor levels of the adjoining properties generally only occurs during the Probable Maximum Flood (PMF) event.

12.2 Indicative Depths of Inundation

The figure below identifies the peak 1% AEP flood level contours and indicative depths of inundation pertaining to the site. It can be seen that spot ponding occurs in a small number of locations throughout the site with Quarry Street and Wattle Street acting as the major overland flow paths for flood waters. The depths of inundation on Quarry Street range between 0.1 to 0.25m whilst Wattle Street experiences depths in the range of 0.25 to 0.5m within the road carriageway. Flows within Quarry Street appear to be conveyed entirely within the carriageway and would be expected to be less than 150mm in depth as they do not overtop the kerb and encroach towards the property boundary.

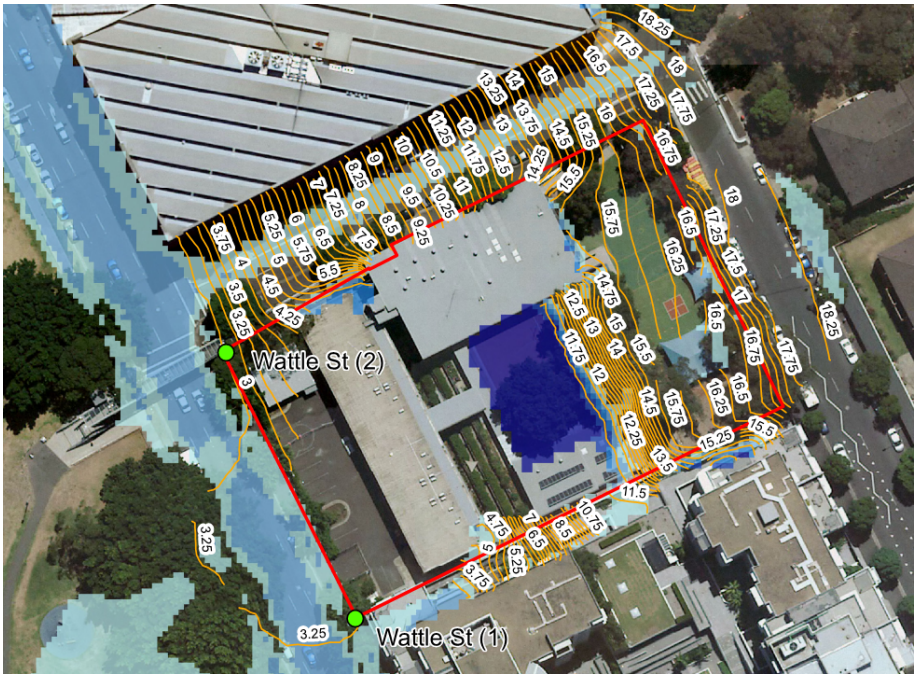


Figure 2 - 1% AEP Flood Contours and Depths of Inundation (WMA 2015)

The table below summarises the peak flood depth and levels on Wattle Street:

Location		PMF	1% AEP	5% AEP	20% AEP
Wattle Street (1)	Depth (m)	1.17	0.09	0.03	0.01
	Level (mAHD)	4.33	3.25	3.19	3.17
Wattle Street (2)	Depth (m)	1.37	0.06	0.04	0.04
	Level (mAHD)	4.30	2.99	2.97	2.97

Table 11 - Flood Depth and Level on Wattle Street (WMA 2015)

The flood contours and levels provided above by WMA were used to set the Flood Planning Levels for the habitable areas, under croft car park and various maintenance, electrical and fire services plant rooms. As the intended use is a school, TTW have assessed the development to provide freeboard as per Council's Interim Floodplain Management Policy but also give the appropriate consideration for the PMF event especially along the major overland flow path that exists on the Wattle Street frontage.

It is noted that a significant amount of inundation is shown to occur within the existing school (dark blue region in Figure 9). WMA water offer an explanation for this representation in the model as a result of water becoming trapped by the buildings which are modelled as obstructions to flow. Site stormwater networks are not normally modelled within catchment wide two dimensional flood models including the Draft Blackwattle Bay Catchment Flood Study by WMA and as such in reality this area would actually be the drained by the site's drainage network towards Wattle Street. WMA confirm this in the flood certificate which is attached to this report as Appendix F. Furthermore, WMA identify the school as a flood free site that has the potential to be utilised as a local evacuation centre. This is further discussed below in Section 12.5. As a result, this area of inundation is not considered to form part of the catchment flood storage but rather represent an anomaly in the flood model results.

12.3 Flood Related Development Controls

Sydney City Council's Interim Floodplain Management Policy sets out the flood related development controls applying to flood prone land.

The general requirements pertaining to the redevelopment of the school are taken from Section 4:

Development Type / Aspect	Objective	Requirement
Industrial and Commercial Properties	• To minimise the damage to industrial and commercial properties from flooding. • To minimise risk to human life from the inundation of industrial and commercial properties and to minimise economic cost to the community resulting from flooding.	• The City may consider merits-based approaches presented by the applicant. The proposed industrial or commercial buildings must meet the Flood Planning Level Requirements. • The proposed industrial or commercial development should not increase the likelihood of flooding on other developments properties or infrastructure.

Car Parking	• To minimise the damage to motor vehicles from flooding. • To ensure that motor vehicles do not become moving debris during floods, which threaten the integrity or blockage of structures or the safety of people, or damage other property. • To minimise risk to human life from the inundation of basement and other car park or driveway areas.	• The proposed car park should not increase the risk of vehicle damage by flooding inundation. • The proposed garage or car park should not increase the likelihood of flooding on other developments, properties or infrastructure. • The proposed garage or car park must meet the Flood Planning level Requirements • Open car parking – The minimum surface level of open space car parking subject to inundation should be designed giving regard to vehicle stability in terms of flood waters. Where this is not possible, it shall be demonstrated how the objectives will be met.

Table 12 - Council Development Controls (City of Sydney 2014)

Further to the above the following definitions outlined by the document are used:

- **Basement car parking or below-ground car parking** – *The car parking area generally below ground level where inundation of the surrounding areas may raise water levels above the entry to the basement resulting in inundation. Basement car parks are areas where the means of drainage of accumulated water in the car park has an outflow discharge capacity significantly less than the potential inflow capacity.*

- **Below-ground garage/car park** – *Applies where the flood of the parking and/or access surface is more than 1m below the surrounding natural ground level.*

The Flood Planning Level requirements set by Council's Interim Floodplain Management Policy are outlined in the table below:

Development		**Type of flooding**	**Flood Planning Level**
Industrial or Commercial	Schools and child care facilities	Mainstream of local drainage flooding	Merits approach presented by the applicant with a minimum of 1% AEP flood level + 0.5m
Above ground car park	Enclosed car parks	Mainstream or local drainage flooding	1% AEP flood level

Table 13 - Council FPL Requirements (City of Sydney 2014)

Note: The below ground garage/car park level applies to all possible ingress points to the car park such as vehicle entrances and exits, ventilation ducts, windows, light wells, lift shaft openings, risers and stairwells.

12.4 Flood Planning Levels

Based on the above requirements set by Council, freeboard is to be achieved by a combination of floor levels and water proof walls. It is important to note that consideration has been given to the effects of climate change and the PMF event due to the major overland flow path that existing along the Wattle Street frontage. As a result, the following measures are proposed to achieve the minimum freeboard levels as well as provide an appropriate safety buffer for flood events in excess of the 1% AEP:

Proposed Use	Finished Floor Levels	Flood Proof Walls
Habitable floor areas	Finished floor levels to be set at the 1% AEP flood level + 500mm freeboard.	Flood proofing up to the 1% AEP + 500mm freeboard.
Non habitable floor areas	Finished floor levels to be set at the 1% AEP flood level.	Flood proofing up to the 1% AEP.
Mechanical and electrical services areas.	Finished floor levels to be set at the 1% AEP flood level + 500mm freeboard where possible.	Flood proofing up to the 1% AEP + 500mm freeboard where possible.

Table 14 - Proposed Measures to Achieve Flood Protection

The flood contours provided by WMA under Appendix F were overlayed and interpolated at the corresponding Location ID's. The architectural layouts showing the ID locations are attached to this report as Appendix G. Based on the freeboard categories above the following FPL's have been set:

Location ID	Description	Interpolated 1% AEP Flood Level (m AHD)	Proposed Flood Planning Level (m AHD)
A	Car park.	RL 3.05 on Wattle Street. RL 4.75 on Quarry Street.	Finished floor level of RL 3.05 (0mm freeboard). Flood proof walls to RL 4.75 on Quarry Street. (0mm freeboard) Flood proof walls to RL 3.25 on Wattle Street (0mm freeboard).
B	Car park entry.	RL 3.05 on Wattle Street.	Finished floor level of RL 3.05 (0mm freeboard).
C	Substation and switch room.	RL 3.18 on Wattle Street.	Finished floor level of RL 3.58 (400mm freeboard).
D	Boiler room and gas assemble meter.	RL 5.15 on Quarry Street.	Finished floor level of RL 5.65 (500mm freeboard) Flood proof adjacent walls to RL 6.50 on Quarry Street.
E	Ground – Lower Ground Floor;	RL 5.15 on Quarry Street.	Finished floor level of RL 5.65 (500mm freeboard).

	habitable floor.		Flood proof adjacent walls to RL 5.65 (500mm freeboard).
F	Rainwater tank, pump room and bulk store.	RL 7.50 on Quarry Street.	Boiler room access point provides 500mm freeboard. Flood proof adjacent walls to RL 8.00 (500mm freeboard).
G	Level 01 – Library; habitable floor.	RL 8.45 at Quarry Street access. RL 8.15 adjacent to top of habitable floor level ramp.	Access off Quarry Street is RL 8.95 (500mm freeboard). Finished floor level of RL 8.83 (min 500mm freeboard).
H	Level 02 – Mid Playground; habitable floor. Fire pump room access; critical service.	RL 11.25 at Quarry Street access. RL 11.35 at Quarry Street access.	Finished floor level of RL 12.00 (min 500mm freeboard). Finished floor level of RL 12.00 (min 500mm freeboard). Flood proof adjacent walls to RL 15.00 (500mm freeboard).
I	Cold water pump + secondary tank; habitable floor.	RL 14.50 adjacent to Quarry Street wall.	Flood proof adjacent walls to RL 15.00 (500mm freeboard).
J	Level 03 – Upper Playground; habitable floor.	RL 14.75 at Quarry Street access. RL 15.25 at adjacent wall.	Finished floor level of RL 15.40 (min 500mm freeboard). Flood proof adjacent walls to RL 15.75 (500mm freeboard).
K	Fire hydrant; critical service.	RL 16.25 to RL 15.50 at Quarry Street.	RL 16.75 to RL 16.00 (min 500mm freeboard)
L	Level 04 – COLA; habitable floor.	RL 16.75 at Jones Street.	Finished floor level of RL 18.58 (min 500mm freeboard).
M	Level 04 – COLA; habitable floor.	RL 16.75 at Jones Street.	Finished floor level of RL 18.58 (min 500mm freeboard).
O	Jones Street courtyards; habitable floors below.	RL 16.75 at Jones Street.	Courtyards to incorporate a flood proof walls along the Jones Street boundary to RL 17.25 to prevent ingress of floodwater into lower levels (500mm freeboard).

Table 15 - Flood Planning Levels

12.5 Potential Evacuation Centre

Due to the relatively short times of concentration and flash flooding nature of urban catchments it is likely that evacuation of properties will occur as a response to storm intensity rather than a preventative action in anticipation of approaching floodwater. Due to the hap hazard response to flooding and dense urban nature of the catchment it would be difficult to effectively organise the transportation of persons to areas outside of the flood affected zones.

The catchment characteristics result in flooding due to an overland flow nature and as a result, changes to flood flows, depths and overland flow paths do not exponentially increase with rarer storm events. For this reason flood affectation in this catchment does not necessarily mean that properties need to be evacuated as a large majority of sites are not exposed to a high hazard nor are they within the 'floodway' hydraulic category.

As a result WMA recommend that evacuation will be generally of the opportunistic nature and largely involve moving persons into a specific number of localised 'flood free' buildings that are accessible by those living in flooded homes. Access to these localised flood free locations would also be relatively straightforward as the majority of areas are categorised as 'rising road access' meaning that occupants are still able to escape either on foot or by vehicle along roadways even if evacuation is left late.

Ultimo/Pyrmont Public School is identified in the Blackwattle Bay Catchment Flood Study as one of these 'flood free locations' and is considered to be a suitable evacuation centre during and following flood events. For this reason it is important that the habitable floor areas remain flood free by implementation of the Flood Planning Levels identified above.

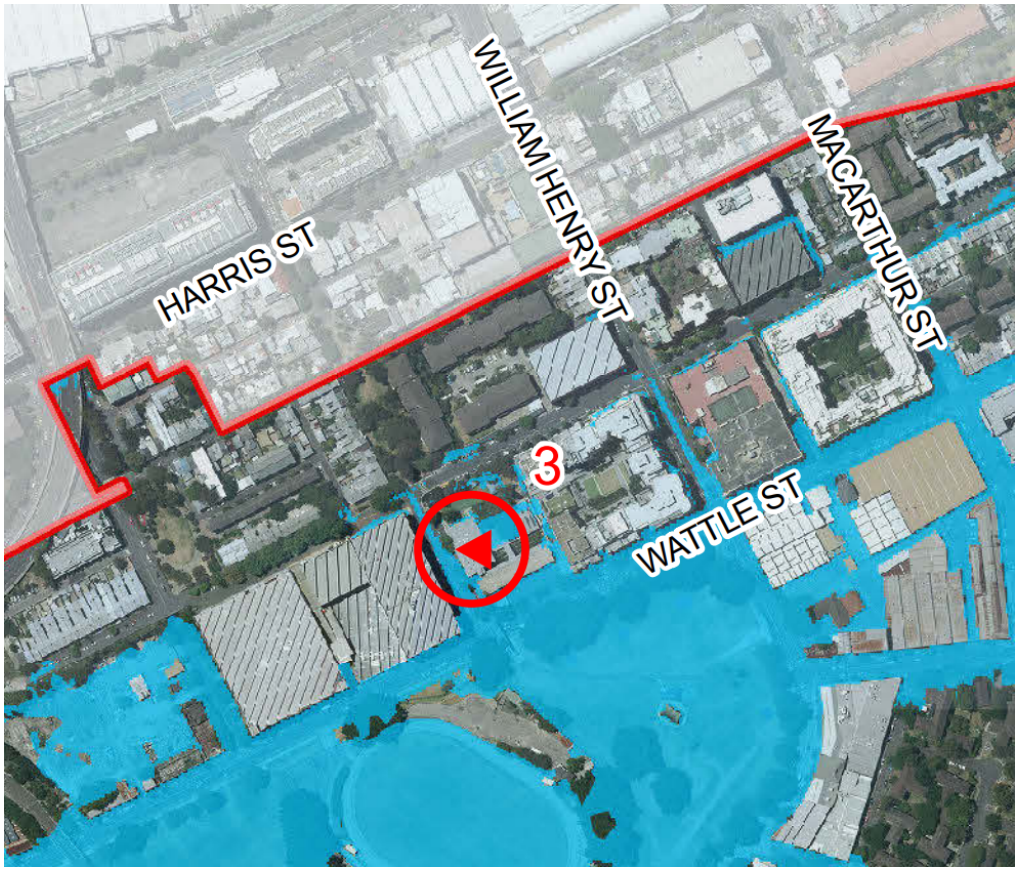


Figure 3 - Identified Flood Free Location; Ultimo/Pyrmont Public School (WMA 2015)

12.6 Potential Evacuation Route

Whilst WMA recommended that the school be considered as a potential flood free evacuation centre by Council and SES, a contingency flood evacuation plan has been investigated in an event of an unforeseen emergency situation. Review of the WMA Floodplain Risk Management Study peak flood depth maps from the 2Y ARI design event through to the PMF give an insight into the safe evacuation routes available as floodwaters rise as a result of increasing rainfall intensity. Interrogation of the results reveals the following flooding pattern as rainfall increases:

- *2Y ARI Design Flood Event:*
  Inundation of the surrounding area is shown to first occur along the length of Quarry Street towards Wattle Street by overland flow within the carriageway.

- *5Y ARI Design Flood Event:*
  Flood water begins to pond locally at the intersection of Wattle and Quarry Street however depths remain less than the kerb height.

- *10% AEP Design Flood Event:*
  Depths of inundation up to between 0.1m to 0.25m begin to form in spot locations along the centreline of Wattle Street.

- *5% AEP Design Flood Event:*
  Depths of inundation up to 0.25m exist within the Wattle Street carriageway.

- *2% AEP Design Flood Event:*
  Depths of inundation begin to increase above 0.25m in spot locations along Wattle Street.

- *1% AEP Design Flood Event:*
  The full width of the Wattle Street road reserve is inundated with floodwater in excess of 0.25m in depth within the carriageway.

- PMF
  Wattle Street is fully submerged with floodwater in excess of 1.0m and Quarry Street begins to experience depths in excess of 0.25m.

From the above it can be seen that the major overland flow path of Wattle Street would be inaccessible. Whilst floodwater down Quarry Street would remain less than 0.25m up to the 1% AEP storm event the high velocity due to the steep topography would also make it an unsafe location for egress. Jones Street remains for the most part flood free except for some small localised ponding occurring on the opposite side of the road. For this reason, evacuation would be best to start from the Jones Street entrance and then head North East up Jones Street towards William Henry Street which would then be at the upper reaches of the catchment.