Flood Assessment and Stormwater Management

Australian Foundation for Disability

Planning Proposal

61-79 Henry Street, Penrith

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1 EXECUTIVE SUMMARY

J. Wyndham Prince has been engaged by Australian Foundation for Disability (AFFORD) to undertake a stormwater management and flood assessment in support of a Planning Proposal for the redevelopment of 61-79 Henry Street, Penrith (hereafter referred to as the Subject Site). The Planning Proposal for the Henry Lawson Centre site at 61-79 Henry Street, Penrith has been refined and now seeks an amendment to Schedule 1 of the Penrith Local Environmental Plan 2010 (LEP 2010) to include residential accommodation as an additional permitted use on the site if a minimum Floor Space Ratio (FSR) of 2:1 is provided for non-residential premises.

The proposed development will provide a mix of retail buildings, residential apartments and a hotel building, together with supporting road and stormwater infrastructure. Details of an indicative development form and layout are shown within the *Concept Masterplan – Henry Lawson Centre* prepared by Environa Studio.

The existing development on the Subject Site is close to 100% impervious. The proposed re-development of the site is approximately 80% impervious. Therefore, it is anticipated that there will be a net reduction in stormwater runoff from the site and On-site Stormwater Detention (OSD) will not be required.

The Subject Site is constrained by an existing major overland flow path and drainage (culvert) infrastructure running through the middle of the site (flowing east to west). As part of this development, an alternative management option has been investigated. Details of this alternate option can be found in Section 5 of this report. A flood assessment utilising information from the Penrith CBD Detailed Overland Flood Study (Cardno 2015) and the subsequent Penrith CBD Flood Risk Management Study and Plan (Molino Stewart, 2020) has been undertaken to inform the flood constraints that need to be considered in the redevelopment of the Subject Site.

The Penrith CBD Flood Risk Management Study and Plan (Molino Stewart, 2020) indicates that the existing flood hazard at the site in the 1% AEP event is predominantly a low H1 or H2 category, with some isolated areas of H3 hazard. It is anticipated that the proposed redevelopment will reduce the flood hazard to a H1 or H2 hazard classification in the 1% AEP event.

The Penrith CBD Flood Risk Management Study and Plan (Molino Stewart, 2020) indicates that the subject Site is not affected by Nepean River flooding (MS, 2020). However, in an extreme local PMF event the flood hazard surrounding the Subject Site is a H5 category. Notwithstanding, the scale of the proposed development lends itself to a design which could withstand the forces of floodwater and buoyancy effects, with all residential areas together with a safe haven for itinerant patrons located above the PMF level.

The flash flood nature of a local PMF event is such that the high hazard external to the building lasts for less than one (1) hour, and with limited warning time means that evacuation of the site is unlikely to be a safe option, rather a shelter on site strategy would be more appropriate, provided that an accessible safe refuge is provided above the PMF level. Notwithstanding, flood safe access and evacuation to a flood free area in the PMF event is feasible via North Street to the Evan Street Overpass.

The Penrith CBD Flood Study (Cardno, 2015) and Penrith CBD Flood Risk Management Study and Plan (Molino Stewart, 2020) have been reviewed and used as the basis for the design of a relocated culvert and channel around the Subject Site. The culvert has been sized to convey flows up to the 1% AEP flood event around the site with larger flows, up to the PMF utilising the channel (over the culvert). The proposed commercial and residential development will need to provide a minimum freeboard requirement of 0.5 m to the finished floor levels, and 0.3 m freeboard to all driveway crests servicing the basement entry/exit locations.

A stormwater quality assessment on an earlier version of the planning proposal concept was undertaken to determine the stormwater treatment train required to achieve Penrith City Council's statutory pollution reduction targets. Fourteen (14) pit filter inserts and a 40 m² Stormfilter Chamber fitted with 34 PSorb cartridges will provide stormwater quality management for the proposed development to ensure statutory pollutant removal targets are met prior to discharge from the site. These devices will also ensure that developed conditions durations of stream forming flows are no greater than the statutory requirement of 3.5 times the duration of existing conditions stream forming flows. While the masterplan has and may change in the future, the assessment demonstrates that a stormwater quality management solution exists for the site.

The masterplan that forms part of the current assessment is one of many that have and may form part of the planning approval process. The stormwater and flood management approaches within this report demonstrate that there is a solution that can cater for the existing flood impacts and ensure water quality objectives can be achieved. While the masterplan is different to that presented within the original planning application, the principal of stormwater management is what is important in obtaining the relevant planning approval for this site. The stormwater management strategy for the proposed development therefore provides a basis for the future detailed design and development of the site to ensure that the environmental, urban amenity, engineering and economic objectives for stormwater management and site discharge are achieved. This report demonstrates a strategy that shows no impacts on flood levels or depths outside the site and no change in flood hazard categories.

The strategy presented satisfies the requirements set by Council for the development of the site.

2 INTRODUCTION

J. Wyndham Prince has been engaged by AFFORD to undertake a stormwater quality and flood assessment of the proposed re-development of 61-79 Henry Street Penrith (the Subject Site).

The Planning Proposal is being prepared to support the site's redevelopment which will include residential apartment buildings, a hotel building and retail shops and cafes at ground level. It should be noted that the commercial land-use is already permissible under the current B3 – Business core zoning under Penrith LEP 2010 and building heights up to 20 m along the Henry and Lawson Street frontages, and 56 m along the North Street frontage are permissible.

The strategy has considered the following specific assessments:

- A flood assessment based off information from the Penrith CBD Detailed Overland Flood Study (Cardno 2015) and the subsequent Penrith CBD Flood Risk Management Study and Plan (Molino Stewart, 2020)
- The sizing of a 1% AEP culvert to convey existing overland flow around the proposed development, without increasing upstream impacts.
- A stormwater quality assessment to determine the treatment train required to achieve the statutory pollutant reduction targets for the site;
- A Stream Erosion Index assessment to ensure that the developed conditions stream forming flow durations are no greater than 3.5 times the existing conditions stream forming durations; and

2.1 Existing site

The Subject Site is approximately 1.6 ha in size and formally identified as Lot 1 of DP 771927. The Subject Site is close to 100% impervious and currently supports a number of retail outlets together with a carpark and stormwater drainage infrastructure.

Plate 2-1 below provides an overview of the existing site.

Plate 2-1 – Existing Site

The Subject Site generally grades from east to west and is serviced by an existing trunk drainage stormwater system. This system is comprised of large inlet pits and both Reinforced Concrete Pipes (RCPs) and reinforced Concrete Box Culverts (RCBSs). Drainage information from Council's CBD flood model (Cardno 2015) is presented in Plate 2-2 below.

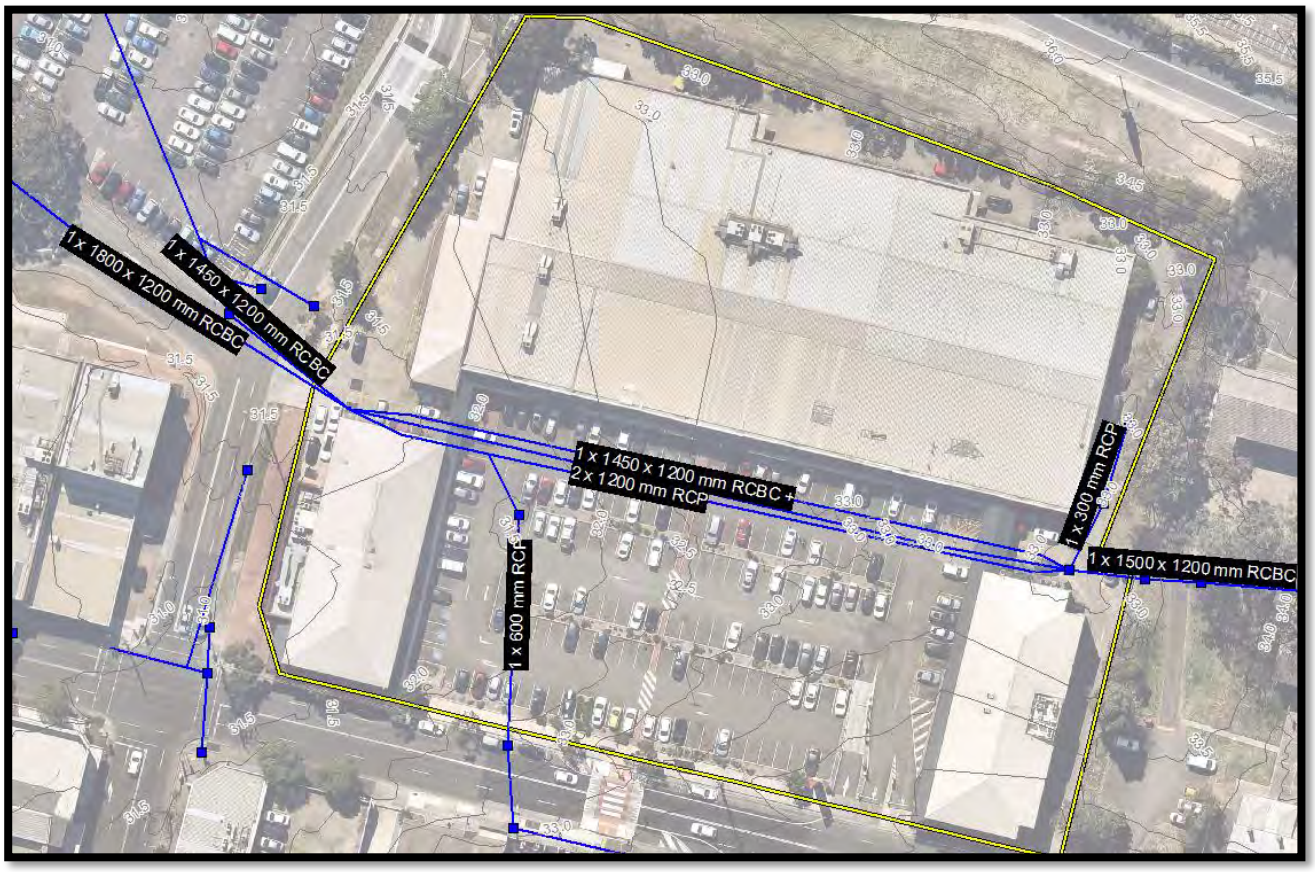

Plate 2-2 – Existing Drainage Infrastructure

2.2 Objectives

This report has been prepared to inform the likely stormwater management and flood constraints which need to be considered in the redevelopment of the Subject Site.

Future detailed design and supporting modelling will inform the final arrangements that form part of a Development Application submission.

2.3 Proposed Development

The planning proposal seeks a re-development of the site with a mixed land use and will include an update to the existing stormwater drainage network through the site. The concept plans prepared by Environa Studio for the Henry Lawson Centre includes residential apartments and a hotel. At ground level, retail/commercial outlets and community services buildings surrounded by generous open space areas are provided. Basement carparking with entry off Lawson Street is also provided.

The existing multi-cell trunk drainage system within the Subject Site which services the broader upstream catchment will be replaced by a single cell 2700 mm x 1200 mm RCBC routed around the northern perimeter of the proposed building. Details of the trunk drainage flood assessment are provided in Section 4 of this report.

An overview of the proposed development is provided in Plates 2-3 and 2-4 below, and the proposed stormwater drainage amendments are shown in Plate 2-5.

Plate 2-3 – Proposed Development (Ground Level)

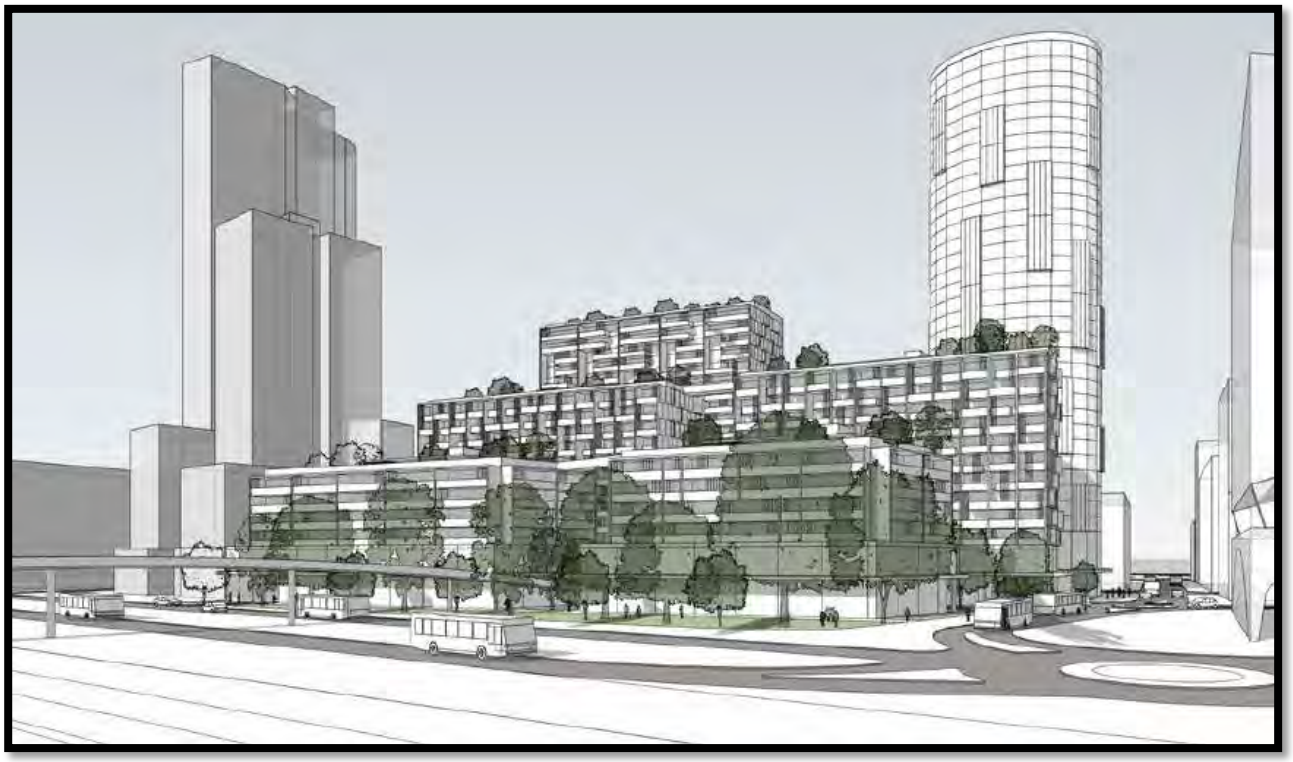

Plate 2-4 – Proposed Development (Aspect)

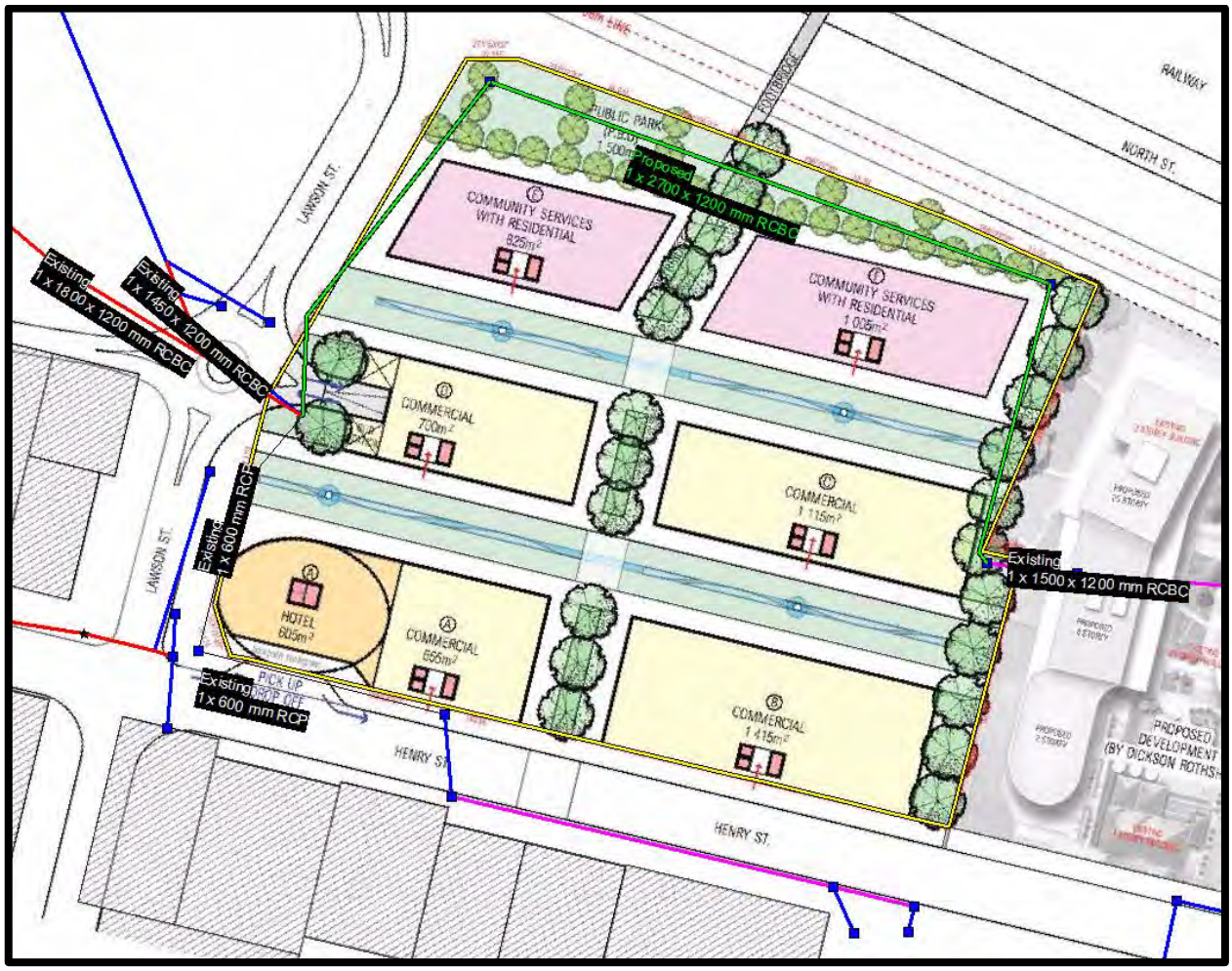

Plate 2-5 – Proposed Stormwater Drainage

3 PREVIOUS RELEVANT STUDIES AND CORRESPONDENCE

3.1 Penrith CBD Detailed Overland Flood Study (Cardno, 2015)

Penrith City Council (PCC) commissioned Cardno to undertake the Penrith CBD Detailed Overland Flood Study (CBD Flood Study, Cardno 2015). The study commenced in 2010, and the final report was issued in July 2015.

The primary objective of the study was to define existing conditions flood behaviour for the study area and prepare a flood damages assessment.

The existing conditions flood behaviour in the 1% AEP adjacent to the Subject Site indicates that the majority of the stormwater runoff upstream (west) of the site is conveyed within a trunk drainage pit and pipe system which traverses the site from east to west. A minor amount of upstream overland flow, together with local rainfall within the site collects in a localised depression within the carpark in the centre of the site. Plate 3-1 below is an extract of Figure 8.14 from the CBD study (Cardno 2015) and provides an overview of the existing conditions 1% AEP flood depth at the site.

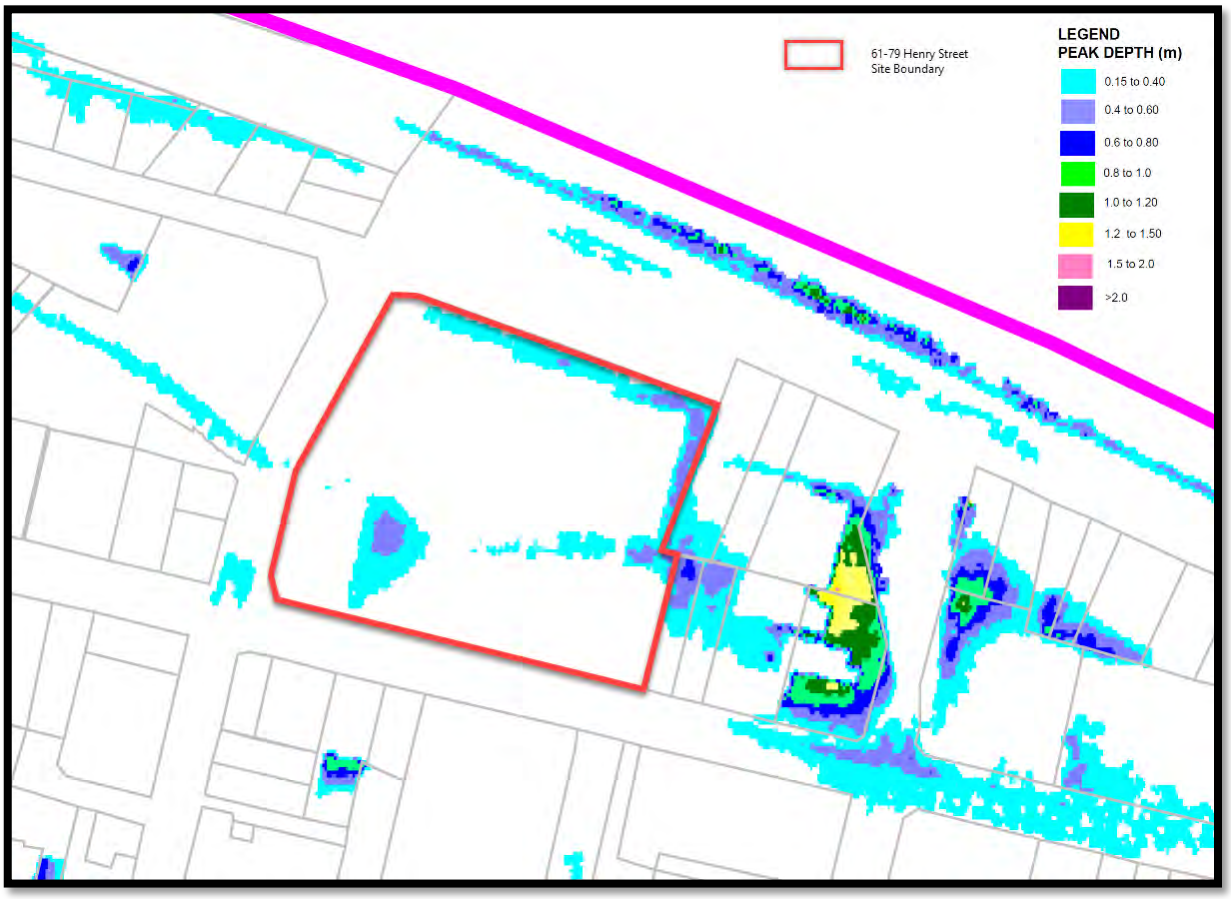

Plate 3-1 – Existing Flood Depth (Extract Fig 8.14 CBD Flood Study 2015)

Generally, it appears that the existing built form on the site has been designed to manage the 1% AEP event safely through the site such that adequate freeboard is provided to the finished floor levels.

The flood depth and level information provided in the CBD Flood Study (Cardno 2015) report has been interrogated to inform the flood constraints that need to be considered in the redevelopment of the Subject Site.

3.2 Penrith CBD Floodplain Risk Management Study and Plan (Molino Stewart, 2020)

The Penrith CBD Floodplain Risk Management Study and Plan (final report) was prepared by Molino Stewart for Penrith City Council in March 2020 (FRMSP, MS 2020) to *"…find practical, affordable and acceptable means to manage the impacts of flooding on people, property and the environment."*

Utilising the Penrith CBD Overland Flood Study (Cardno, 2015) flood model as a base, Molino Stewart updated the model to reflect more accurate terrain utilising 2011 LIDAR data, together with the inclusion of recently constructed trunk drainage infrastructure in both High Street and from the intersection of Lethbridge Street and Castlereagh Street to the Showground Channel. Plate 3-2 below is an extract of Map 15 from the FRMSP (MS, 2020) which indicates that existing conditions 1% AEP flood depth at the site is consistent with the earlier CBD Flood Study (Cardno 2015).

Plate 3-2 – Existing 1% AEP Flood Depth (Extract Map 15; FRMSP, MS 2020)

A blockage factor of 50% was applied to inlet pits consistent with the CBD Flood Study (Cardno, 2015), and a range of flood depth, level, hazard and category maps were prepared. It is noted that climate change modelling was not undertaken, however the 0.5% AEP (200 yr ARI) model results reflect a 12% increase in the ARR 1987 IFD adopted for the modelling and was utilised to discuss the climate change event.

Flooding hot-spot areas were identified and a flood damage assessment was undertaken to quantify the economic impact of existing conditions flooding. A series of mitigation options were investigated to address the flooding hot-spot areas, including the Subject Site where it was noted that the submitted planning proposals for the adjacent 57 Henry Street included upgraded stormwater drainage arrangements. The proposed 57 Henry Street drainage upgrades (modified) were included in the mitigations assessment, and it is evident that the re-development of the Subject Site could quite easily extend the proposed 57 Henry Street flood mitigation works along the northern portion of the site.

As a proxy for a dedicated climate change event, the 0.5% AEP event (+12% increase in rainfall intensity compared with the 1% AEP event) was utilised in the FRMSP (MS, 2020). The report (MS, 2020) suggests that the flood level increases between the 1% AEP event and the 0.5% AEP are in the order of 0.4 m (40 cm). While this does appear to be true in the lower end of the Penrith CBD catchment at Castlereagh Road, the mapped flood extents and depths of both the 1% AEP and 0.5% AEP events generally appear quite similar within the study area and at the subject site. Compare Plate 3-2 above (1% AEP flood depth) with Plate 3-3 below (0.5% AEP flood depth).

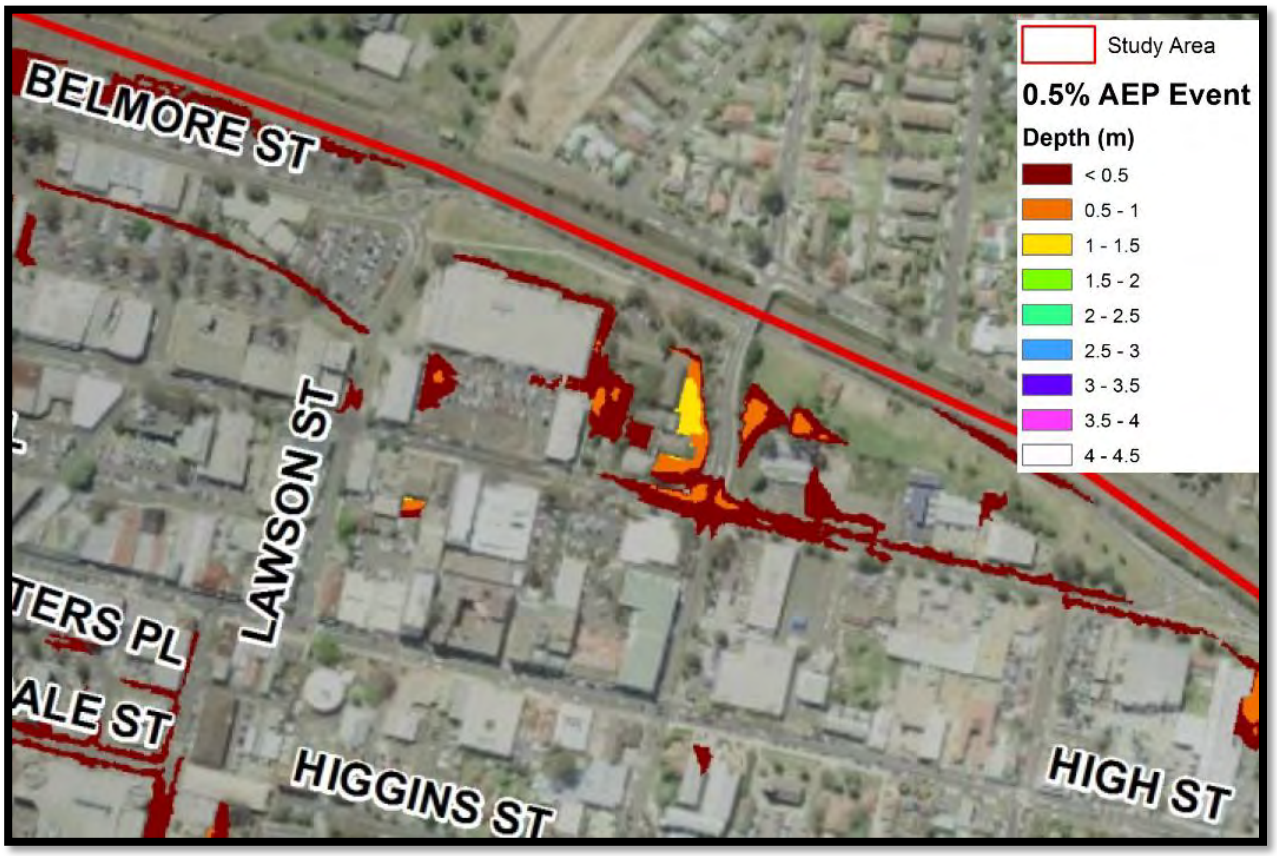

Plate 3-3 – Existing 0.5% AEP Flood Depth (Extract Map 16; FRMSP 2020)

In the PMF event, flood depths of up to 2.0 m occur both within and immediately adjacent to the Subject Site. Please see Plate 3-4 below.

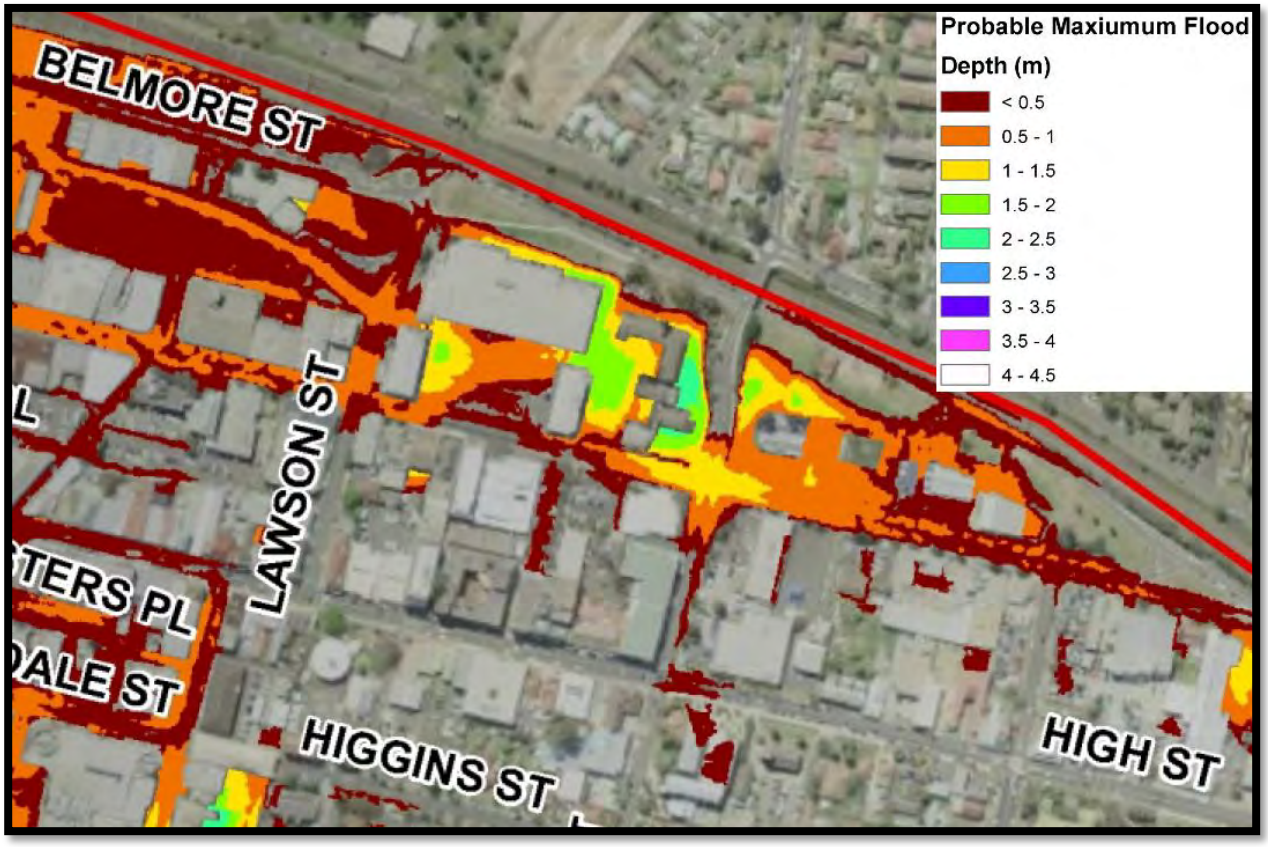

Plate 3-4 – Existing PMF Depth (Extract Map 17; FRMSP 2020)

It should be noted that the PMF flood depths appear to be related to the location of buildings within the site and localised depressions at drainage structures. An alternate landform and drainage arrangement could significantly reduce these flood depths and associated flood hazard. It is also noted that an alternate landform supporting buildings and carparks with height ranging from 20 m to 56 m would also be permissible under the current zoning of the site.

4 FLOOD ASSESSMENT

The proposed development will provide a generous amount of landscaped open space area which is anticipated to encompass approximately 25% - 30% of the Subject Site. Conservatively, we estimate that the overall proposed development will be approximately 80% impervious. The existing site is close to 100% impervious (refer Plate 2-1). Given the reduction in impervious surface area, it anticipated that there will be no net increase in runoff from the site. Thus, On-site Stormwater Detention (OSD) will not be required.

To ensure that flood level increases external to the site do not occur, the existing trunk drainage system traversing the site will be replaced with a structure with sufficient capacity such that the design event flood levels upstream of the site are not increased.

Climate change and flood risk at the Subject Site has also been assessed and flood evacuation requirements have been considered.

4.1 Existing Trunk Drainage Flow

Plate 4-1 below provides a schematic of the existing pipe infrastructure in the CBD flood model (Cardno, 2015) and the structure identification numbers.

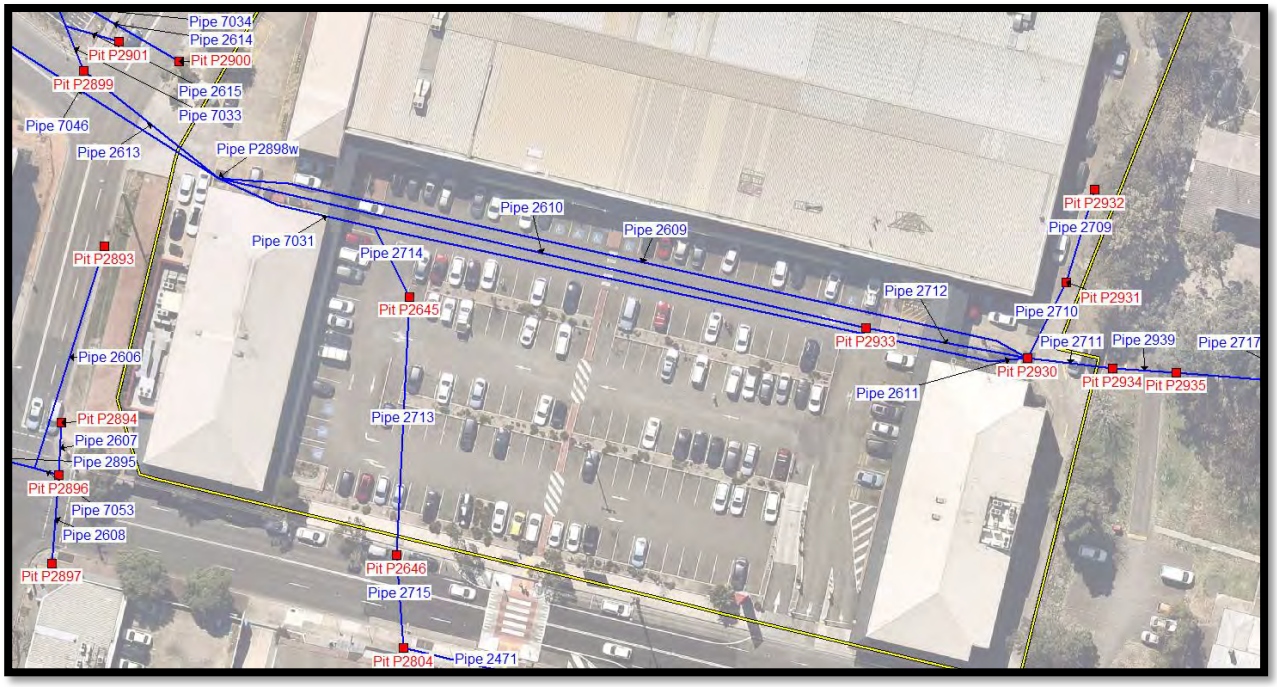

Plate 4-1 – Existing Stormwater Drainage

The Penrith CBD FRMSP (MS, 2020) updated the flood model utilised in the Penrith CBD Flood Study (Cardno, 2015). However, the changes at the Subject Site relate to surface information only and the detailed pipe drainage results presented in the earlier flood study (Cardno, 2015) have informed this drainage assessment.

The pipe capacity analysis in Appendix G of the CBD Flood Study (Cardno 2015) indicates that the 1% AEP (100 year ARI) piped flow approaching the eastern (upstream) side of the Subject Site (pipe 2711) is 6.14 m³/s. The peak 1% AEP overland flow approaching the site is 2.77 m³/s (reference 2d flow line Q168 Fig 8.40 and Table in Appendix I of CBD report). Therefore, the combined flow (piped and overland) approaching the eastern side of the site is 8.91 m³/s.

Appendix G of the CBD Flood Study (Cardno 2015) indicates that the 1% AEP (100 year ARI) combined flow in pipes 2609, 2610 and 7031 at the western (downstream) end of the site is 9.01 m³/s. The peak 1% AEP overland flow leaving the site is 0.03 m³/s (reference 2d flow line Q169 Fig 8.40 and Table in Appendix I of CBD report). Therefore, the combined flow (piped and overland) discharging to the west of the site is 9.04 m³/s.

The flow from the Subject Site itself would be in the order of 0.6 m³/s to 0.7 m³/s, however, this is not evident when comparing the flows entering and discharging the site in a 1% AEP event.

4.2 Proposed Trunk Drainage

It is proposed to convey existing 1% AEP flows around the Subject Site via a box culvert arrangement around the northern side of the site. The drainage invert levels at the eastern and western boundaries of the site are considered fixed constraints that any alternate arrangement through or around the site would need to connect into.

Appendix D of the CBD Flood Study (Cardno 2015) indicates that the drainage infrastructure at the eastern boundary has an invert level of 31.21 m AHD. This equates to pipe grade of 1.3% for the current alignment, or once the diversion is completed, a new pipe gradient of 0.7%.

Figure 8.11 (Cardno 2015) indicates that the 120-minute storm is the critical duration in the 1% AEP event at the site. The 1% AEP 120-minute flood model results were interrogated, and it was determined that the peak 2d water level at the eastern side of the site (at pit 2930, shown on Plate 4-1) is 33.43 m AHD.

J. Wyndham Prince has sized a 1% AEP culvert to ensure that the anticipated flow from both the upstream catchment and the Subject Site can be conveyed.

The following parameters were adopted in the culvert assessment:

- Design 1% AEP flow = 9.61 m³/s (8.91 m³/s external upstream flow + approx. 0.7 m³/s from site)
- Upstream Invert level = 31.21 m AHD
- Downstream Invert level = 29.55 m AHD
- New Culvert length = 245 m (see Plate 4-2 for proposed alignment).
- Tailwater = 31.29 m AHD (existing 1% AEP flood level western side of Subject Site)
- Mannings n roughness coefficient = 0.015

It was determined that a single 2700 x 1200 mm box culvert can convey 9.61 m³/s with an upstream hydraulic grade line (HGL) of 33.10 m AHD and therefore has sufficient capacity to cater for both the existing upstream flow and the flow from the proposed development of the Subject Site. It is understood that 50% blockage has already been considered in the modelled pit inlet capacities, and therefore a blockage assessment of the pipe infrastructure is not considered necessary. The HGL is lower than the existing headwater level, (i.e. 33.43 m AHD) determined in the CBD Flood Study (Cardno 2015), and therefore flood level impacts are not anticipated.

Detailed hydraulic modelling has been undertaken to confirm the final arrangement for the Subject Site and to confirm compliance with Penrith Council's relevant policies and guidelines. Plate 4-2 below provides an overview of the proposed drainage arrangement.

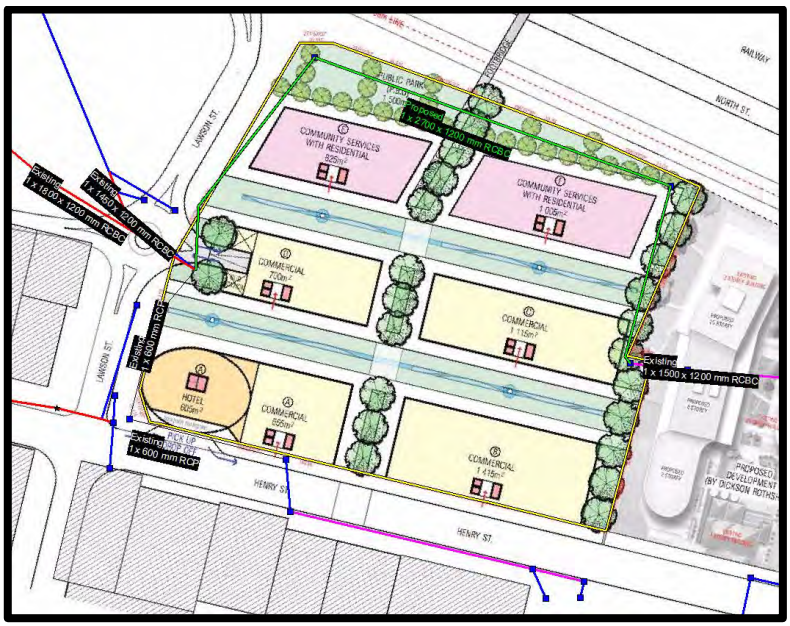

Plate 4-2 – Proposed Drainage Arrangement

4.3 Future Adjacent Development and Flood Mitigation Options

As part of the hot-spot analysis in the FRMSP (MS, 2020), mitigation options were investigated which included an alternate drainage arrangement proposed as part of a planning proposal for the adjacent (east) 57 Henry Street site. Plate 4-3 below is an extract from the FRMSP (MS, 2020) showing a proposed mitigation option for 57 Henry Street Penrith, and Plate 4-4 shows 1% AEP flood level changes for this option.

Plate 4-3 – 57 Henry Street Mitigation Option (Extract Map 55; FRMSP, MS 2020)

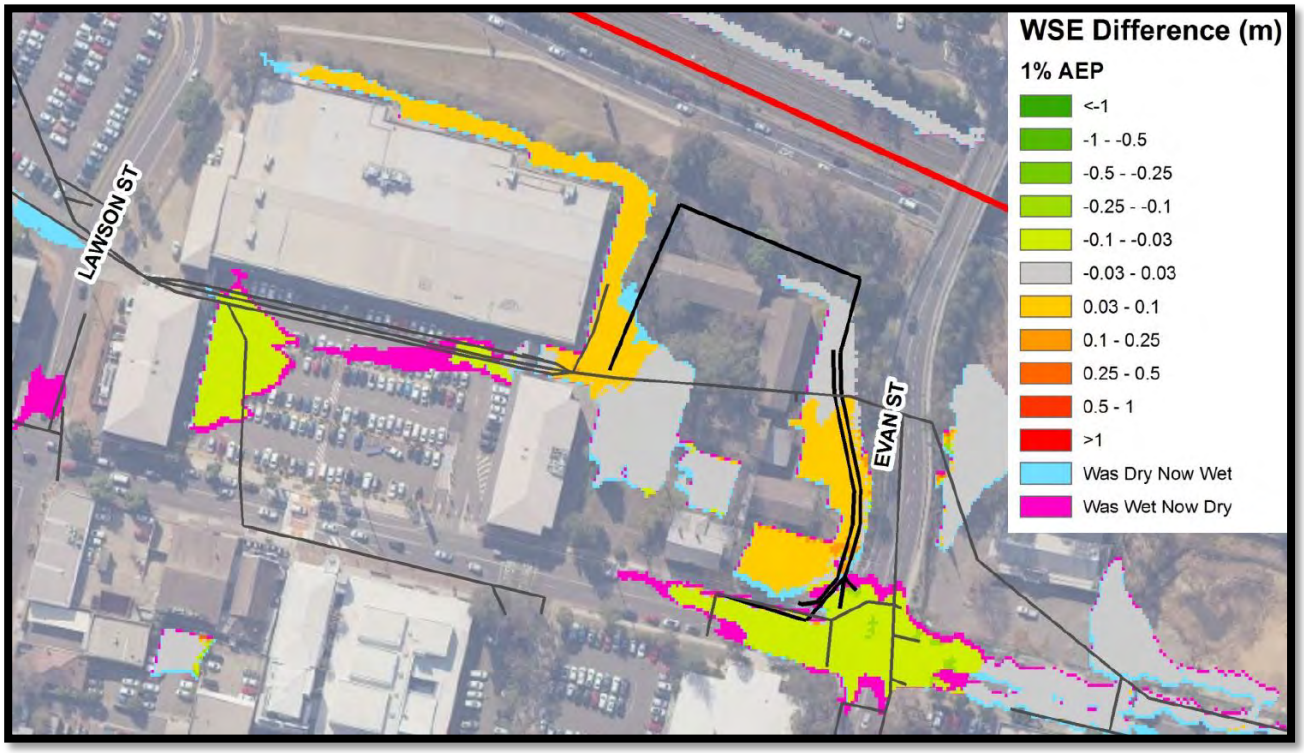

Plate 4-4 – 57 Henry Street Mitigation Option 1% AEP Flood Difference (Extract Map 58; FRMSP, MS 2020)

We note that this mitigation option does provide reasonable benefit at the intersection of Henry Street and Evan Street in more frequent events such as the 5% AEP. However, the benefits at this intersection in the 1% AEP are marginal and result in flood level increases in the order of 0.03 m to 0.1 m within the Subject Site. Notwithstanding, these flood level increases could be alleviated via the extension of the 2.10 m (w) x 1.5 m (h) box culvert with the proposed 2.7 m (w) x 1.2 m (h) culvert realignment.

An alternate mitigation arrangement comprising 2 x 1500 mm diameter concrete pipes within Henry Street and then north along the common boundary of 57 Henry Street and the Subject Site was also considered in the FRMSP (MS, 2020) as this would also reduce flood levels at the Evan Street intersection while also servicing 39-49 Henry Street which is also in a flooding hot-spot. Plate 4-5 provides an overview of this arrangement. Flood level differences were not presented for this option.

Plate 4-5 – 57 Henry Street Alternate Mitigation Option (Extract Map 59; FRMSP, MS 2020)

A trunk drainage solution across the northern portion of the 57 Henry Street and Subject Site (combination of arrangements shown in Plate 4-2 and 4-3) would provide an improved flood management outcome for both sites and provide a more efficient means of delivering trunk flow from the upstream catchment while also providing improvements at the intersection of Evan Street and Henry Street. Notwithstanding, the alternate mitigation option presented in Plate 4-5 will integrate with the culvert option assessed for the Subject Site.

5 FLOOD IMPACT ASSESSMENT

The Penrith City Council TUFLOW hydraulic model that informed the Penrith CBD FRMSP (MS, 2020) has been updated to better reflect the key features of the existing site that are likely to affect flood behaviour. The model was then augmented to reflect the proposed development to assess any flood impacts that might occur due to the proposed development.

Our approach to the flood impact assessment was as follows:

- Re-run the PCC's model using TUFLOW Classic solver to confirm the 1% AEP flood results provided by Council are replicated.
- Update PCC's model re-run to 2020 TUFLOW HPC (Heavily Parallelised Compute) solver from the original TUFLOW Classic Solver.
- Create an "existing" conditions model for the current existing conditions.
- The existing condition model was then augmented to reflect the developed conditions of the Subject Site.

The TUFLOW modelling is further described in detail below:

5.1 Available Data

The following data was used to inform the modelling:

- Penrith CBD Floodplain Risk Management Study and Plan (MS, 2020)
- TUFLOW model of the Penrith CBD Floodplain Risk Management Study and Plan (MS, 2020)
- Data from the neighbouring site Development application (NSW DPIE)
- Aerial photography of the site recorded by Metromap, 2022

5.2 Existing Conditions Flood Model

To establish an existing conditions model for the site, the following amendments were made to PCC's 2020 flood model:

Existing Conditions flood model:

- Update TUFLOW model from the original Classic solver to the TUFLOW HPC solver.

5.3 Developed Conditions Flood Model for Subject Site

An assessment of the developed conditions was undertaken by amending both existing conditions model with:

Developed Conditions flood model:

- Added the proposed development building pads and elevations
- Updated the drainage network surrounding the proposed development site.
- Added an open drainage channel around the outside of the proposed development.
- Updated the materials as a result of the proposed development.

5.4 Model Validation

Two (2) model validation runs were completed to enable comparison to the Penrith CBD FRMSP (MS, 2020) TUFLOW model results provided by Council.

Validation 1 – Re-run Council's model and compare to Council's results

The 1% AEP flood event was run and compared with the results provided by Council. Plate 5-1 below provides a flood level difference map which shows that there are isolated areas of flood level differences. Given that the differences are relatively minor, the results have been successfully replicated for the subject site area.

Plate 5-1 – Replicate 1% AEP Council Model Results

Validation 2 – Update Council's model to TUFLOW HPC 2020 build and compare to Council re-run results

The 1% AEP HPC model has been compared with the Council re-run results. The flood difference map shown in Plate 5-2 shows that there are areas with minor flood level differences. TUFLOW HPC's computational approach differs from the TUFLOW Classic, which is a 2nd order (space) implicit finite difference solver. TUFLOW HPC is an explicit solver for the full 2D Shallow Water Equations (SWE), and is both volume and momentum conserving, is 2nd order in space and 4th order in time, with adaptive or fixed time step. As such, the difference in flood levels is anticipated.

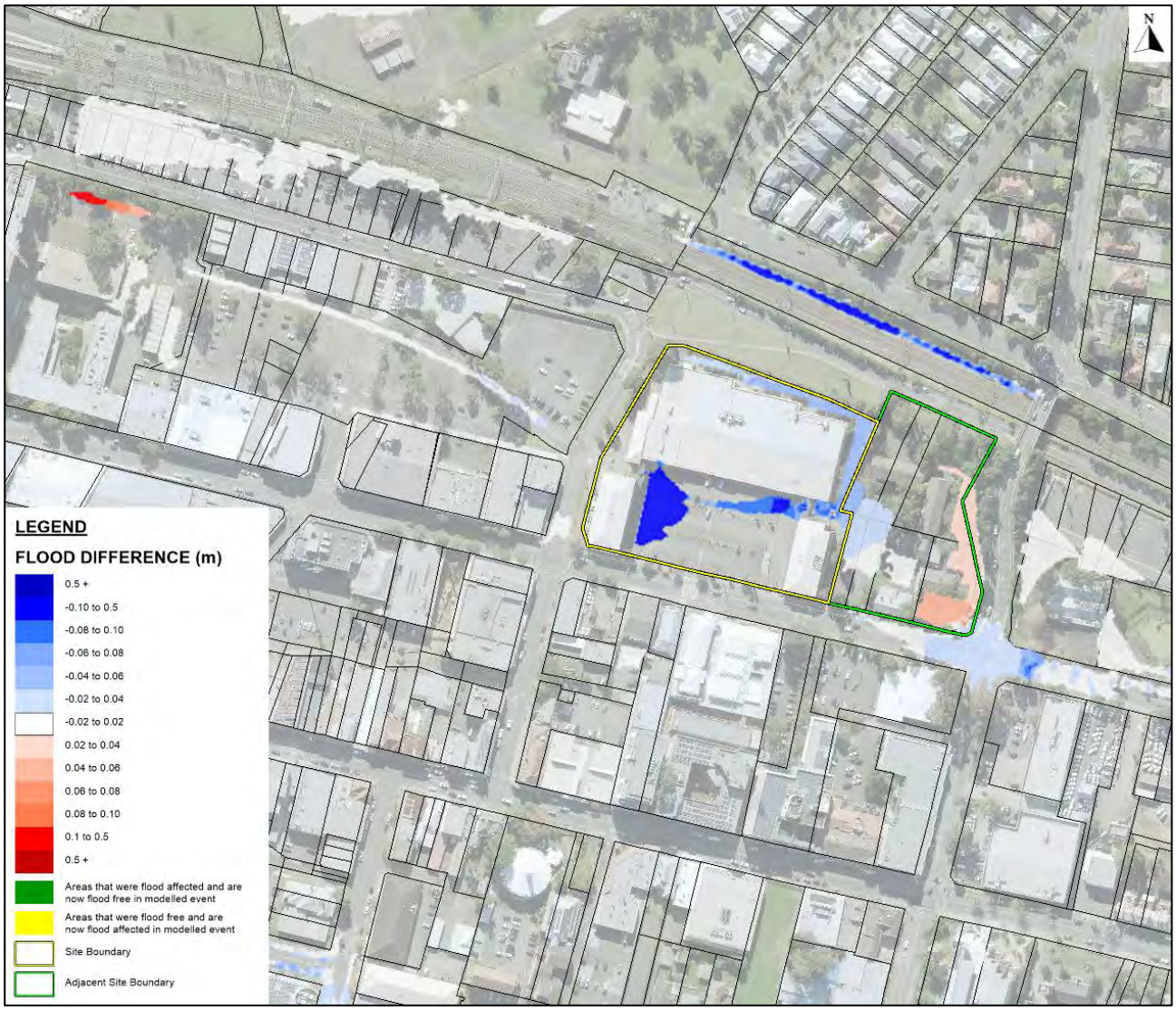

Plate 5-2 – Compare 1% AEP HPC Solver results to Classic Solver Results

5.5 Flood Assessment Analysis

The flood assessment was undertaken for the existing and developed conditions for the range of storm event including 10% AEP, 5% AEP, 1% AEP and PMF storm events.

It was found that the 9-hour and 2-hour storm duration were critical within the modelled catchment for 10% AEP, 5% AEP and 1% AEP. The 15-minute and 30-minute were the critical storm durations for the PMF storm event, with the subject site and consequent regions pertaining only to the 2-hour storm duration for the 10% AEP, 5% AEP and 1% AEP and 30-minute for the PMF storm event. The flood level, depth and velocity have been prepared for the existing and developed conditions for the 10%, 5%, 1% AEP and PMF flood events together with the flood level difference for the 1% AEP storm event are presented in Appendix A.

5.5.1 Existing Conditions Flood Behaviour

Figure 5-5 depicts the 1% AEP peak flood depth and level of the site and the neighbouring site in its existing state. The flood depths within the proposed site appear to be in the range of 0.2 m-0.3 m. However, this is mostly localised around the outside of the existing buildings on the site. The existing flow path travels through the site in an east to west direction, with the majority travelling through a culvert which runs underneath the site. Some flow exceeds the culvert capacity, in this case the excess re-routes along the northern boundary and around the site.

Figure 5-7 outlines the respective hazard regions in the 1% AEP storm event for the existing conditions model. Overall, the site is within the H1 category (generally safe) with only a few regions around the site and the adjacent site falling under the H2 (unsafe for small vehicles) and H3 categories (unsafe for vehicles, children and the elderly).

5.5.2 Developed Conditions Flood Behaviour

Figure 5-11 illustrates the 1% AEP peak flood depth and level of the site in developed conditions and existing conditions for the neighbouring site. The results show that there is no increase in flood depth as a result of the proposed development on the upstream and downstream ends of the site. Flooding along the northern portion of the site can be attributed to the proposed drainage channel which drains through the proposed drainage network.

Figure 5-13 outlines the respective hazard regions in the 1% AEP storm event. Overall, the site is still within the H1 category (generally safe) with only a few regions around the site and the adjacent site falling under the H2 (unsafe for small vehicles) and H3 categories (unsafe for vehicles, children and the elderly).

5.5.3 Flood Impact

The 1% AEP flood level difference was prepared by comparing the developed conditions flood results with the existing conditions flood results.

Figure 5-15 highlights there is no flood affectation downstream of the site and no flood level differences upstream of the site. A flood level increase can be seen within the proposed open channel around the proposed site. This is due to the alteration of the existing flow path to the existing drainage infrastructure downstream of the site.

5.5.4 Flood Velocity Impact

The 1% AEP flood velocity difference was prepared by comparing the developed conditions flood results with the existing conditions flood results.

Figure 5-16 highlights there appears to be only minor increases within the proposed open channel and no flood velocity increase across the neighbouring site as a result of the proposed development.

5.6 Flood Levels and Freeboard

The proposed drainage system discussed in Section 4.2 above will provide suitable conveyance for 1% AEP flows from the Subject Site and the upstream catchment. The 1% AEP flooding within the site will therefore be limited to localised sheet flow and building roof water which can be managed via the internal drainage network and site grading.

Given that flood levels external to the site are not to be increased in a 1% AEP event, Council's existing conditions CBD flood model results are considered fit for purpose to inform flood levels surrounding the site and the required freeboard to the proposed finished floor levels and driveway crests.

Council's *Stormwater Drainage Guidelines for Building Developments* (PCC, May 2018) requires the following freeboard to be achieved above 1% AEP flood level:

- Residential, Industrial or Commercial Floor Levels = 500 mm
- Garages and non-habitable flood levels = 100 mm
- Crest of driveway ramps, pedestrian entry points and any openings to the basement (e.g. vents) = 300 mm

Our assessment confirms that an appropriate flood solution for the developed conditions 1% AEP flood affectation of the Subject Site can be achieved and that Council's freeboard requirements to finished floor and driveway crest levels can be provided based on Figure 5-11.

5.7 Flood Hazard and Flood Evacuation

Flood hazard mapping was prepared for the modelled events completed as part of FRMSP (MS, 2020). The hazard zones consistent with the Australian Rainfall and Runoff Revision 2016 (ARR, 2016) are shown in Plate 5-4 below.

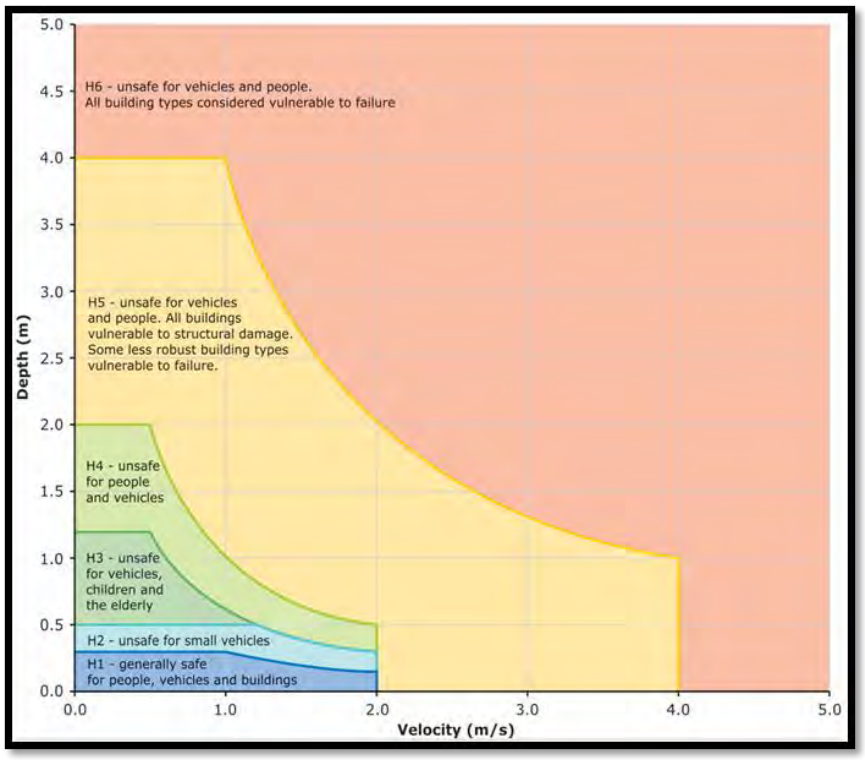

Plate 5-3 – ARR 2016 Hazard Categories

Hazard maps are useful to obtain an appreciation of the relative depth and velocity of floodwater within a locality and are a critical element in determining:

- The locations of critical public infrastructure such as hospitals and aged care facilities.
- The areas in the floodplain for which public safety is “at risk”.
- Assist in the Flood Emergency response and Evacuation Management Process.

The existing 1% AEP flood hazard at the subject site is generally H1 and H2 which is considered safe for pedestrians, including children and the elderly. Isolated areas of H3 are evident in ponded areas both within and immediately to the east of the site.

The flood hazard mapping of the proposed development as part of this assessment can be found in Appendix A.

As noted in Section 3, an alternate landform supporting buildings and carparks with height ranging from 20 m to 56 m is permissible under the current zoning of the site. Based on the built form of the current planning proposal is anticipated that the flood hazard within the Subject Site will be reduced to H1 or H2 category for events up to and including the PMF event. See Plate 5-5 below for an extract of Map 22 from the FRMSP (MS, 2020) showing the existing 1% AEP flood hazard at the site.

Plate 5-4 – Existing 1% AEP Flood Hazard (Extract Map 22; FRMSP, MS 2020)

In an extreme PMF event, flood hazard both within and surrounding the Subject Site of up to a H5 category is possible. Plate 5-6 showing peak PMF hazard is an extract of Map 23 from the FRMSP (MS, 2020).

Plate 5-5 – Existing PMF Hazard (Extract Map 23; FRMSP, MS 2020)

This flood hazard appears to predominantly be associated with PMF depths caused by restriction of flow due to existing building locations and landform. An alternate landform would be permissible under the current zoning of the site, and the proposed redirection of flows around the northern edge of the site as part of the current proposal can be managed as part of the building and drainage design. It is also noted that the proposed development can be designed to withstand flood forces that may occur in this extreme event, and the future landform is more amenable to the safe passage of PMF water through the Subject Site.

The existing flood emergency response classification for the Subject Site is identified in the FRMSP (MS, 2020) is a “low flood island”. Low flood islands occur where evacuation routes are cut off before the site itself becomes inundated, and eventually floodwater could rise and cover the entire site.

The flood hazards around the proposed development were updated as part of the current assessment and were found to remained consistent with the previous assessment outlined in the FRMSP (MS, 2020).

5.7.1 Flood Emergency Response Plan

A flood emergency response plan sets out how the occupants of the site are to safely manage the flood risk on the site. The nature of the local PMF that may result in the need to evacuate the proposed development will be short in duration (typically less than a 1-hour event), which does not allow for formal flood evacuation to occur.

The proposed redevelopment of the Subject Site will include significant areas where occupants can take refuge above the local PMF level. The PMF flood depths at the site (see Plate 3-4) are in the order of up to 2.0 m, and therefore the proposed residential apartments located on the third floor and above would be approximately four (4) to six (6) metres above the PMF level. Provided that accessible ramps are included from the lower level of the commercial, community services, and hotel buildings to the first floor, it is anticipated that there would be more than sufficient space for the ground level occupants to find refuge above the local PMF level.

It should also be noted that local flood waters would also recede quite quickly after the storm, which is supported by the ‘Road Inundation - Frequency of Closure’ mapping and associated Table 1 in the FRMSP (MS, 2020) which indicates that the nearby Evan Street and Lawson Street intersections with Henry Street would only be inundated by a flood hazard higher than a H2 category for 1 hr or less in any of the modelled storm events. Notwithstanding, in the event that occupants do need to evacuate, a crossing on the northern side of the development over the PMF flood extent could be provided to the North Street Road reserve which is flood free in the PMF event. From there, pedestrians could walk east along North Street to the existing stairs leading up to the Evan Street overpass.

Plate 5-7 below provides a schematic of the proposed flood evacuation route. Existing PMF depths in the north-western corner of the site are less than 1 m and could easily be accommodated in a structurally designed crossing or culvert arrangement. It also demonstrates that flood safe access to the site by nearby emergency services is also feasible. Alternate emergency services routes via the Northern Road and Cox Avenue are also available.

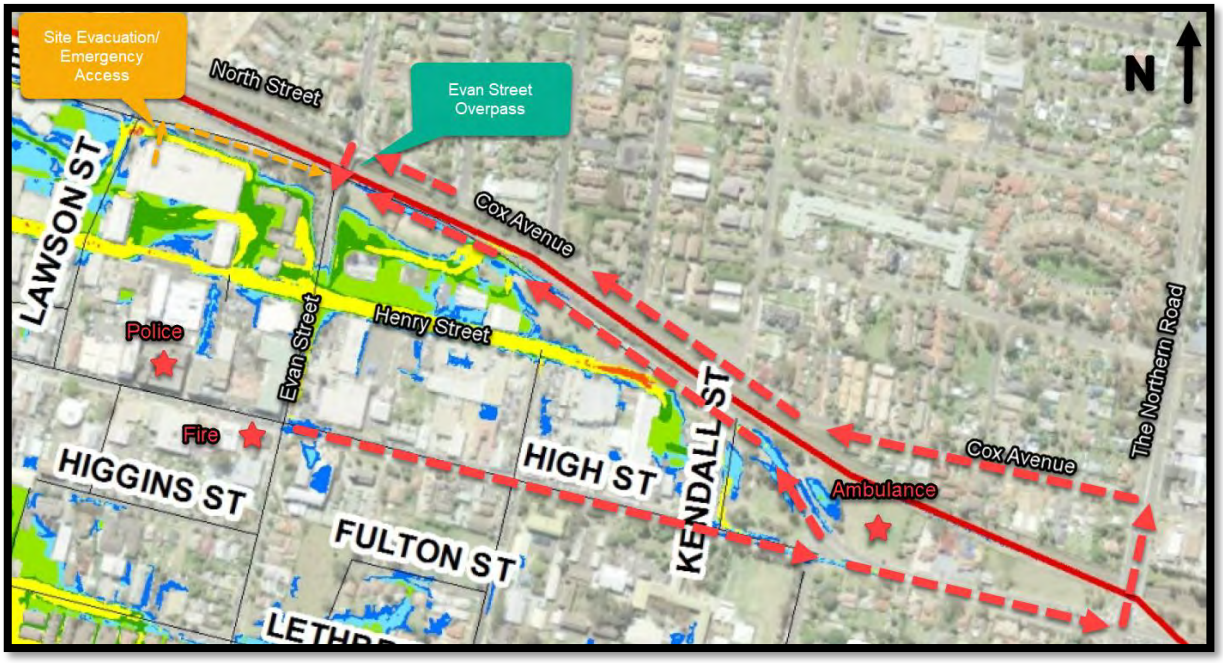

Plate 5-6 – PMF Evacuation and Flood Safe Access (Extract Map 23; FRMSP, MS 2020)

Plate 5-8 shows an indicative PMF crossing within the north-western corner of the site, viewed from Lawson Street. Plates 5-9 and 5-10 provide a view looking east on North Street toward the access stairs to the Evan Street overpass, demonstrating that flood safe evacuation and access to the building is feasible.

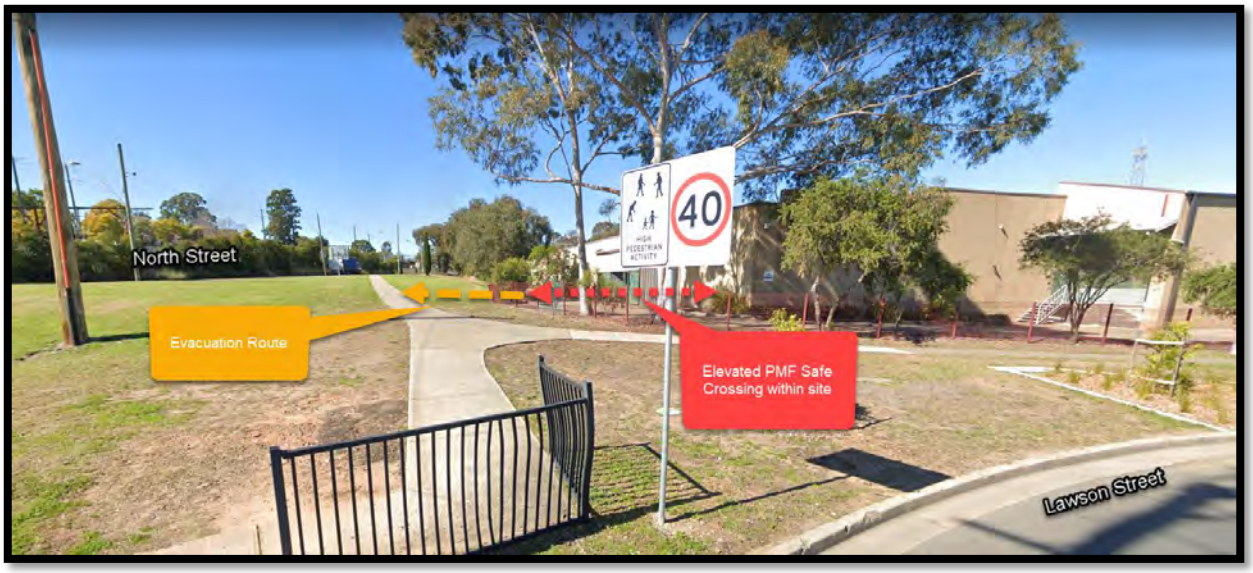

Plate 5-7 – PMF Crossing Within Site

Plate 5-8 – PMF Evacuation and Flood Safe Access on North Street

Plate 5-9 – PMF Evacuation and Flood Safe Access North Street to Evan Street Overpass

The flood evacuation route and flood safe access points were reviewed as part of the current assessment and was found to still be consistent with the previous assessment outlined in the FRMSP (MS, 2020).

5.8 Climate Change

As noted in Section 3.3, the 0.5% AEP event was utilised in lieu a 1% AEP climate change event. The report (MS, 2020) suggests that the flood level increases between the 1% AEP event and the 0.5% AEP are in the order of 0.4 m (40 cm). However, a comparison of flood depths between the two (2) events shown in Plate 3-2 and 3-3 indicate minimal change in flood depth and extent due to climate change at the Subject Site.

Therefore, any change in flood level as a result of climate change will be minimal and would already be mitigated and managed by Penrith City Council's freeboard requirements applicable to the site.

5.9 Recommendations

As part of any future development application for the site, the proposed building landform and drainage arrangements should be tested in a hydraulic (flood) model to:

- determine the developed conditions flood behaviour and confirm no adverse impacts
- confirm the performance of the drainage arrangements and the preferred flood mitigation options for the locality
- inform the structural design of the building if it needs to withstand PMF forces
- inform the design of a PMF safe access which will need to be provided within the Site to North Street

6 STORMWATER 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 6.3.0 and MUSIC-link data version 6.32 was adopted for this study.

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

Penrith City Council requires the following Pollution reduction targets to be achieved:

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

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

6.1 Catchments

A MUSIC model was prepared to reflect the proposed development. The model considers the entire site (catchment M1) discharging to a single stormwater management device.

A small amount of bypass catchment (M2) reflects the new entry off Lawson Street. Plate 6-1 provides an overview of the MUSIC model arrangement.

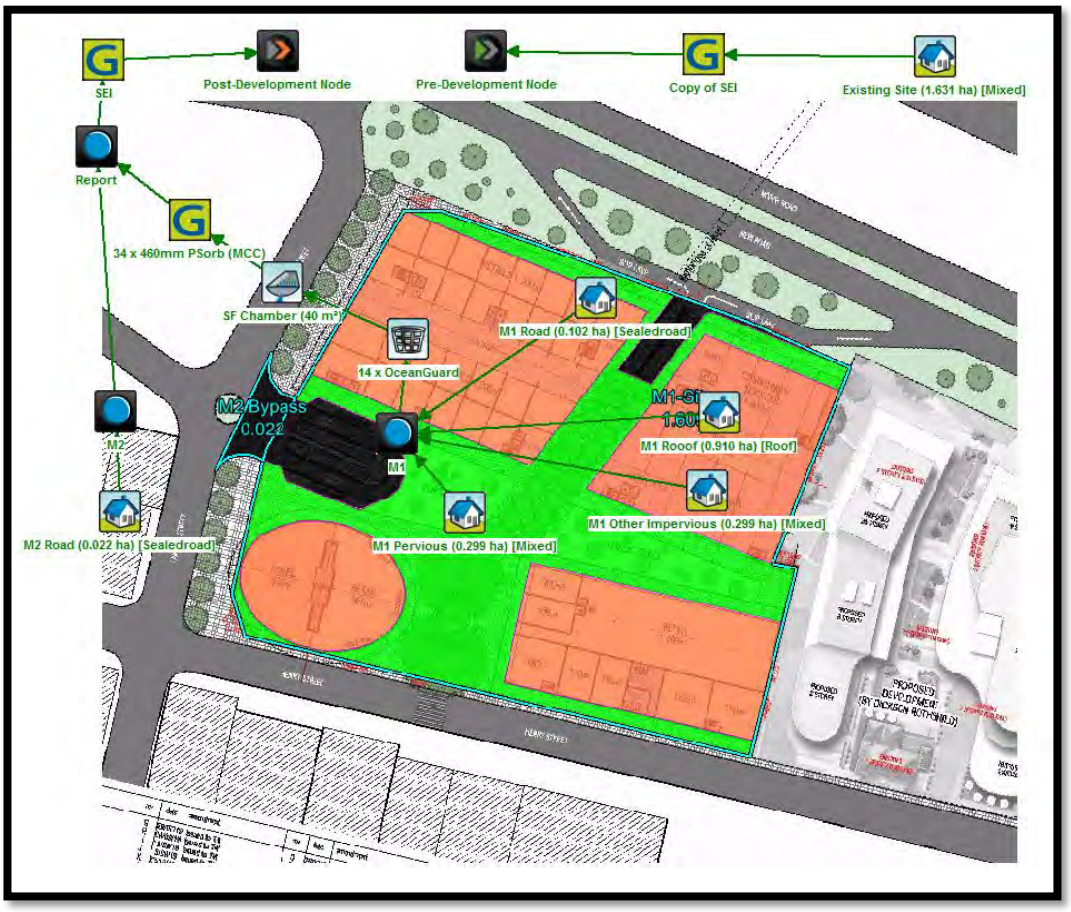

Plate 6-1 – MUSIC model layout (110606-02_MU4.sqz)

It is noted that the concept layout shown in Plate 6-1 was based on an earlier concept arrangement for the Subject Site. Regardless of the final form of the proposed redevelopment of the site, the modelling presented here demonstrates that a feasible stormwater quality management solution exists for the Subject Site.

6.2 Modelling Parameters and Assumptions

The following catchment assumptions were adopted in the MUSIC model:

- Roof Area = 9,100 m², modelled as 100% Impervious
- Landscaped Area = 5,970 m², modelled as 50% impervious (average)
- Road Pavement = 1,240 m², modelled as 100% Impervious
- All areas within the site can be drained (i.e. piped or overland) to a Stormfilter chamber located in the western portion of the site near the Lawson Street entry.

A MUSIC Catchment Plan is provided in Figure 5-1 in Appendix B. Full details of the MUSIC area breakdown and node inputs are also provided in Appendix B.

6.3 Pollutant Load Estimates

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

It was found that the following treatment device configuration would be required to ensure that the statutory pollutant reduction targets are met prior to discharge from the site:

- With the exception of the bypassing catchment, all piped and overland runoff within the site is to be directed to fourteen (14) OceanGuard (or equivalent) pit filter inserts prior to discharge to the Stormfilter chamber.
- A 40 m² Stormfilter chamber fitted with twenty-eight (34) PSorb Stormfilter cartridges.

Table 6-1 details the results of the stochastic assessment.

Table 6-1 – Summary of Estimate Mean Annual Pollutant Loads and Reductions

Pollutant	Total Developed Source Nodes	Minimum Reduction Required	Total Residual Load from Site	Total Reduction Achieved	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)	(%)	(%)
TSS	773	657	116	657	85.0%	85.0%
TP	1.84	1.10	0.558	1.28	60.0%	69.7%
TN	18.1	8.15	8.78	9.32	45.0%	51.5%
Gross Pollutants	221	199	3.64	217	90.0%	98.4%

6.4 Stream Erosion Index

PCC's Water Sensitive Urban Design (WSUD) Policy (2013) requires that the duration of developed conditions stream forming flows are not greater than 3.5 times the duration of existing conditions streaming flows.

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

Details of the SEI assessment are provided in Table 6-2 below.

Table 6-2 – SEI Results

	Determination of Critical Flow							Stream Erosion Index		
Assessment Location	Area (km^2)	$t_c = 0.76A^{0.38}$ (hour)	t_c (minutes)	I_2 (mm/hr)	C_2	Q_2 (m^3/s)	Q_{crit} (m^3/s)	Pre Dev Outflow (ML/yr)	Post Dev Outflow (ML/yr)	SEI
Site Discharge	0.01631	0.16	9.5	75	0.281	0.096	0.048	1.55	1.12	0.7

Results indicate that the SEI for the proposed development is a maximum of 0.7, which is below the maximum allowable target of 3.5. This is an improvement from the existing landuse of the Subject Site. The provision of WSUD elements within the development will assist in minimising the impact of urbanisation on the waterway stability of the receiving watercourse.

Refined modelling as part of a future Development Application could explore a combination of above and below ground treatment measures. However, the stormwater quality modelling confirms that an appropriate management solution can be achieved for the Subject Site and is suitable to support the Planning Proposal.

7 REFERENCES

BMT WBM Pty Ltd (2015). NSW MUSIC Modelling Guidelines

Penrith City Council Stormwater Drainage Guidelines for Building Developments (2018)

Penrith Overland Flood Study (Cardno, Lawson, Treloar 2006)

Penrith CBD Detailed Overland Flood Study (Cardno 2015)

Penrith CBD Flood Risk Management Plan and Study (Molino Stewart, 2020)

Penrith City Council Water Sensitive Urban Design (WSUD) Policy (2013)

Penrith City Council WSUD Technical Guidelines (2015).

APPENDIX A

FLOOD MAPPING RESULT FIGURES

J. WYNDHAM PRINCE
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LEGEND

FLOOD DIFFERENCE (m)

- 0.50 +
- -0.20 to 0.50
- -0.15 to 0.20
- -0.10 to 0.15
- -0.08 to 0.10
- -0.06 to 0.08
- -0.04 to 0.06
- -0.02 to 0.04
- -0.02 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.15
- 0.15 to 0.20
- 0.20 to 0.50
- 0.50 +
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-1

Planning Proposal
61-79 Henry Street, Penrith

1% AEP
Council Re-run minus Council
Flood Difference

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-1_COUNCIL_1AEP_DIFF_A.wor

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LEGEND

FLOOD DIFFERENCE (m)

- 0.50 +
- -0.20 to 0.50
- -0.15 to 0.20
- -0.10 to 0.15
- -0.08 to 0.10
- -0.06 to 0.08
- -0.04 to 0.06
- -0.02 to 0.04
- -0.02 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.15
- 0.15 to 0.20
- 0.20 to 0.50
- 0.50 +

Areas that were flood affected and are now flood free in modelled event

Areas that were flood free and are now flood affected in modelled event

61-79 Henry Street

57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-2

Planning Proposal
61-79 Henry Street, Penrith

1% AEP
Council Re-run GPU minus Council Re-run
Flood Difference

Date: 20/07/2022 Issue: A

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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.15
- 0.15 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-3

Planning Proposal
61-79 Henry Street, Penrith

10% AEP
Existing Conditions
Flood Depth and Levels

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-3_EX01_10AEP_DEP_A.wor

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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.15
- 0.15 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

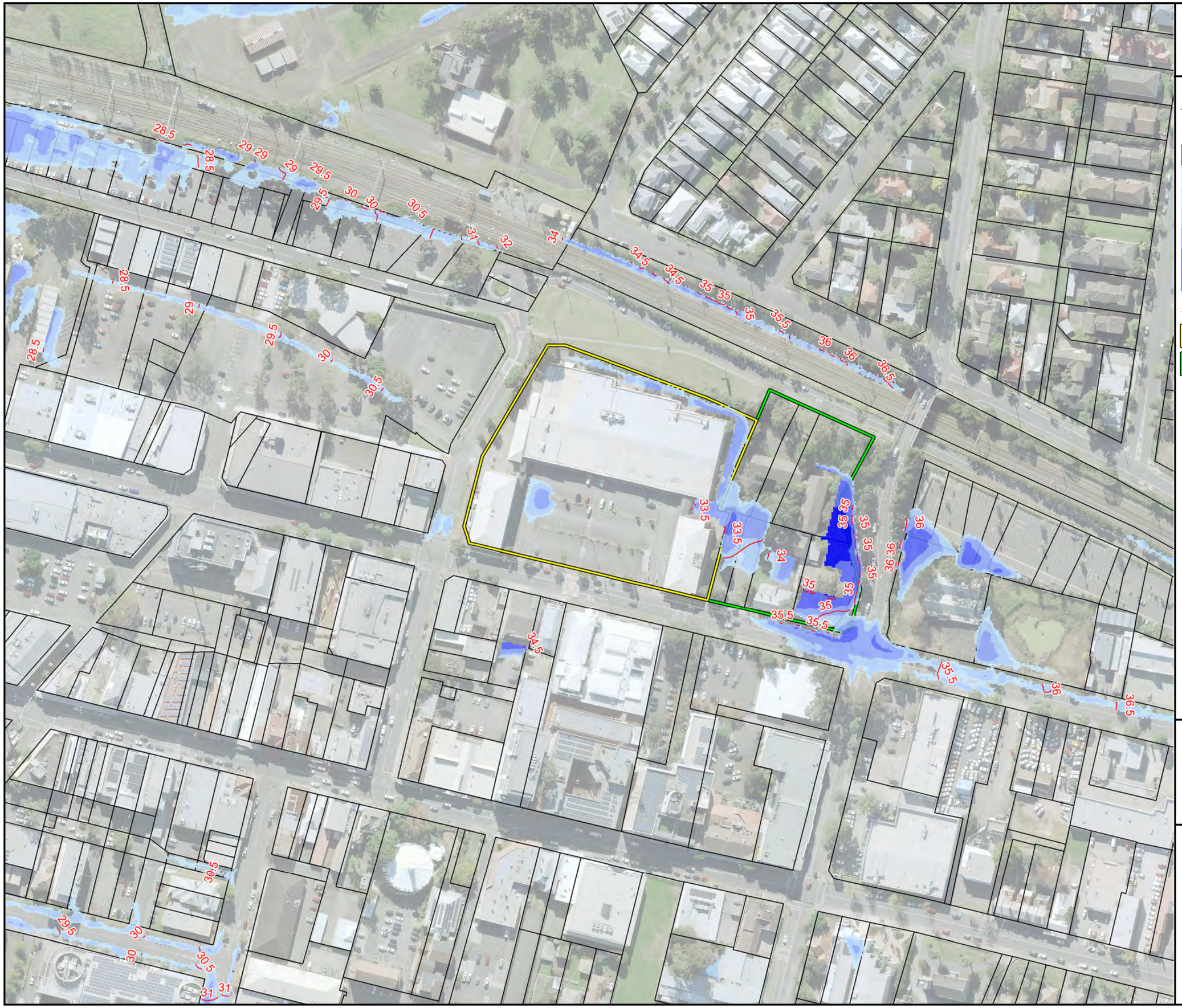
Figure 5-4

Planning Proposal
61-79 Henry Street, Penrith

5% AEP
Existing Conditions
Flood Depth and Levels

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-4_EX01_5AEP_DEP_A.wor



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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.15
- 0.15 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-5

Planning Proposal
61-79 Henry Street, Penrith

1% AEP
Existing Conditions
Flood Depth and Levels

Date: 20/07/2022 Issue: A

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& PROJECT MANAGERS

LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.15
- 0.15 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 — 0.5 m Flood Contours

61-79 Henry Street

57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

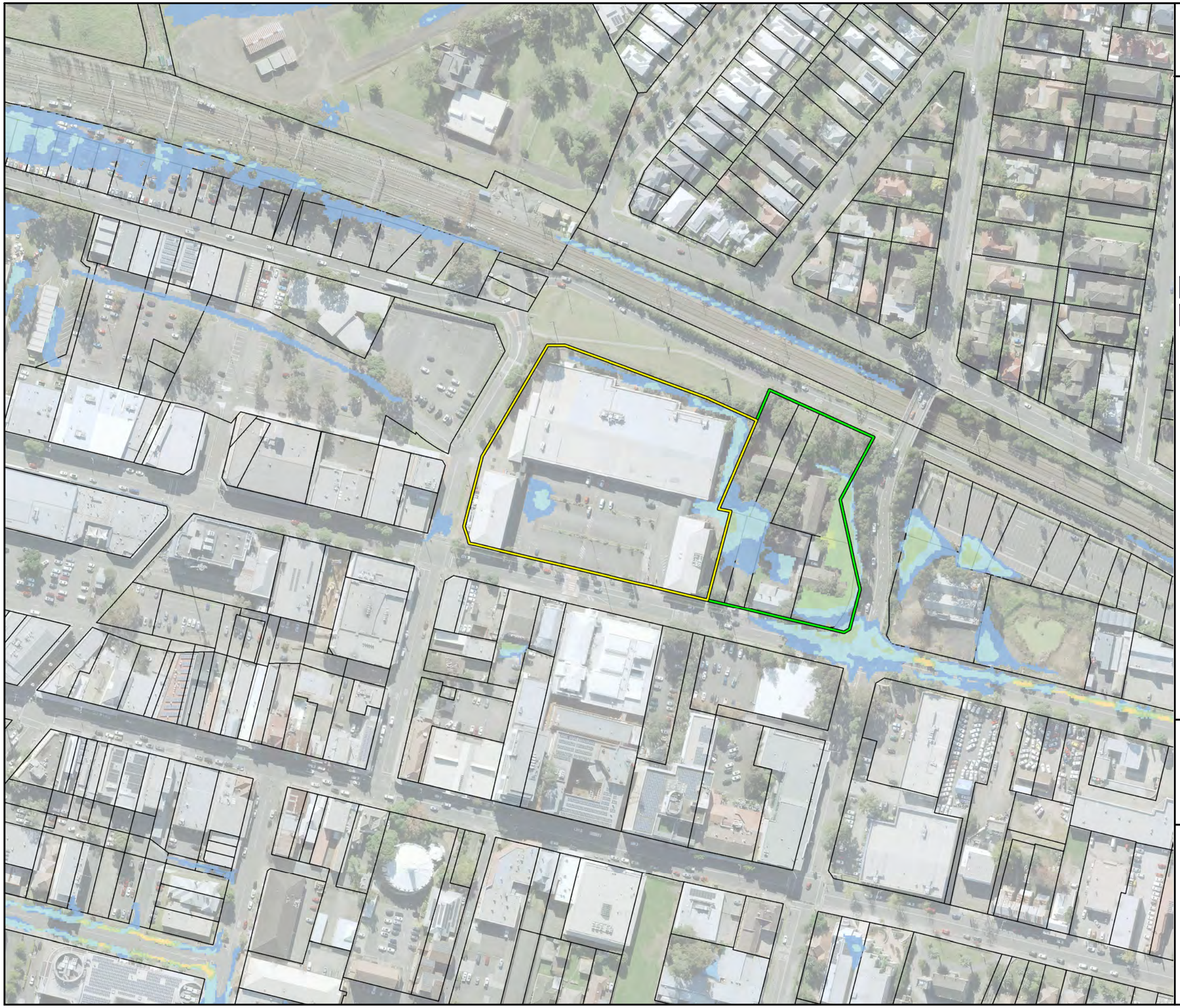
Figure 5-6

Planning Proposal
61-79 Henry Street, Penrith

PMF
Existing Conditions
Flood Depth and Levels

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-6_EX01_PMF_DEP_A.wor



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LEGEND

FLOOD HAZARD

- H1 - Generally safe.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4- Unsafe for people and vehicles.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to failure.
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-7

Planning Proposal
61-79 Henry Street, Penrith

1% AEP
Existing Conditions
Flood Hazard

Date: 20/07/2022 Issue: A

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LEGEND

FLOOD HAZARD

- H1 - Generally safe.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4- Unsafe for people and vehicles.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to failure.
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

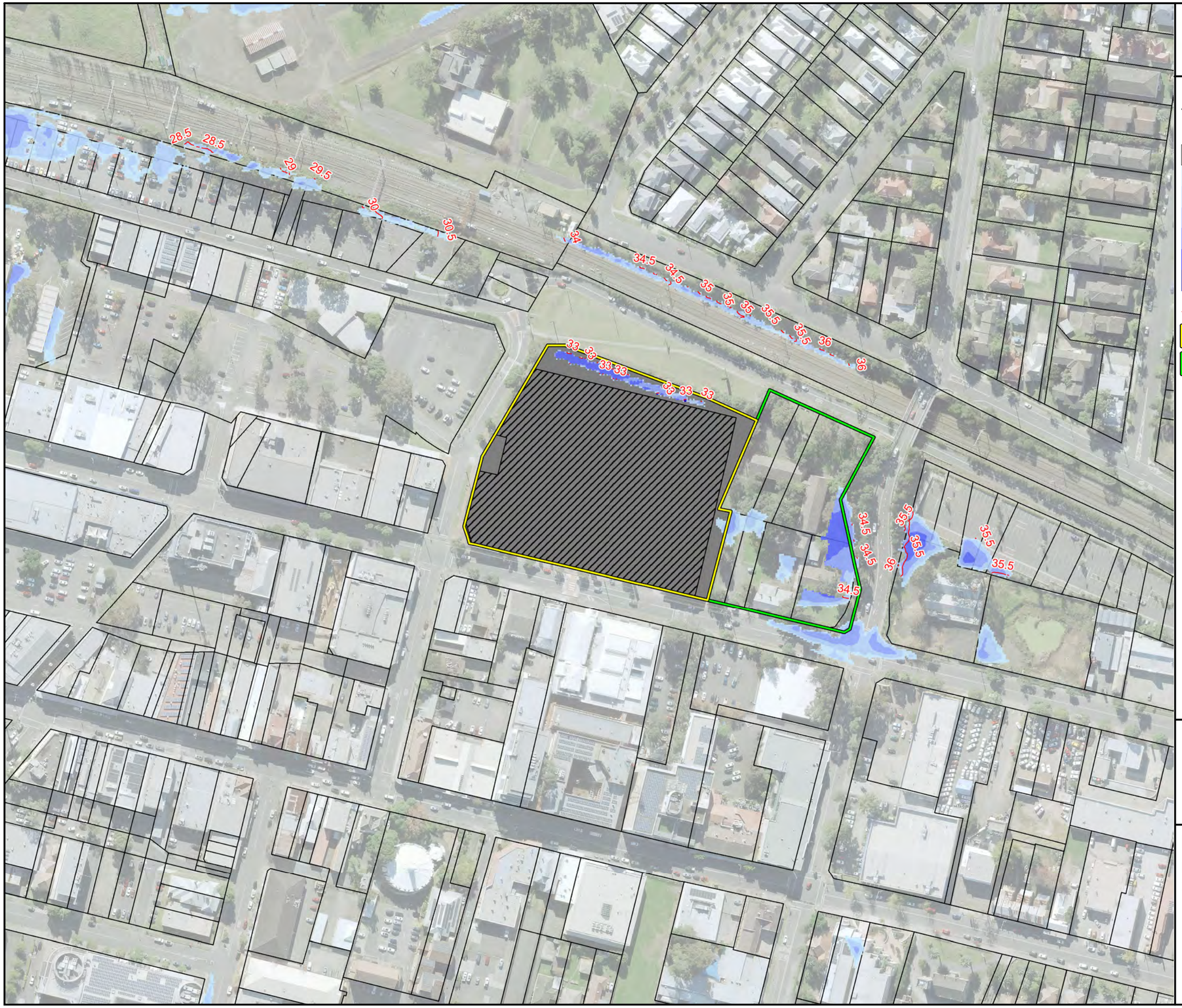
Projection: GDA 1994 MGA Zone 56

Figure 5-8

Planning Proposal
61-79 Henry Street, Penrith

PMF
Existing Conditions
Flood Hazard

Date: 20/07/2022 Issue: A



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& PROJECT MANAGERS

LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.15
- 0.15 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +
- 35.0 — 0.5 m Flood Contours
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-9

Planning Proposal
61-79 Henry Street, Penrith

10% AEP
Developed Conditions
Flood Depth and Levels

Date: 20/07/2022 Issue: A

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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.15
- 0.15 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 — 0.5 m Flood Contours

61-79 Henry Street

57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-10

Planning Proposal
61-79 Henry Street, Penrith

5% AEP
Developed Conditions
Flood Depth and Levels

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 - Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-10_DEV08_5AEP_DEP_A.wor

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LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.15
- 0.15 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 — 0.5 m Flood Contours

61-79 Henry Street

57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-11

Planning Proposal
61-79 Henry Street, Penrith

1% AEP
Developed Conditions
Flood Depth and Levels

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 - Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-11_DEV08_1AEP_DEP_A.wor

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& PROJECT MANAGERS

LEGEND

FLOOD DEPTH (m)

- 0.0 to 0.15
- 0.15 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

35.0 — 0.5 m Flood Contours

61-79 Henry Street

57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-12

Planning Proposal
61-79 Henry Street, Penrith

PMF
Developed Conditions
Flood Depth and Levels

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-12_DEV08_PMF_DEP_A.wor

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& PROJECT MANAGERS

LEGEND

FLOOD HAZARD

- H1 - Generally safe.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4- Unsafe for people and vehicles.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to failure.
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-13

Planning Proposal
61-79 Henry Street, Penrith

1% AEP
Developed Conditions
Flood Hazard

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\MapInfo\Figure

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LEGEND

FLOOD HAZARD

- H1 - Generally safe.
- H2 - Unsafe for small vehicles.
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- H4- Unsafe for people and vehicles.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage.
- H6 - Unsafe for vehicles and people. All buildings vulnerable to failure.
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-14

Planning Proposal
61-79 Henry Street, Penrith

PMF
Developed Conditions
Flood Hazard

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-14_DEV08_PMF_HAZ_A.wor

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LEGEND

FLOOD DIFFERENCE (m)

- 0.50 +
- -0.20 to 0.50
- -0.15 to 0.20
- -0.10 to 0.15
- -0.08 to 0.10
- -0.06 to 0.08
- -0.04 to 0.06
- -0.02 to 0.04
- -0.02 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.15
- 0.15 to 0.20
- 0.20 to 0.50
- 0.50 +
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-15

Planning Proposal
61-79 Henry Street, Penrith

1% AEP
Developed - Existing
Flood Difference

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\MapInfo\Figures\Report Figures\110606-02_Fig5-15_DEV08-EX01_1AEP_DIFF_A.wor

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& PROJECT MANAGERS

LEGEND

VELOCITY DIFFERENCE (m)

- -2.0 +
- -1.5 to 2.0 +
- -1.0 to 1.5
- -0.5 to 1.0
- -0.25 to 0.5
- -0.10 to 0.25
- -0.1 to 0.1
- 0.10 to 0.25
- 0.25 to 0.5
- 0.5 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 +
- Areas that were flood affected and are now flood free in modelled event
- Areas that were flood free and are now flood affected in modelled event
- 61-79 Henry Street
- 57 Henry Street

N

0 80

metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-16

Planning Proposal
61-79 Henry Street, Penrith

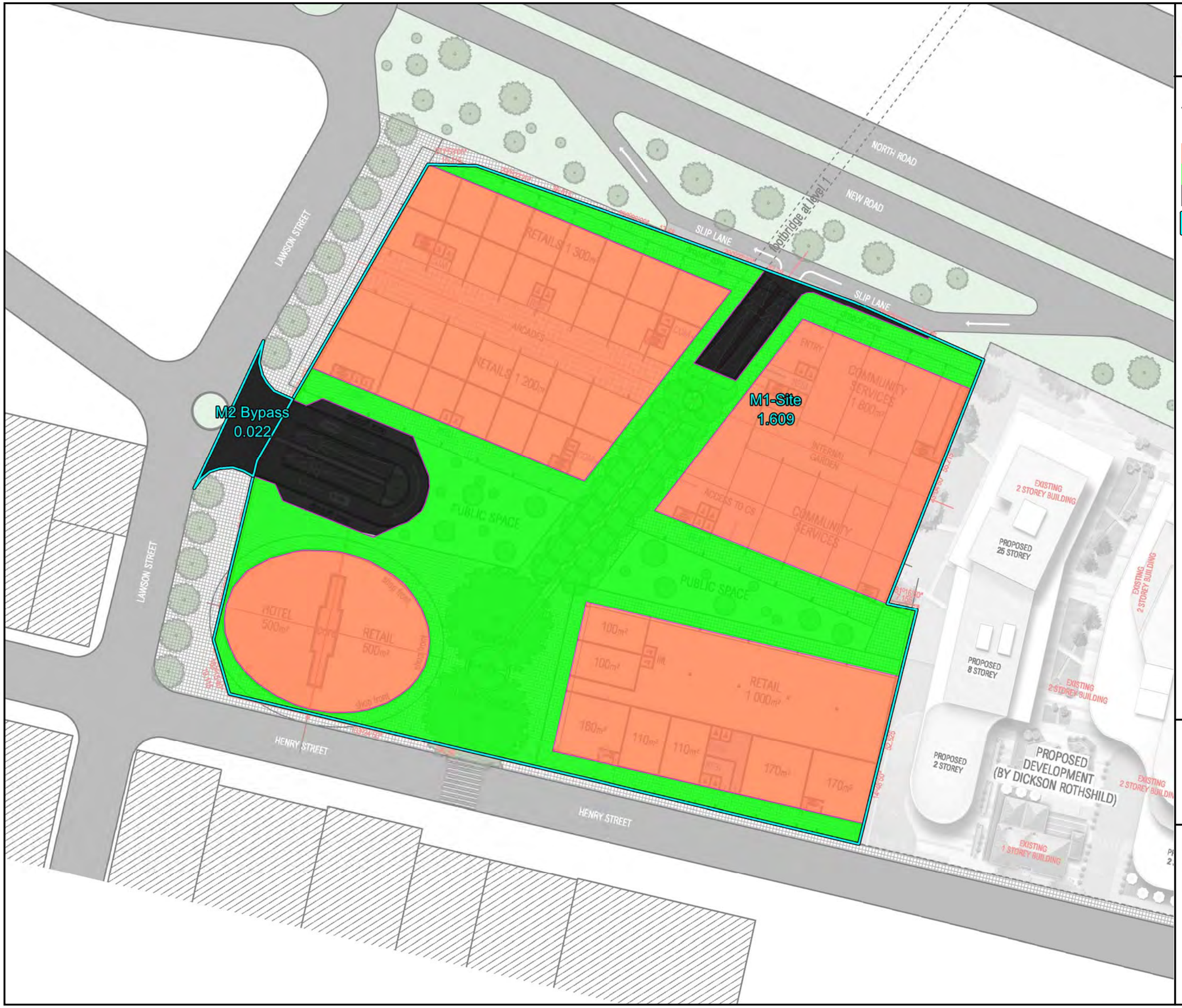
1% AEP
Developed - Existing
Velocity Difference

Date: 20/07/2022 Issue: A

Filename: J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&EMapInfo\Figures\Report Figures\110606-02_Fig5-16_DEV08-EX01_1AEP_VDIF_A.wor

APPENDIX B

MUSIC MODEL CATCHMENT DATA



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LEGEND

MUSIC Catchment

- Roof Area
- Public Space
- Road Area
- MUSIC Catchment Boundary

N

0 30

metres

Scale 1:750 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 5-1

61-79 Henry Street Penrith Planning Proposal

MUSIC Catchment Plan

Date: 9/12/2019 Issue: A

Filename: "J:\110606 - 61-79 Henry Street Penrith\02 -Flooding and Infrastructure Report\SW&E\Drawings\Figures\Fig5-1_MUSIC_Cat_001.wor"

MUSIC MODELLING WORKSHEET

61-69 Henry Street Planning Proposal

	Catchment Division				Node Inputs: Catchment Split Road/Roof/Impervious/Pervious				
Catchment	**Total Catchment Area (ha)**	**Building (ha)**	**Road Pavement Area (ha)**	**Public Space (ha)**	**Road and driveways (ha)**	**Roof (ha)**	**Other Impervious (ha)**	**Pervious (ha)**	**Effective % Impervious**
M1	1.609	0.910	0.102	0.597	0.102	0.910	0.299	0.299	81%
M2 Bypass	0.022		0.022		0.022				100%
Total	1.631	ha						Avg. Imp.	81.7%

%Impervious	
Building	100%
Road Pavement	100%
Landscape (int)	50%

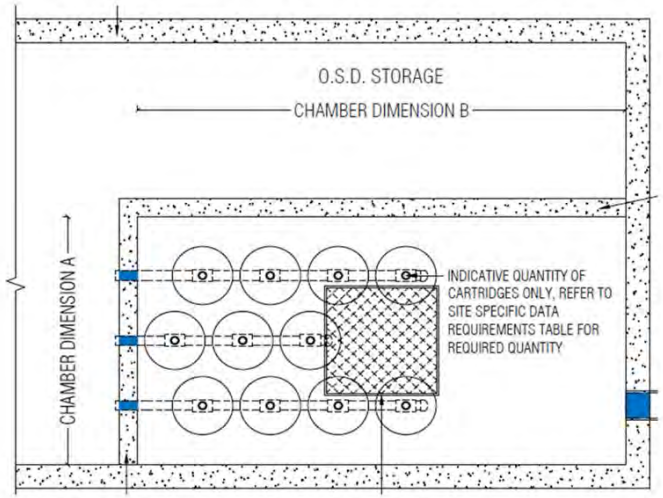
SYSTEM INPUTS

System Type	Variable Detention Area	
Cartridge Height	460	
Number of Cartridges	34	1 - 1000
Cartridge Media	PSorb	

Variable Detention Area Inputs

Length B (m)	20.0	
Width A (m)	2.0	
Diameter (m, leave blank if not a manhole)		

OSD PLAN VIEW



MUSIC MODEL PROPERTIES

OCEAN PROTECT
oceanprotect.com.au | 1300 354 722

Properties of SF Chamber

Location: SF Chamber (40m²)

Inlet Properties

Low Flow By-pass (cubic metres per sec)	0.00000
High Flow By-pass (cubic metres per sec)	100.0000

Storage Properties

Surface Area (square metres)	34.0
Extended Detention Depth (metres)	0.54
Permanent Pool Volume (cubic metres)	0.0
Initial Volume (cubic metres)	0.00
Exfiltration Rate (mm/hr)	0.00
Evaporative Loss as % of PET	0.00

Estimate Parameters

Outlet Properties

Equivalent Pipe Diameter (mm)	107
Overflow Weir Width (metres)	2.0
Notional Detention Time (hrs)	87.9E-3

Use Custom Outflow and Storage Relationship

Define Custom Outflow and Storage — Not Defined

Re-use... | Fluxes... | Notes... | More

Cancel | Back | Finish

Properties of StormFilter

Location: 34 x 460 PSorb StormFilter

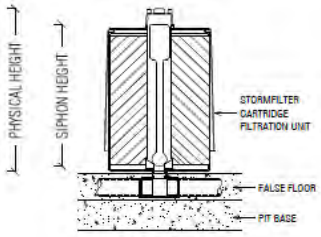
Inlet Properties

Low Flow By-pass (cubic metres per sec)	0.00000
High Flow By-pass (cubic metres per sec)	0.01564

STORMFILTER DESIGN TABLE

- STORMFILTER TREATMENT CAPACITY VARIES BY NUMBER OF FILTER CARTRIDGES INSTALLED.
- THE STANDARD CONFIGURATION IS SHOWN. ACTUAL CONFIGURATION OF THE SPECIFIED STRUCTURE(S) PER CERTIFYING ENGINEER WILL BE SHOWN ON SUBMITTAL DRAWING(S).
- FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF-CLEANING. RADIAL MEDIA DEPTH SHALL BE 178mm.

CARTRIDGE NAME / SIPHON HEIGHT (mm)	690	460	310
CARTRIDGE PHYSICAL HEIGHT (mm)	840	600	600
TYPICAL WEIR HEIGHT [H] (mm)	920	690	540
CARTRIDGE FLOW RATE FOR ZPG MEDIA (L/s)	1.6	1.1	0.7
CARTRIDGE FLOW RATE FOR PSORB MEDIA (L/s)	0.9	0.46	0.39



STORMFILTER CARTRIDGE DETAIL

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MUSIC-*link* Report

Project Details		Company Details	
Project:	61-79 Henry Street Planning Proposal	**Company:**	J. Wyndham Prince
Report Export Date:	9/12/2019	**Contact:**	Francis Lane
Catchment Name:	110601-02_MU4	**Address:**	77 Union Road Penrith NSW 2750
Catchment Area:	1.632ha	**Phone:**	4720 3385
Impervious Area*:	81.67%	**Email:**	flane@jwprince.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

Node: Report	Reduction
Flow	-0.00113%
TSS	85%
TP	69.6%
TN	51.5%
GP	98.3%

Treatment Nodes

Node Type	Number
Sedimentation Basin Node	1
GPT Node	1
Generic Node	3

Source Nodes

Node Type	Number
Urban Source Node	6

Comments

The consolidated model incorporates the SEI assessment. Pollution reductions on existing site pre-development node are not relevant.

Stormfilter node parameters provided by OceanProtect

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Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
GPT	14 x OceanGuard	Hi-flow bypass rate (cum/sec)	None	99	0.28
Post	Post-Development Node	% Load Reduction	None	None	86.3
Post	Post-Development Node	GP % Load Reduction	90	None	99.9
Post	Post-Development Node	TN % Load Reduction	45	None	89.7
Post	Post-Development Node	TP % Load Reduction	60	None	90.9
Post	Post-Development Node	TSS % Load Reduction	85	None	95.7
Pre	Pre-Development Node	% Load Reduction	None	None	83.2
Pre	Pre-Development Node	TN % Load Reduction	45	None	83.2
Pre	Pre-Development Node	TP % Load Reduction	60	None	83.2
Sedimentation	SF Chamber (40 m)	High Flow Bypass Out (ML/yr)	None	None	0
Urban	Existing Site (1.631 ha)	Area Impervious (ha)	None	None	1.557
Urban	Existing Site (1.631 ha)	Area Pervious (ha)	None	None	0.073
Urban	Existing Site (1.631 ha)	Total Area (ha)	None	None	1.631
Urban	M1 Other Impervious (0.299 ha)	Area Impervious (ha)	None	None	0.299
Urban	M1 Other Impervious (0.299 ha)	Area Pervious (ha)	None	None	0
Urban	M1 Other Impervious (0.299 ha)	Total Area (ha)	None	None	0.299
Urban	M1 Pervious (0.299 ha)	Area Impervious (ha)	None	None	0
Urban	M1 Pervious (0.299 ha)	Area Pervious (ha)	None	None	0.299
Urban	M1 Pervious (0.299 ha)	Total Area (ha)	None	None	0.299
Urban	M1 Road (0.102 ha)	Area Impervious (ha)	None	None	0.102
Urban	M1 Road (0.102 ha)	Area Pervious (ha)	None	None	0
Urban	M1 Road (0.102 ha)	Total Area (ha)	None	None	0.102
Urban	M1 Rooof (0.910 ha)	Area Impervious (ha)	None	None	0.91
Urban	M1 Rooof (0.910 ha)	Area Pervious (ha)	None	None	0
Urban	M1 Rooof (0.910 ha)	Total Area (ha)	None	None	0.91
Urban	M2 Road (0.022 ha)	Area Impervious (ha)	None	None	0.022
Urban	M2 Road (0.022 ha)	Area Pervious (ha)	None	None	0
Urban	M2 Road (0.022 ha)	Total Area (ha)	None	None	0.022

Only certain parameters are reported when they pass validation

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Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Pre	Pre-Development Node	GP % Load Reduction	90	None	86.3
Pre	Pre-Development Node	TSS % Load Reduction	85	None	84
Sedimentation	SF Chamber (40 m)	Notional Detention Time (hrs)	8	12	0.26
Sedimentation	SF Chamber (40 m)	Total Nitrogen - k (m/yr)	500	500	1
Sedimentation	SF Chamber (40 m)	Total Phosphorus - k (m/yr)	6000	6000	1
Sedimentation	SF Chamber (40 m)	Total Suspended Solids - k (m/yr)	8000	8000	1

Only certain parameters are reported when they pass validation