PENRITH CITY COUNCIL

College, Orth and Werrington Creeks Catchment
Floodplain Risk Management Study and Plan

Final Summary Report

October 2021

Catchment Simulation Solutions

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Acknowledgement
Penrith City Council has prepared this document with financial assistance from the NSW Government through its Floodplain Management Program. This document does not necessarily represent the opinions of the NSW Government or the Department of Planning Industry and Environment.

The preparation of the Study and Plan was steered by Penrith City Council Floodplain Risk Management Committee whose members include councillors, council staff, community representatives and representatives from state agencies and adjacent councils. The Study and Plan is the culmination of many months of investigation, analysis and flood modelling, which has been supported by valuable contributions from representatives of the Floodplain Risk Management Committee, community of Penrith and Penrith City Council.

It has been prepared by incorporating contributions from individuals from the local community and key stakeholders. Contributions from members of the Floodplain Risk Management Committee have been essential to the formation of management strategies that have been considered as part of the Plan and are greatly appreciated. The collegial manner in which input has been provided to the project from representatives from the Penrith City Council has been critical to its success.

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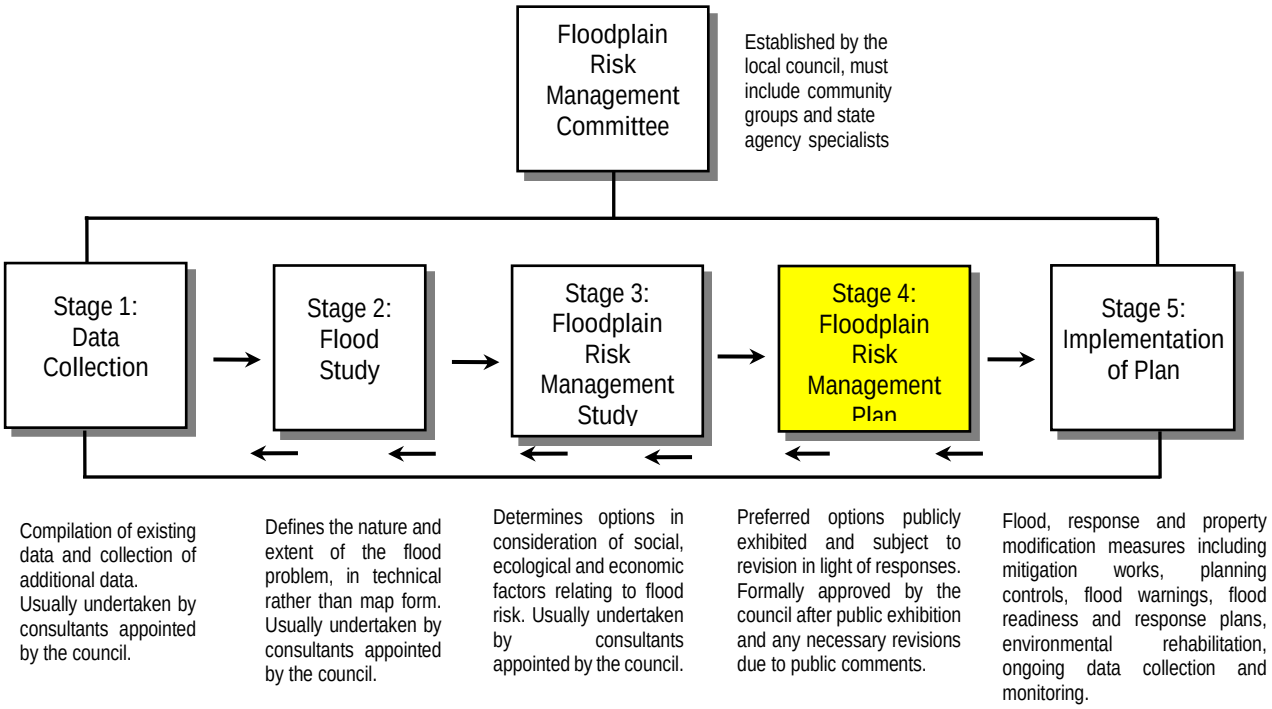
Overview

The College, Orth and Werrington Creeks catchment is located within the Penrith City Council Local Government Area. The catchment covers an area of about 12 square kilometres (km^2) and includes the suburbs of Orchard Hills, Caddens, Kingswood, Cambridge Park, Werrington and Werrington County. The extent of the catchment is shown on **Figure 1**.

The catchment includes a significant urban area with a mix of residential and commercial properties as well as a smaller area of industrial properties. The urbanised sections of the catchment are typically drained by a stormwater system that conveys runoff into College and Orth Creeks which, in turn, drain into Werrington Creek. During periods of heavy rainfall across the catchment, there is potential for the capacity of the stormwater system to be exceeded. In these circumstances, the excess water travels overland, potentially leading to inundation of roadways and properties. There is also potential for water to overtop the banks of the various creeks and inundate the adjoining floodplain.

In recognition of the flooding problems confronting residents and business owners in the College, Orth and Werrington Creeks catchment, Penrith City Council commisioned Catchment Simulation Solutions to prepare a Floodplain Risk Management Study (referred to as the 'Study') and develop a Floodplain Risk Management Plan (referred to as the 'Plan') for the catchment. The Study and Plan form Stage 3 and Stage 4 respectively of the NSW Government's floodplain risk management process, which is outlined below.



As outlined above, the primary goals of the Study and Plan were:

- The Study quantified the nature and extent of the existing and potential future flooding problem and evaluated options that could be potentially implemented to better manage the flood risk.

- The Plan provides a consolidated and prioritised list of options that can be implemented by Penrith City Council and others to manage the flood risk. The list of recommended options in the Plan is based on the evaluation outcomes documented in the Study.

The following document provides a summary of the work that was completed as part of the Study and Plan including the recommended flood mitigation scheme for the College, Orth and Werrington Creeks catchment.

The Existing Flooding Problem

The nature and extent of the existing flooding problem was quantified using a computer flood model that extends across the full extent of the College, Orth and Werrington Creeks catchment (refer **Figure 1**). The computer flood model was originally developed as part of the *'College, Orth and Werrington Creeks Catchment Overland Flow Flood Study'* (Catchment Simulation Solutions, 2017). However, the model was updated as part of the current study to better reflect contemporary topographic and development conditions and to also apply the best practice hydrologic procedures detailed in *'Australian Rainfall and Runoff – A Guide to Flood Estimation'* (Ball et al, 2019)

The updated computer model was used to simulate a range of design floods up to and including the Probable Maximum Flood (i.e., from small and frequent floods right up to the largest flood that could occur). A range of information was produced by the flood model to assist in defining the location of flooding 'trouble spots'. This flood information included the mapping of the flood levels, flood depths, velocities, hazards and hydraulic categories and the definition of the flood planning area.

A copy of the flood level and flood hazard mapping that was produced by the computer flood model for the 1% Annual Exceedance Probability (AEP) (i.e. 100 Year ARI) flood and Probable Maximum Flood (PMF) are provided in **Figure 2** to **Figure 5** in **Appendix A**. The flood hazard mapping describes the potential impact that floodwaters will have on people, vehicles, buildings, and properties in the catchment. A detailed description of the flood hazard categories is provided in **Table 1**.

Table 1 Description of Adopted Flood Hazard Categories (Geoscience Australia, 2019)

Hazard Category	Description
H1	Generally safe for vehicles, people, and buildings. Relatively benign flood conditions.
H2	Unsafe for small vehicles
H3	Unsafe for vehicles, children and the elderly
H4	Unsafe for vehicles and people
H5	Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

The Flood Planning Area map is also provided in **Figure 6**.

As shown in **Figure 2** to **Figure 5**, the flood modelling across the catchment can be characterised as follows:

- During relatively frequent rainfall events, floodwater is generally concentrated within defined watercourses with only limited ponding in localised depressions. Very little inundation is predicted across private property during the 0.5EY (i.e., 2 Year ARI) flood.
- More extensive inundation is predicted during the 20% AEP (i.e. 5 Year ARI) flood with several continuous overland flow paths extending through private property. This includes:
  - Jamison Road to Bringelly Road, Kingswood.
  - Cox Avenue to Orth Street, Kingswood.
  - Edward Close to Dunkley Place, Werrington.
  - Railway Street, Werrington.
- During the 1% AEP (i.e. 100 Year ARI) flood, floodwater depths along the major overland flow paths discussed above are commonly predicted to exceed 0.5 metres and new overland flow paths become apparent. This includes:
  - Victoria Street to Heath Street, Kingswood.
  - Chapman Gardens to the railway line, Kingswood.
  - Sandringham Avenue & Lincoln Drive Park to Herbert Street, Cambridge Park.
  - Oxford Street, Cambridge Park.
  - Rugby Street to Oxford Street, Cambridge Park.
  - Orleton Place to Francis Street, Werrington County.
- During the PMF, overland flow water depths are predicted to exceed 1 metre at many locations. The impediment to flow afforded by the railway line is emphasised during the PMF with significant 'ponding' on the southern side of the railway at Kingswood and Werrington.

The results of the flood modelling also demonstrated that:

- During a 1% AEP flood, one hundred and eighty-nine (189) residential properties are predicted to suffer 'external' flood damage (i.e., damage to fences, sheds, garage contents), and an additional sixty-nine (69) properties are predicted to experience above floor inundation. During the PMF, five hundred and fifty (550) residential properties are predicted to incur external flood damage, with a further eight hundred and fifty-four (854) residential properties inundated above floor level.
- A flood damage assessment was also undertaken to estimate the flood damage costs in the catchment for existing conditions and across the full range of design floods for residential, commercial, and industrial properties. The flood damage assessment estimated a bill of approximately $9 million across the College, Orth and Werrington Creeks catchment should a 1% AEP flood occur. The average annual damage (AAD) for the catchment is predicted to be about $800,000 per annum. Accordingly, if the 'status

quo' was maintained and no flood management measures are implemented, residents and business owners within the catchment as well as infrastructure providers, such as Penrith City Council, would likely be subjected to cumulative flood damage costs of around $800,000 per annum (on average).

The Potential Future Flood Risk

Future development across the catchment as well as climate change induced rainfall increases have the potential to increase the existing flood risk across the College, Orth and Werrington Creeks catchment in the future. More specifically:

- The additional runoff from future development across the catchment has the potential to increase existing 1% AEP flood levels by up to 0.1 metres at some locations across the catchment. Adjacent to the railway embankment, flood level increases of between 0.1 and 0.2 metres are anticipated during the 1% AEP flood.
- A 9% increase in rainfall scenario of climate change is predicted to increase 1% AEP flood levels by at least 0.05 metres along most watercourses and overland flow paths.
- A 23% increase in rainfall scenario of climate change is predicted to increase existing 1% AEP flood levels by more than 0.1 metres at most locations. The most significant increases in flood levels are predicted to occur on the southern side of the railway embankment. This includes flood level increases of between 0.2 and 0.5 metres along Werrington Ck at Kingswood (near George Street) and 0.1 to 0.2 metre increases across Railway St at Werrington.

Options Considered for Better Managing the Flood Risk

The outcomes of the existing flood risk assessment were used to identify where flood risk management measures should be targeted to manage the flood risk in the College, Orth and Werrington Creeks Catchment. This information was used to develop an initial list of flood risk management options. This included:

- **Flood Modification Options**: are measures that aim to modify existing flood behaviour, thereby reducing the extent, depth and velocity of floodwater across flood liable areas. A total of forty-nine (49) flood modification options were initially identified as part of the Study.
- **Property Modification Options**: refers to modifications to planning controls or modifications to individual properties to reduce the potential for inundation in the first instance or improve the resilience of properties should inundation occur. A total of five (5) property modification options were identified as part of the Study.
- **Response Modification Options**: are measures that can be implemented to change the way in which emergency services as well as the public respond before, during and after a flood. A total of ten (10) response modifications were identified as part of the Study.

Each of the options that were identified were evaluated in further detail to determine the feasibility of each option and which options would progress into the Plan. Further details on the evaluation outcomes are summarised below.

Evaluation Outcomes for Flood Risk Management Options

Flood Modification Options

It was not feasible to undertake a detailed assessment of all forty-nine (49) flood modification options as part of the Study. Therefore, a qualitative assessment of each potential option was completed to assess the potential feasibility of each option and to determine which measures showed merit for further detailed assessment. The full list of forty-nine (49) options that were initially considered are provided in the Study and the final list of flood modification options that were selected for detailed assessment are provided in **Table 2**. Reference is made to Chapter 8 of the Floodplain Risk Management Study for a comprehensive description of the measures.

The 'shortlist' of flood modification options identified in **Table 2** were assessed in detail as part of the Study to determine which would be feasible and move forward for inclusion in the Plan. Each flood modification option was assessed against a range of criteria, as detailed below:

- Hydraulic Factors: Each option was included in an updated version of the computer flood model and was used to re-simulate flood behaviour with the option in place. This allowed the hydraulic benefits (i.e., reductions in flood levels) afforded by each option across different parts of the catchment to be quantified.
- Financial Feasibility: Concept design plans were prepared for each option which allowed preliminary implementation cost estimates to be prepared. The results from the computer model simulations were also used to prepare updated flood damage cost estimates for each option. This allowed the 'benefits' of each option to be quantified (in terms of a reduction in flood damage costs) and compared to the implementation cost of each option (refer **Table 2**). This allowed a monetary benefit to cost ratio (BCR) to be prepared for each option. A BCR of more than 1 indicates the economic benefits are predicted to outweigh the implementation cost while a BCR of less than 1 indicates that there will still be a financial benefit, but it will not be sufficient to cover the implementation cost. The BCR for each option is also summarised in **Table 2**.
- Change in Above Floor Flooding: The results from the updated flood modelling were also used to quantifying the change in the number of buildings subject to above floor inundation with each option in place during each design flood.
- Emergency Response Impacts: This assessment focussed on the ability of each option to result in less frequent and deep inundation of roads which would provide improved opportunities for vehicular evacuation.
- Technical Feasibility: An assessment of any technical impediments was completed for each measure to determine if there would be any 'showstoppers' that may render the option impractical.

The outcomes of the options evaluation were used to inform a multi criteria assessment (MCA). The MCA assigns an overall 'score' to each option that reflects the full range of evaluation criteria (including tangible and intangible evaluation criteria). The score reflects how well each option performs relative to other options allowing the options to be ranked,

which provides valuable insight into implementation priorities as part of the Floodplain Risk Management Plan.

Based on the outcomes of the MCA, the following options were selected to move forward into the Plan:

- FM1 – Chapman Gardens Basin
- FM3 – Lincoln Drive Basin.
- FM4 – Stafford Street Basins.
- FM5 – Jamison Road Basin Augmentation.
- FM6 - Victoria Street Culvert Upgrade
- FM9 - Werrington Creek Railway Culvert Upgrade #2

Property Modification Options

A total of five (5) planning and property modification options were identified for evaluation as part of the Study and are summarised in **Table 3** and are denoted PM1 to PM5. Reference is made to Chapter 9 of the Floodplain Risk Management Study for a comprehensive description of the measures.

Based on the outcomes of the evaluation in the Study, the following options were selected to move forward into the Plan:

- PM1 – Updates to LEP.
- PM2 – Updates to DCP.
- PM3 – Updates to Section 10.7 certificates.

Response Modification Options

A total of ten (10) response modifications were identified as part of the Study and are summarised in **Table 4** and are denoted RM1 to RM10. Reference is made to Chapter 10 of the Floodplain Risk Management Study for a comprehensive description of the measures.

Based on the outcomes of the evaluation of each response modification option, the following options were selected for inclusion in the Plan:

- RM1 – Community education activities.
- RM2 – Make property level flood information available.
- RM3 and RM10 – Local flood plan updates.
- RM4 - Preparation of residential flood plans
- RM5 - Preparation of business flood plans
- RM6 - Develop a Focussed Education and Evacuation Strategy for High Flood Hazard Areas

Table 2 Flood Modification Options Assessed in Detail as Part of the Study

Flood Modification Option		Description of Option	Economic Impact			Multi Criteria Assessment Ranking
			Cost of proposed work ($ millions)	Reduction in Flood Damage Costs ($ millions)	Benefit Cost Ratio	
FM1	Chapman Gardens basin	Provide additional flood storage volume in existing Chapmans Gardens basin at Kingswood by elevating basin wall plus excavation to provide additional storage depth	$1.14	$0.25	0.2	4
FM2	Great Western Highway basin	Construct new detention basin in existing open space between the Great Western Highway and Railway Line at Kingswood	$0.80	$0.00	Less than 0.1	10
FM3	Lincoln Drive Park basin	Elevate the existing embankment in Lincoln Drive Park to create a larger detention area	$0.05	$0.03	0.6	=5
FM4	Stafford Street Basins	Create two new detention basins in existing open space on either side of Stafford Street at Kingswood	$0.52	$0.38	0.7	=5
FM5	Jamison Road basin modifications	Lower existing basin invert to provide additional storage volume and provide new 525mm diameter low flow pipe	$0.58	$2.47	4.3	2
FM6	Victoria Street culvert upgrade	Replace the existing 5 x 3.35m wide x 1.8m high box culverts with 6 x 3.6m wide x 2.1m high box culverts and elevate road surface by 200mm	$2.11	$0.01	Less than 0.1	=9
FM7	Great Western Highway culvert upgrade	Provide a new 3.2m wide x 2.1m high box culvert from the outlet of the Chapman Gardens basin, along the Great Western Highway and into College Creek just upstream of the Orth and Werrington Creeks confluence	$2.45	$0.08	Less than 0.1	12
FM8	Werrington Creek railway culvert upgrade #1	Replace the existing 4 x 2.25m diameter culverts under the railway line with 3 x 3m wide x 1.8m high box culverts	$1.12	$0.02	Less than 0.1	=7
FM9	Werrington Creek railway culvert upgrade #2	Installation of an additional 1.5 metre diameter culvert that would extend from upstream of the railway line near French Street subdivision to northern Victoria Street. 2 new 3m wide x 0.9m high box culverts would also be installed under Victoria Street	$1.33	$0.01	Less than 0.1	=9
FM10	Werrington Railway Station culvert upgrade	Installation of a new 0.9 metre diameter culvert through the railway (starting near the northern extent of	$0.85	$0.10	0.1	=9

Flood Modification Option		Description of Option	Economic Impact			Multi Criteria Assessment Ranking
			Cost of proposed work ($ millions)	Reduction in Flood Damage Costs ($ millions)	Benefit Cost Ratio	
		Landers Street) and extending into the Parkes Avenue Sporting Complex				
FM11	Dunkley Place stormwater upgrades	Installation of additional stormwater pits and pipes in Chrisan Close, Gibson Avenue and Dunkley Place at Werrington	$1.29	$0.23	0.2	=6
FM12	Orleton Place to Francis Street stormwater upgrades	Installation of additional stormwater pits and pipes between Orleton Place to Francis Street including Rugby Street and Glencoe Avenue at Werrington County	$1.51	$0.18	Less than 0.1	=6
FM13	Rugby Street to Neeta Avenue stormwater upgrades	Installation of additional stormwater pits and pipes between Rugby Street and Neeta Avenue at Cambridge Park (including Wembley Avenue and Twickenham Avenue)	$0.84	$0.02	Less than 0.1	=9
FM14	Victoria Street to Joseph Street stormwater upgrades	Installation of additional stormwater pits and pipes between Victoria Street and area of open space south of Joseph Street at Kingswood	$0.78	$0.23	0.3	=7
FM16	Stapley Street to Bringelly Road stormwater upgrades	Duplication of existing stormwater system between the existing Jamison Road detention basin (south of Stafford Street) and First Street	$3.59	$0.13	Less than 0.1	11
FM17	College Creek and Orth Creek channel enlargement	Enlarging existing College Creek and Orth Creek channels by around 20 metres north of Great Western Highway at Kingswood	$0.31	$0.02	Less than 0.1	8
FM18	Great Western Highway Median Modification	Remove a section of median strip at low point in Great Western Highway near College Creek culvert at Kingswood	$0.06	$0.02	0.3	6
FM19	Combined option #1	FM1: Chapman Garden Basin plus FM4: Stafford Street Basins plus FM5: Jamison Road Basin	$2.24	$2.74	1.2	1
FM20	Combined option #2	FM1: Chapman Garden Basin plus FM4: Stafford Street Basins plus FM5: Jamison Road Basin plus FM6: Victoria Street Culvert Upgrade plus FM9: Werrington Creek Railway Culvert Upgrade #2	$5.68	$2.77	0.5	3

Table 3 Property Modification Options Assessed as part of the Study

Option ID	Property Modification Option	Description of Option
PM1	Updates to Local Environmental Plan (LEP)	Update Council LEP to reflect the detailed review of the LEP completed as part of the Study.
PM2	Updates to Development Control Plan (DCP)	Update Council DCP to reflect the detailed review completed as part of the Study.
PM3	Updates to Section 10.7 certificates	Update Council Section 10.7 certificates to include updated flood prone land information generated as part of the current study.
PM4	Voluntary purchase of select properties	Voluntary purchase of select properties in high hazard, floodway areas as per eligibility requirements in NSW Government Guidelines.
PM5	Voluntary House raising of select properties	Voluntary house raising of select properties as per eligibility requirements in NSW Government Guidelines.

Table 4 Response Modification Options Assessed as part of the Study

Option ID	Response Modification Option	Description of Option
RM1	Community education activities	Various community education activities to increase flood awareness and allow residents to be more self-sufficient during future floods.
RM2	Make property level flood information available	Increase the availability and access to the most contemporary property level flood information for all residents and businesses within the LGA to increase flood awareness. An online platform will make this information available in an accessible and consistent framework across all sections of the LGA.
RM3	Local flood plan updates	Update Penrith Local Flood Plan 2017 to take advantage of updated flood information generated as part of the current study.
RM4	Preparation of residential flood plans	Preparation of flood plans by residential property occupiers to identify actions to be taken BEFORE, during and after a flood.
RM5	Preparation of business flood plans	Preparation of flood plans by business owners to identify actions to be taken before, during and after a flood.
RM6	Develop a Focussed Education and Evacuation Strategy for High Flood Hazard Areas	Develop a strategy to educate the community and establish evacuation protocols for areas exposed to H5 and H6 hazard in the PMF (i.e., Adelaide Street to Hobart Street area).
RM7	Flash flood warning system	Development of a flood warning system (and associated recommendations for supporting infrastructure, such as rain gauges) for the catchment to provide additional evacuation time.
RM8	Great Western Highway upgrade	Upgrade to Great Western Highway to improve level of service.
RM9	Victoria Street upgrade	Upgrade to Victoria Street at Werrington Creek crossing to improve level of service.
RM10	Local Flood Plan Updated to Accommodate Recovery Planning	Update Penrith Local Flood Plan 2017 to include additional, specific items to further assist emergency services and the community to expedite post-flood recovery.

Floodplain Risk Management Plan

Based upon the outcomes of the detailed evaluation, the management options outlined in **Table 5**, **Table 6** and **Table 7** are recommended for further investigation and for implementation as part of the Floodplain Risk Management Plan for the College, Orth and Werrington Creeks catchment. The recommended set of management options are also shown on **Figure 4**.

The recommended management options have been prioritised based on a range of criteria including the anticipated benefits afforded by each option (i.e., how effective the option is in reducing existing flood levels and above floor flooding), how easily each option could be implemented, the implementation cost, emergency response benefits as well as the potential social and environmental impacts. The implementation priorities are listed in **Table 5**, **Table 6** and **Table 7**.

Table 5, **Table 6** and **Table 7** also provide cost estimates for each option, who will be responsible for implementing the option and what other investigations and actions will be required to work towards implementation of each option.

It is recommended that flood modification options FM1, FM3, FM4 and FM5 are targeted for implementation in the short to medium term. The capital cost to implement these options is predicted to be about $2.3 million. However, implementation of these options is predicted to reduce the total flood damage costs across the catchment by about $2.7 million over the next 50 years.

Flood modification options FM6 and FM9 are recommended for implementation as longer term options. This will add a further $3.4 million to the overall implementation cost of the Plan, however, would provide significant improvements to emergency response and additional evacuation opportunities along the major east-west transportation links of the Great Western Highway and Victoria Street. This is considered essential to support the ongoing urban expansion within and adjacent to the catchment and help ensure the existing flood risk is not increased because of the expected population increase in the area.

Despite the significant capital outlay that would be required to implement the Plan, the reduced frequency and severity of flooding would provide a range of non-monetary benefits to the local community. This would include less frequent and less deep inundation of local roads (including the major east-west transportation links of the Great Western Highway and Victoria Street) and less disruption, inconvenience and anxiety associated with frequent inundation.

It is also recommended to consider the property and the response modification measures listed in **Table 6** and **Table 7** to manage the future flood problem in the College, Orth and Werrington Creeks catchment. Implementation of the property and the response modification measures would largely draw upon Penrith City Council and SES available resources.

Table 5 Recommended Flood Modification Options

Flood Modification Option		Description of Option	Required Actions	Cost Estimate	Implementation Responsibility	MCA Ranking	Priority
FM1	Chapman Gardens basin	Providing additional flood storage volume in existing Chapmans Gardens basin at Kingswood by elevating basin wall plus excavation to provide additional storage depth	1) Council to initiate discussions with TfNSW to provide an overview of benefits that FM1 affords the Great Western Highway and determine any constraints within and adjacent to the road corridor that may impact on the option. These discussions could also be used as an opportunity to determine if TfNSW is planning other road works in the area that could enhance the performance of FM1. 2) Complete a survey of services and other assets in the vicinity of the proposed work. 3) Based on any constraints identified above, undertake a concept design investigation to confirm the optimal basin configuration. This should explore alternate embankment heights, spillway arrangements, stormwater upgrades and outlet modifications. The assessment should consider all potential. The assessment should also consider the performance of the basin upgrade in isolation as well as in combination with FM5 and FM4. In this regard, a combined concept design investigation incorporating FM1, FM4 and FM5 may be the most efficient approach for this stage of work. 4) Detailed construction plans can then be prepared, final cost estimates can be prepared, funding can be sought, and the option can be potentially implemented.	$1.14 million	Penrith City Council	4	High

Flood Modification Option		Description of Option	Required Actions	Cost Estimate	Implementation Responsibility	MCA Ranking	Priority
FM3	Lincoln Drive basin	Elevate the existing embankment in Lincoln Drive Park to create a larger detention area	1) Complete a concept design investigation that investigates alternate embankment height and basin outlet configurations (including a spillway to cater for PMF) to confirm optimal basin arrangement. 2) Prepare revised cost estimate for preferred option so economic feasibility of option can be confirmed. 3) Detailed construction plans should then be prepared for the preferred concept design option. This should be supported by a detailed cost estimate so that funding for the option can be sought.	$0.05 million	Penrith City Council	=5	Medium
FM4	Stafford Street basin	Create two new detention basins in existing open space on either side of Stafford Street at Kingswood	1) Council to undertake discussions local community to gauge level of community support for this option. This would include discussing the current flood exposure of the local area and how this option would benefit the same area. It is likely that this consultation can be completed in conjunction with FM5, given the close proximity of each option. 2) If the above discussions yield a positive outcome, concept design options should be explored that takes account of any issues or concerns that are raised by the local community. This should aim to maximise the hydraulic benefits across downstream properties while avoiding adverse flood impacts across private property (as	$0.52 million	Penrith City Council	=5	Medium

Flood Modification Option		Description of Option	Required Actions	Cost Estimate	Implementation Responsibility	MCA Ranking	Priority
			discussed above, the concept design explored as part of the Study resulted in flood level increases extending marginally into some properties). It is recommended that hydraulic assessment consider the performance FM4 in isolation as well as in combination with FM5 and FM1. 3) Detailed construction plans should then be prepared for the preferred concept design option. This should be supported by a detailed cost estimate so that funding for the option can be sought and the option can move towards implementation.				
FM5	Jamison Road basin	Lower existing basin invert to provide additional storage volume and provide new 525mm diameter low flow pipe	1) Complete a survey of services and other assets in the vicinity of the proposed work to confirm potential basin excavation depths or potential need for relocation of services or assets. 2) Undertake a concept design investigation that aims to optimise basin volume and stormwater modifications. It is recommended that hydraulic assessment consider the performance of FM5 in isolation to confirm if adverse flood impacts are still predicted across downstream properties. If adverse flood impacts are still predicted, the assessment should consider FM5 in combination with FM1 or FM4 to offset the flood impacts.	$0.58 million	Penrith City Council	2	High

Flood Modification Option		Description of Option	Required Actions	Cost Estimate	Implementation Responsibility	MCA Ranking	Priority
			3) Once a preferred concept design option is prepared, undertake consultation with the local community. 4) Detailed construction plans should then be prepared for the preferred concept design option while taking into account any feedback that is received from the local community. This should include preparation of a detailed cost estimate so that funding for the option can be sought and the option can move towards implementation.				
FM6	Victoria Street culvert upgrade	Replace the existing 5 x 3.35m wide x 1.8m high box culverts with 6 x 3.6m wide x 2.1m high box culverts and elevate road surface by 200mm	1) Undertake consultation with SES to confirm current emergency response limitations for Victoria Street and identify likely future emergency response requirements. 2) Refine scope of required culvert and road upgrades for FM6 and FM9 to meet emergency response requirements and explore opportunities for hydraulic improvements upstream and downstream of Victoria Street. 3) Work towards preparation of design plans to support future urban expansion for the area	$2.11 million	Penrith City Council	=9	Low
FM9	Werrington Creek railway culvert upgrade #2	Installation of an additional 1.5 metre diameter culvert that would extend from upstream of the railway line near French Street subdivision to Victoria Street. Two new 3m wide x 0.9m high box culverts would also be installed under Victoria Street		$1.33 million	Penrith City Council and Transport for NSW	=9	Low

Table 6 Recommended Property Modification Options

Property Modification Option		Required Actions	Cost Estimate	Implementation Responsibility	Priority
PM1	Changes to LEP	1. Council planners to consolidate the LEP update recommendations from all recent floodplain risk management studies and plans (including this Plan) within the LGA. 2. Council to prepare planning proposal and undertake various exhibition and review processes to prepare updated LEP.	$20k	Penrith City Council	High
PM2	Changes to DCP	1. Council to consolidate the DCP recommendation contained in this Plan along with other recent floodplain risk management studies and plans within the LGA. 2. Council to prepare draft DCP and complete exhibition processes to prepare updated DCP.	$40k	Penrith City Council	High
PM3	Update Section 10.7 Certificates	1. Council to update Section 10.7 certificates to reference the updated design flood information generated as part of the Floodplain Risk Management Study.	$8k	Penrith City Council	High

Table 7 Recommended Response Modification Options

Response Modification Option		Required Actions	Cost Estimate	Implementation Responsibility	Priority
RM1	Community education strategy	1. SES to prepare FloodSafe documents for the local area to provide general flood education information (focussing on overland flooding). 2. SES to develop a range of messaging that can be disseminated to the community via media agencies (both print and online).	$30k up front and $10k bi-annually.	SES and Penrith City Council	High
RM2	Make property level flood information available	1. Council to consider arranging for future studies to provide flood mapping at a consistent scale and provide standard mapping outputs in a consistent colour scheme. 2. Council to consider using their internal GIS resources to prepare a standardised set of maps based on the GIS outputs that have been produced as part of each study. 3. Council to collate the available spatial flood outputs that are generated as part of flood studies and floodplain risk management studies and incorporate information on an online mapping webpage to serve as a central repository for flood information.	$20k for required IT infrastructure. $30k for compiling required datasets and website interface.	Penrith City Council	High (mapping updates) & Medium (for online mapping portal)
RM3 + RM10	Local Flood Plan updates to accommodate response and recovery planning	1. SES to update LFP to include information from recently completed flood studies and floodplain risk management studies and actual floods. 2. SES to include additional, specific items in the LFP to further assist emergency services and the community to expedite post-flood recovery.	$50k	SES	High

Response Modification Option		Required Actions	Cost Estimate	Implementation Responsibility	Priority
RM4	Home flood plans	1. Council and SES could assist in 'prefilling' some of the required information for the preparation of the Home and Business Emergency Flood Plans.	Residents and business owner's time. Plus, approximately $15k for Council and SES time	Individual home and business owners with assistance from SES and Council	High
RM5	Business flood plans				High
RM6	Develop a Focussed Education and Evacuation Strategy for High Flood Hazard Areas	1. SES to conduct one-on-one meetings with high risk households and businesses (with potential support from Council staff) to present the available flood information, answer questions and assist in the preparation of flood emergency response plans. 2. SES to explore opportunities to establish a 'communication group' for the local high-risk area to allow for rapid communication between the SES and households and assist in promoting more efficient evacuation efforts. 1. SES to explore an automated alert system where a sub-daily rainfall gauge could be set up with a telemetry system with predefined rainfall triggers that could send an automated message, phone call and or text message to potentially vulnerable properties.	$50k	SES and Penrith City Council	Medium

Glossary

annual exceedance probability (AEP)	the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. E.g., if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m^3/s or larger events occurring in any one year (see ARI).
Australian Height Datum (AHD)	a common national surface level datum approximately corresponding to mean sea level.
average annual damage (AAD)	depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
average recurrence interval (ARI)	the long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
catchment	the land area draining through the mainstream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
disaster plan (DISPLAN)	a step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
discharge	the rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
effective warning time	The time available after receiving advice of an impending flood and before floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	a range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.

flash flooding	flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, or local overland flooding associated with major drainage before entering a watercourse, or coastal inundation resulting from super-elevated sea levels or waves overtopping coastline defences excluding tsunami.
flood awareness	Awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood education	flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
flood fringe areas	the remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	is synonymous with flood prone land, i.e., land susceptible to flooding by the PMF event. Note that the term flood liable land covers the whole floodplain, not just that part below the FPL (see flood planning area).
flood mitigation standard	the average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	the measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	a management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at state, division and local levels. Local flood plans are prepared under the leadership of the SES.
flood planning area	the area of land below the FPL and thus subject to flood related development controls.

flood planning levels (FPLs)	are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans.
flood proofing	a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.
flood readiness	Readiness is an ability to react within the effective warning time.
flood risk	potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below. existing flood risk**:** the risk a community is exposed to as a result of its location on the floodplain. future flood risk: the risk a community may be exposed to as a result of new development on the floodplain. continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
flood storage areas	those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
floodway areas	those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
freeboard	provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.

hazard

a source of potential harm or a situation with a potential to cause loss. In relation to this study the hazard is flooding which has the potential to cause damage to the community.

Definitions of high and low hazard categories are provided in Appendix L of the *Floodplain Development Manual* (*2005*).

historical flood

a flood which has actually occurred.

hydraulics

term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.

hydrograph

a graph which shows how the discharge or flood level at any particular location varies with time during a flood.

hydrology

term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.

local overland flooding

inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.

local drainage

smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.

mainstream flooding

inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.

major drainage

councils have discretion in determining whether urban drainage problems are associated with major or local drainage. Major drainage involves:

- the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; or
- water depths generally in excess of 0.3m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; or
- major overland flowpaths through developed areas outside of defined drainage reserves; or
- the potential to affect a number of buildings along the major flow path.

computer models

the mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.

minor, moderate and major flooding	Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood. minor flooding: Causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded. moderate flooding: Low lying areas are inundated requiring removal of stock or evacuation of some houses. Main traffic routes may be covered. major flooding: Appreciable urban areas are flooded or extensive rural areas are flooded. Properties, villages and towns can be isolated.
peak discharge	the maximum discharge occurring during a flood event.
probable maximum flood (PMF)	the PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.
probable maximum precipitation (PMP)	the PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
probability	A statistical measure of the expected chance of flooding (*see annual exceedance probability*).
risk	chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	the amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	equivalent to water level (both measured with reference to a specified datum).

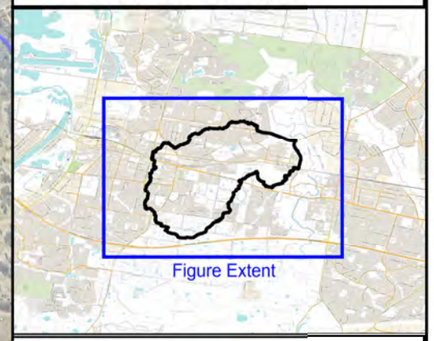
stage hydrograph	a graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
sub-daily rainfall gauge	Also referred to as a 'pluviometer' or 'tipping bucket' gauge. Automated rainfall gauge that reports rainfall at small time increments
TUFLOW	is a 1-dimensional and 2-dimensional flood simulation software. It simulates the complex movement of floodwaters across a particular area of interest using mathematical approximations to derive information on floodwater depths, velocities and levels.
velocity	the speed or rate of motion (*distance per unit of time, e.g., metres per second*) in a specific direction at which the flood waters are moving.
water surface profile	a graph showing the flood stage at any given location along a watercourse at a particular time.
wind fetch	the horizontal distance in the direction of wind over which wind waves are generated.

APPENDIX A

FIGURES

PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

College, Orth and Werrington Creeks Catchment

Watercourse

Railway

Notes:

Aerial photograph date: 2019

N

W E

S

Scale 1:16,000 (at A3)

0 0.5 1.0

Km

Figure 1: College, Orth and Werrington Creeks Catchment

Prepared By:

Catchment Simulation Solutions

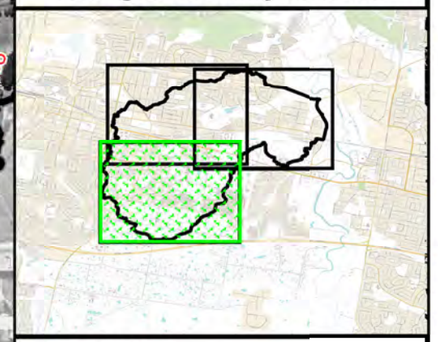
Suite 10.01, 70 Philip St

Sydney, NSW 2000

File Name: Figure 1 College, Orth and Werrington Creeks Catchment.wor

PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

30 Peak Flood Level Contour
Flood Level (mAHD)

	<= 25		55
	30		60
	35		55
	40		60
	45		65
	50		>= 80

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5
Km

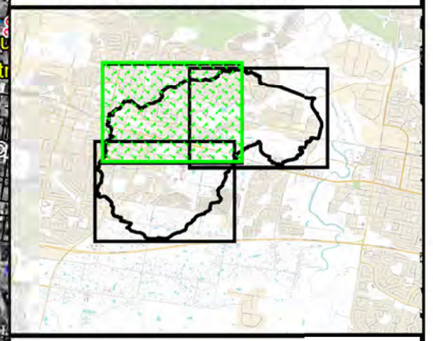
Figure 2.1: Peak Floodwater Levels for the 1%AEP Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure 2 Peak Floodwater Levels for the 1%AEP Flood.wor

PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

30 Peak Flood Level Contour

Flood Level (mAHD)

	<= 25		55
	30		60
	35		55
	40		60
	45		65
	50		>= 80

Notes:

N

W E

S

Scale 1:9,000 (at A3)

0 0.25 0.5

Km

Figure 2.2: Peak Floodwater Levels for the 1%AEP Flood

Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Philip St
Sydney, NSW 2000

File Name: Figure 2 Peak Floodwater Levels for the 1%AEP Flood.wor

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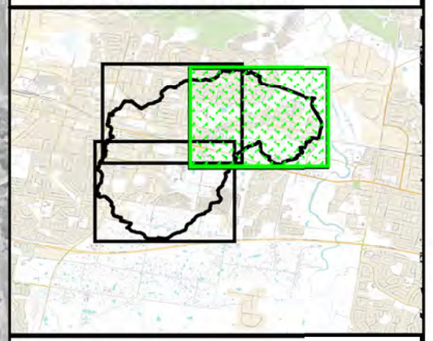
College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

30 Peak Flood Level Contour

Flood Level (mAHD)

<= 25	55
30	60
35	55
40	60
45	65
50	>= 80

Notes:

N

W E

S

Scale 1:9,000 (at A3)

0 0.25 0.5

Km

Figure 2.3: Peak Floodwater Levels for the 1%AEP Flood

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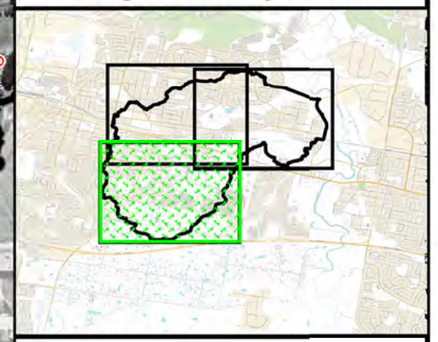
College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

30 Peak Flood Level Contour
Flood Level (mAHD)

	<= 25		55
	30		60
	35		55
	40		60
	45		65
	50		>= 80

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5
Km

Figure 3.1: Peak Floodwater Levels for the PMF

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure 3 Peak Floodwater Levels for the PMF Flood.wor

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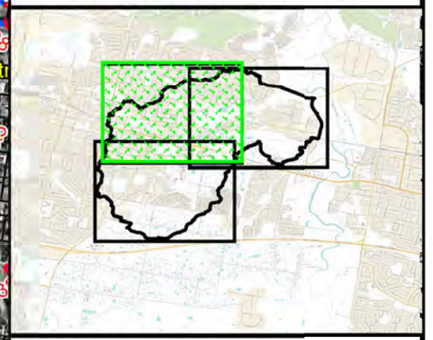
College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

30 Peak Flood Level Contour

Flood Level (mAHD)

	<= 25		55
	30		60
	35		55
	40		60
	45		65
	50		>= 80

Notes:

N

W E

S

Scale 1:9,000 (at A3)

0 0.25 0.5

Km

Figure 3.2: Peak Floodwater Levels for the PMF

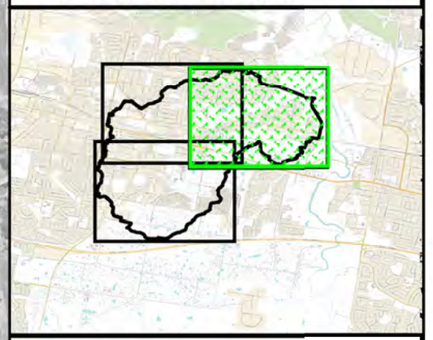
Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure 3 Peak Floodwater Levels for the PMF Flood.wor

PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

30 Peak Flood Level Contour
Flood Level (mAHD)

<= 25	55
30	60
35	55
40	60
45	65
50	>= 80

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5
Km

Figure 3.3: Peak Floodwater Levels for the PMF

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Philip St
Sydney, NSW 2000

File Name: Figure 3 Peak Floodwater Levels for the PMF Flood.wor

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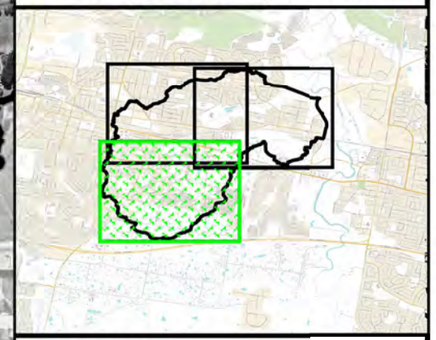
College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

Hazard Categories

- H1 - Generally Safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles. Buildings require special design
- H6 - Unsafe for people and vehicles.All buildings vulnerable to failure

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5 Km

Figure 4.1: Flood Hazard for the 1% AEP Flood

Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure 4 Flood Hazard for the 1%AEP Flood.wor

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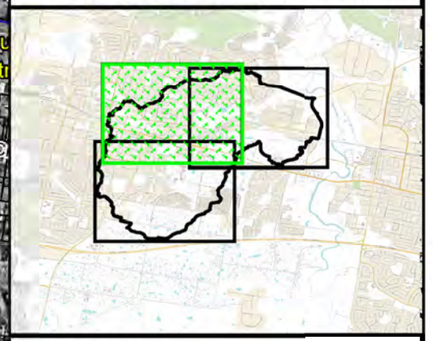
College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

Hazard Categories

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- H3 - Unsafe for vehicles, children and elderly
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- H5 - Unsafe for people and vehicles. Buildings require special design
- H6 - Unsafe for people and vehicles.All buildings vulnerable to failure

Notes:

N

W E

S

Scale 1:9,000 (at A3)

0 0.25 0.5

Km

Figure 4.2: Flood Hazard for the 1% AEP Flood

Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure 4 Flood Hazard for the 1%AEP Flood.wor

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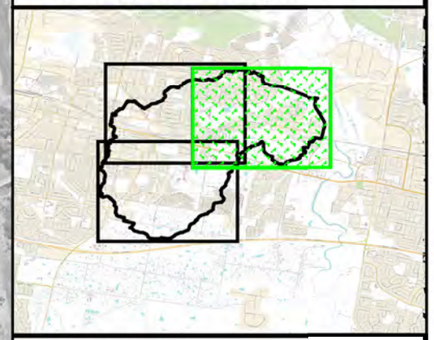
College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

Hazard Categories

- H1 - Generally Safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles. Buildings require special design
- H6 - Unsafe for people and vehicles.All buildings vulnerable to failure

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5 Km

Figure 4.3: Flood Hazard for the 1% AEP Flood

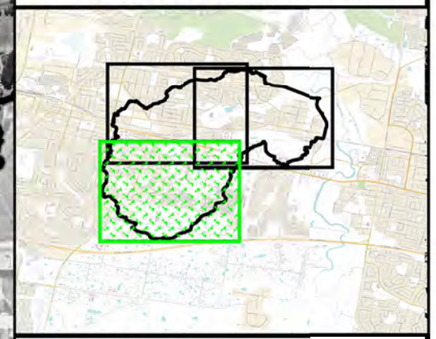
Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Philip St
Sydney, NSW 2000

File Name: Figure 4 Flood Hazard for the 1%AEP Flood.wor

PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

Hazard Categories

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- H3 - Unsafe for vehicles, children and elderly
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- H6 - Unsafe for people and vehicles.All buildings vulnerable to failure

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5 Km

Figure 5.1: Flood Hazard for the PMF

Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure 5 Flood Hazard for the PMF.wor

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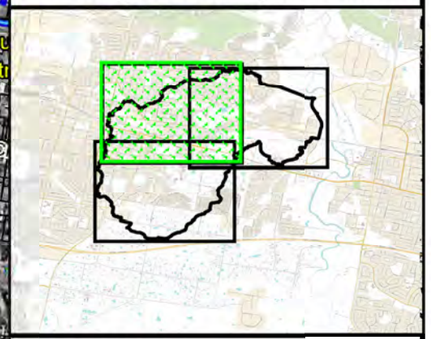
College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

Hazard Categories

- H1 - Generally Safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles. Buildings require special design
- H6 - Unsafe for people and vehicles.All buildings vulnerable to failure

Notes:

N

W E

S

Scale 1:9,000 (at A3)

0 0.25 0.5

Km

Figure 5.2: Flood Hazard for the PMF

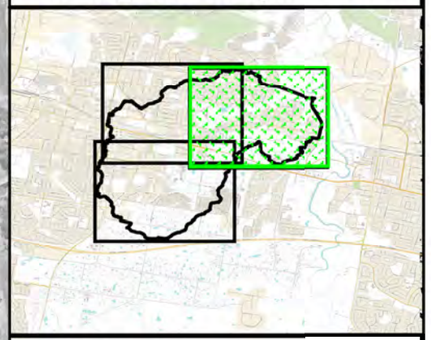
Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure 5 Flood Hazard for the PMF.wor

PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

Hazard Categories

- H1 - Generally Safe
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- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles. Buildings require special design
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Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5 Km

Figure 5.3: Flood Hazard for the PMF

Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Philip St
Sydney, NSW 2000

File Name: Figure 5 Flood Hazard for the PMF.wor

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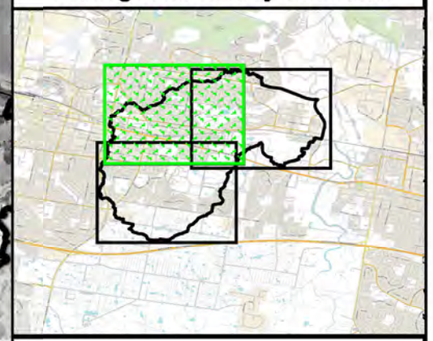
College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

- Study Area
- Flood Planning Area

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5 Km

Figure 6.1: Flood Planning Area

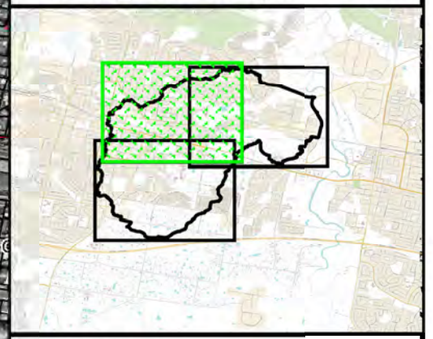
Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure 6 Flood Planning Area

PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

- Study Area
- Flood Planning Area

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5 Km

Figure 6.2: Flood Planning Area

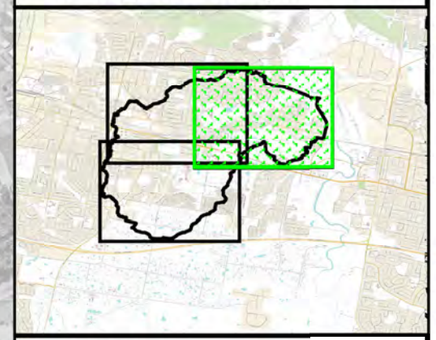
Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Philip St
Sydney, NSW 2000

File Name: Figure 6 Flood Planning Area

PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

- Study Area
- Flood Planning Area

Notes:

N
W E
S

Scale 1:9,000 (at A3)

0 0.25 0.5

Km

Figure 6.3: Flood Planning Area

Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Philip St
Sydney, NSW 2000

File Name: Figure 6 Flood Planning Area

Response Modification Options

RM1 - Community Education Strategy
High Priority

RM2 - Make property level flood information available
Medium Priority

RM3 - Local flood plan updates to accommodate response planning
High Priority

RM4 - Home flood plans
High Priority

RM5 - Business flood plans
High Priority

RM6 - Develop a Focussed Education and Evacuation Strategy for High Flood Hazard Areas
Medium Priority

RM10 - Local Flood Plan Updates to Accommodate Recovery Planning
High Priority

Property Modification Options

PM1 - Changes to LEP
High Priority

PM2 - Changes to DCP
High Priority

PM3 - Update Section 10.7 Certificates
High Priority

Flood Modification Options

FM3 - Lincoln Drive Park Basin Augmentation
Medium Priority

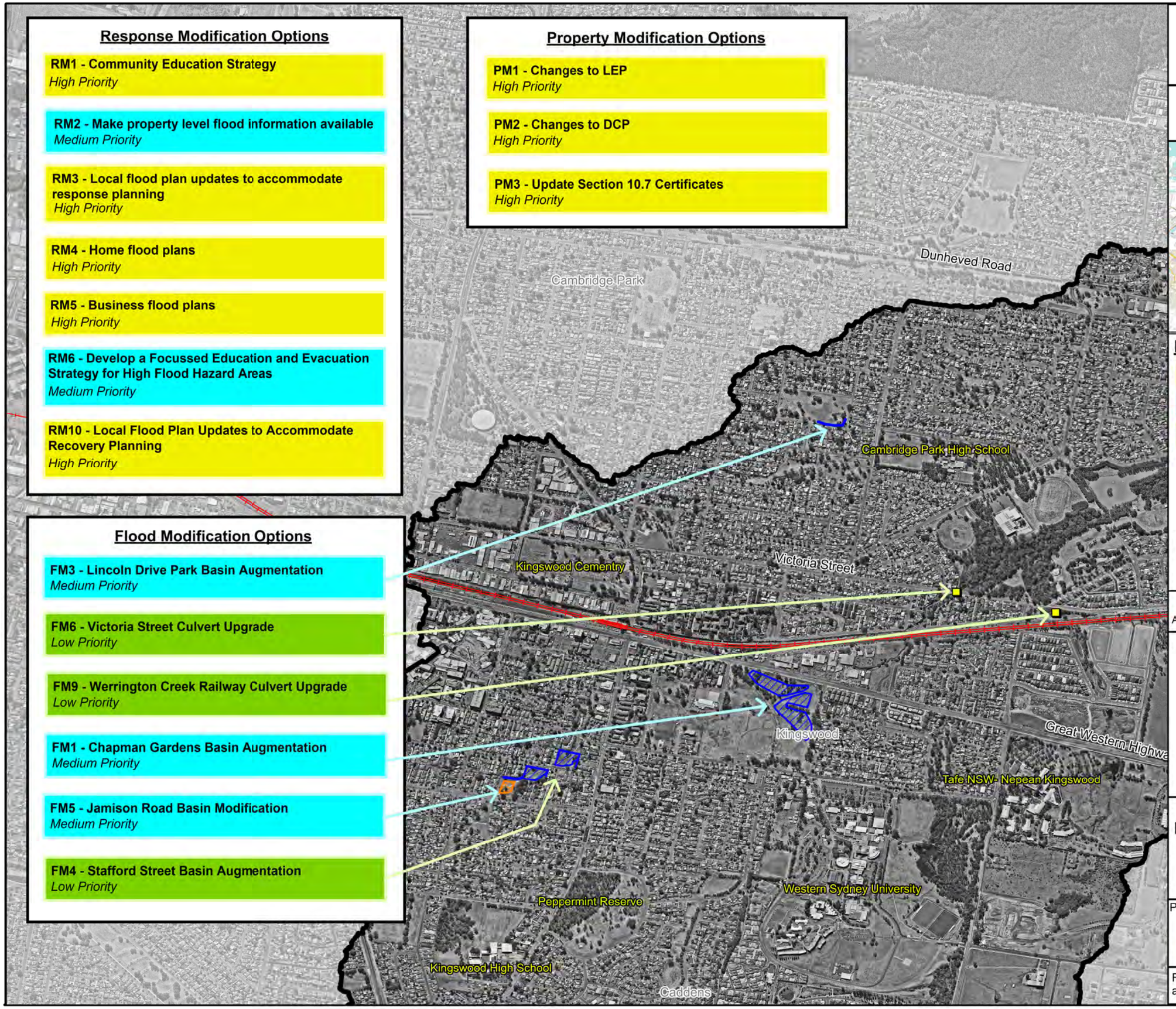
FM6 - Victoria Street Culvert Upgrade
Low Priority

FM9 - Werrington Creek Railway Culvert Upgrade
Low Priority

FM1 - Chapman Gardens Basin Augmentation
Medium Priority

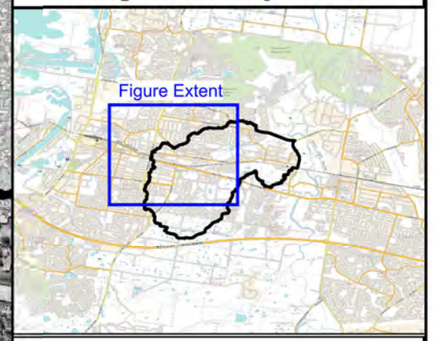
FM5 - Jamison Road Basin Modification
Medium Priority

FM4 - Stafford Street Basin Augmentation
Low Priority



PENRITH CITY COUNCIL

College, Orth and Werrington Creek Catchment Flood Risk Management Study and Plan



LEGEND

- High Priority Option
- Medium Priority Option
- Low Priority Option

Notes:

Aerial photograph date: 2019

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Scale 1:16,000 (at A3)

0 0.5 1.0

Km

Figure 4: Floodplain Risk Management Plan for College, Orth and Werrington Creeks Catchment

Prepared By:

Catchment Simulation Solutions
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File Name: Figure 4 FRMP for College, Orth and Werrington Creeks Catchment.wor