



Coast, Estuary & Floodplain Advisory Sub- Committee

Business Paper

date of meeting: Thursday 20 February 2020

location: Council Chambers
Port Macquarie-Hastings Council
17 Burrawan Street
Port Macquarie

time: 2:00pm

Coast, Estuary & Floodplain Sub-Committee

CHARTER

Adopted: OC 21/08/19

1.0 OBJECTIVES

- Assist Council in undertaking coast, estuary and floodplain management and planning.
- Assist Council in reviewing coast, estuary and floodplain studies, plans, and policies.
- Engage with and provide input to Council on other coast, estuary and floodplain matters and issues which are relevant to the Local Government Area.
- Provide and receive two-way feedback from the community.

2.0 KEY FUNCTIONS

- Advise Council on conditions and management issues for the coast, estuaries and floodplains of the Port Macquarie-Hastings Local Government Area.
- Advise Council on the development of coastal, estuary and floodplain management plans for the Port Macquarie-Hastings Local Government Area.
- Advise Council on the implementation of adopted coastal, estuary and floodplain management plans.
- Act as a Sub- Committee for the purpose of relevant NSW guidelines as they relate to coastal, estuary and floodplain management.

3.0 MEMBERSHIP

3.1 Members

Community Representatives			
Name	Title	Catchment	Coast, estuary, flood
Alan MacIntyre	Community Representative	Camden Haven	Coast and estuary
Vacant	Community Representative	Hastings	Coast and estuary
Bob Jolly	Community Representative	Lake Cathie	Coast and estuary
Kingsley Searle	Oyster Industry	Hastings	Coast and estuary
Tony Troup	Oyster Industry	Camden Haven	Coast and estuary
Paul Hyde	Fishing Industry	Hastings	Coast and estuary
Vacant	Development Industry	Hastings	Flood
Vacant	Development Industry	Camden Haven	Flood
Vacant	Community Representative	Hastings	Flood
Vacant	Community Representative	Camden Haven	Flood
Vacant	Community Representative Revive Lake Cathie (RLC)	Lake Cathie	Flood

Council Representatives	
Name	Title
Michael Cusato (Chairperson)	Councillor
	Director, Development & Environment
	Manager, Environmental Services
	Natural Resources Manager
	Environmental Projects Officer

Agency Representatives			
Name	Title	Organisation	Coast, estuary, flood
Tina Clemens	NRM Project Officer	DPI - Lands	All
Mick Northam Scott Anderson (alternative)	Fisheries Officer	DPI - Fisheries	Coast and estuary
Shane Robinson Geoff James (alternative)	Manager, Hastings Macleay Area North Coast Branch	DPIE - NPWS	Coast and estuary
John Schmidt Toong Chin (alternative)	Natural Resource Officer - Water, Floodplains & Coast	DPIE - Biodiversity and Conservation Division	Coast and estuary
Nic Denshire Toong Chin (alternative)	Principal Floodplain Officer - Water, Floodplains & Coast	DPIE - Biodiversity and Conservation Division	Flood
Paul Burg Maria Frazer (alternative)	Local Commander, Hastings Cluster	SES	Flood
Matt Dawson Andre Uljee (alternative)	Boating Safety Officer	RMS	Coast and estuary

3.2 Obligations of Members

- Act honestly and in good faith.
- To act professionally and respectfully.
- Act impartially at all times.
- Participate actively in the work of the Sub-Committee.
- Exercise the care, diligence and skill that would be expected of a reasonable person in comparable circumstances.
- Comply with this Charter at all times.
- Facilitate and encourage community engagement with the Sub-Committee and Council.
- As per Section 226 (c) of the NSW Local Government Act 1993, the Mayor is the principal spokesperson for the governing body and Councillors that are members of a Sub-Committee are to obtain the Mayor's agreement to make media and other statements. Further, only the Mayor, or a Councillor with the Mayor's agreement and otherwise in accordance with Council policies and procedures, may release Council information through media statements or otherwise, and the release of such information must be lawful under the Council adopted Code of Conduct.
- A Councillor as a member of a Sub-Committee or the Sub-Committee itself has no delegation or authority to make decisions on behalf of Council, nor to direct the business of Council. The only decision making power open to Councillors is through formal resolutions of Council.

- A Councillor as a member of a Sub-Committee or the Sub-Committee itself cannot direct staff and must abide by the decisions of Council and the policies of Council.
- Councillors, Council staff and members of this Sub-Committee must comply with the applicable provisions of Council's Code of Conduct in carrying out the functions as Council officials. It is the personal responsibility of Council officials to comply with the standards in the Code of Conduct and regularly review their personal circumstances with this in mind.

3.3 Member Tenure

Sub-Committee members will serve for a period of five (5) years after which Council will call expressions of interest for the next five (5) year period. Existing Sub-Committee members will be eligible to re-apply for a position and serve additional terms. Any changes in the composition of the Sub-Committee requires the approval of Council.

3.4 Appointment of Members

- A formal Expression of Interest process will be undertaken across the Local Government Area as a way of determining the independent representatives on the Sub-Committee.
- Applications from individuals and representatives from interest groups, and who meet the selection criteria will be encouraged.
- Council, by resolution duly passed, will appoint members to the Sub-Committee.

4.0 TIMETABLE OF MEETINGS

Meetings will be held quarterly as a minimum or more regularly if required. Meetings will generally be held at the main administration office of Port Macquarie-Hastings Council.

5.0 MEETING PRACTICES

5.1 Decision Making

- Recommendations of the Sub-Committee shall be by majority of the members present at each Meeting and each member shall have one (1) vote.
- The Chairperson shall not have a casting vote.
- In the event of an equality of votes on any matter, the matter shall be referred directly to Council's Executive Group and then to Council.
- Recommendations from the Sub-Committee are to be made through the relevant Director, who will determine under delegation, the process for implementation.
- The Sub-Committee has no delegation to allocate funding on behalf of Council. The Sub-Committee may make recommendations to Council about how funding should be spent in relation to the above-mentioned objectives, however those funds will only be applied and expended following a formal resolution of Council.
- The Sub-Committee may establish working groups to support actions and activities within the strategies or to assist in the delivery of projects and events as deemed appropriate. All projects are to be aligned with Council's suite of Integrated Planning and Reporting documents.

5.2 Quorum

The quorum for the Sub-Committee will be half of the members plus one. A quorum must include a minimum of one (1) Councillor and one (1) Council staff member being present.

5.3 Chairperson and Deputy Chairperson

- The Chairperson shall be the Councillor, Chair Coast, Estuary and Floodplain Sub-Committee
- At all Meetings of the Sub-Committee, the Chairperson shall occupy the Chair and preside. In the absence of the Chairperson the Director will act as Chairperson for that meeting.

5.4 Secretariat

- The Director is responsible for ensuring the Sub-Committee has adequate secretariat support.
- The secretariat will ensure that the business paper and supporting papers are circulated at least three (3) days prior to each meeting.
- Minutes shall be appropriately approved and circulated to each member within three (3) weeks of a meeting being held.
- All Sub-Committee agendas and minutes will be made available to the public via Council's web site, unless otherwise restricted by legislation.

5.5 Recording of decisions and explicit discussions on risks

The Secretariat shall record all discussions that relate to risks.

6.0 CONVENING OF "OUTCOME SPECIFIC" WORKING GROUPS

- The Sub-Committee can at times request a working group to be convened, for a limited period of time, for a specific action, these specifics will be minuted clearly. The working group will report back to the Sub-Committee with outcomes.
- Any working groups established under this Sub-Committee will be responsible for providing updates to the Sub-Committee. The working groups will be an informal gathering with notes collected and managed by the senior staff member in attendance and will be tabled at the Sub-Committee meetings.

7.0 CONFIDENTIALITY AND CONFLICT OF INTEREST

- Any independent members of the Sub-Committee will be required to complete a confidentiality agreement that will cover the period of their membership of the Sub-Committee.
- Sub-Committee members must declare any conflict of interests at the start of each meeting or before discussion of a relevant item or topic. Details of any conflicts of interest should be appropriately minuted.
- Where members or invitees at Sub-Committee meetings are deemed to have a real or perceived conflict of interest, it may be appropriate that they be excused from Sub-Committee deliberations on the issue where the conflict of interest may exist

Coast, Estuary & Floodplain Sub-Committee

ATTENDANCE REGISTER

Community Representatives	Representing	Catchment	Expertise Area	30/01/20	20/02/20	Date
Alan MacIntyre	Community	Camden Haven	Coast, Estuary	✓		
Bob Jolly	Community	Lake Cathie	Coast, Estuary	✓		
Kingsley Searle	Oyster Industry	Hastings	Coast & Estuary	✓		
Tony Troup	Oyster Industry	Camden Haven	Coast & Estuary	✓		
Paul Hyde	Fishing Industry	Hastings	Coast & Estuary	✓		
Vacant	Development Industry	Hastings	Flood			
Vacant	Development Industry	Camden Haven	Flood			
Vacant	Community	Hastings	Flood			
Vacant	Community	Camden Haven	Flood			
Vacant	Community - Revive Lake Cathie	Lake Cathie	Flood			
Council Representatives						
Councillor Peter Alley (Chair)				✓		
Councillor Lisa Intemann (Deputy Chair)				✓		
Director Development & Environment - Melissa Watkins				✓		
Group Manager Regulatory & Environment Services - Debbie Archer						
Natural Resources Manager - Blayne West				✓		
Environmental Projects Officer - Jesse Dick				✓		
Agency Representatives	Title	Organisation	Expertise Area			
Tina Clemens	NRM Project Officer	DPI - Lands	Coast, Estuary, Flood	✓		
Michael Northam Scott Anderson (alt.)	Fisheries Officer	DPI - Fisheries	Coast, Estuary	✓		
Shane Robinson Geoffrey James (alt.)	Manager, Hastings Macleay Area North Coast Branch	DPIE - NPWS	Coast, Estuary	A A		
John Schmidt	Natural Resource Officer - Water, Floodplains & Coast	DPIE - Biodiversity & Conservation Division	Coast, Estuary	A		
Nic Denshire	Principal Floodplain Officer - Water, Floodplains & Coast	DPIE - Biodiversity & Conservation Division	Flood	✓		
Paul Burg	Local Commander, Hastings Cluster	SES	Flood	X		
Maria Fraser (alt.) Anthony Day		SES	Flood	✓ A		
Matt Dawson Andre Uljee (alt.)	Boating Safety Officer	RMS	Coast, Estuary	✓		

Key: ✓ = Present
 A = Absent With Apology
 X = Absent Without Apology

Meeting Dates for 2020

30/01/2020	Council Chambers	2:00pm
20/02/2020	Council Chambers	2:00pm
27/05/2020	Council Chambers	2:00pm
26/08/2020	Council Chambers	2:00pm
26/11/2020	Council Chambers	2:00pm

Coast, Estuary & Floodplain Advisory Sub-Committee Meeting

Thursday 20 February 2020

Items of Business

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06	North Brother Local Catchments Floodplain Risk Management Study - Initial Options Assessment Report - Review of draft options and community engagement strategy	<u>20</u>
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Item: 01

Subject: ACKNOWLEDGEMENT OF COUNTRY

"I acknowledge that we are gathered on Birpai Land. I pay respect to the Birpai Elders both past and present. I also extend that respect to all other Aboriginal and Torres Strait Islander people present."

Item: 02

Subject: APOLOGIES

RECOMMENDATION

That the apologies received be accepted.

Item: 03

Subject: CONFIRMATION OF PREVIOUS MINUTES

RECOMMENDATION

That the Minutes of the Coast, Estuary & Floodplain Advisory Sub-Committee Meeting held on 30 January 2020 be confirmed.

PRESENT

Community Representatives:

Alan MacIntyre (Community - Camden Haven - Coast, Estuary)
Bob Jolly (Community - Lake Cathie - Coast, Estuary)
Kingsley Searle (Oyster Industry - Hastings - Coast, Estuary)
Tony Troup (Oyster Industry - Camden Haven - Coast, Estuary)
Paul Hyde (Fishing Industry - Hastings - Coast, Estuary)

Council Representatives:

Councillor Peter Alley (Chair)
Councillor Lisa Intemann (Deputy Chair)
Director Development and Environment - Melissa Watkins
Natural Resources Manager - Blayne West
Environmental Projects Officer - Jesse Dick

Agency Representatives:

Tina Clemens (DPI - Lands - Coast, Estuary, Flood) *left the meeting after item 09*
Michael Northam (DPI - Fisheries - Coast, Estuary)
Nic Denshire (DPIE - Biodiversity & Conservation Division - Flood)
Maria Fraser (SES - Flood)
Matt Dawson (RMS - Coast, Estuary)

Other Attendees:

Mayor - Peta Pinson *left the meeting during item 06*
General Manager - Craig Swift-McNair *left the meeting after item 08*
David Curry (Revive Lake Cathie)
Danielle Maltman (Revive Lake Cathie, Camden Haven Chamber of Commerce & Lake Cathie Progress Association)

The meeting opened at 2:03pm.

01 ACKNOWLEDGEMENT OF COUNTRY

The Acknowledgement of Country was delivered.

02 APOLOGIES

CONSENSUS:

That the following apologies received be accepted:

- Shane Robinson (DPIE - NPWS - Coast, Estuary)
 - Geoffrey James (DPIE - NPWS - Coast, Estuary)
 - John Schmidt (DPIE - Biodiversity & Conservation Division - Coast, Estuary)
 - Anthony Day (State Emergency Services)
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03 CONFIRMATION OF MINUTES

CONSENSUS:

That the Minutes of the Coast, Estuary & Floodplain Advisory Sub-Committee Meeting held on 28 March 2019 be confirmed.

11 PASSING OF PATRICK MCENTEE AND LAURIE LARDNER

Alan MacIntyre spoke and paid respects to the memory of Patrick & Laurie.

Councillor Peter Alley moved for a minute of silence.

A minute of silence was observed.

Kingsley Searle and Tony Troup also paid their respects and acknowledge the efforts of Patrick and Laurie's efforts, especially in the management of ASS issues within the LGA.

CONSENSUS:

That the Committee:

1. Acknowledge the important contribution of the late Mr Patrick McEntee and the late Mr Laurie Lardner to the Coast, Estuary and Floodplain advisory subcommittee.
 2. Request Council write to the families of Mr McEntee and Mr Lardner to express the appreciation of the committee for their contribution.
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04 DISCLOSURES OF INTEREST

There were no disclosures of interest presented.

05 BUSINESS ARISING FROM PREVIOUS MINUTES

CONSENSUS:

That the Business Arising Schedule be noted with the following updates:

Item 11.02 - 28/03/19 - Forestry Operations, Lorne State Forest:

Cr Intemann requested that Council staff continue to attempt to contact NSW State Forests on this matter. Council staff will follow up again and will invite NSW State Forests to attend a future CE&F Committee meeting.

Item 11.03 - 28/03/19 - Personal Watercraft use in local waterways:

Matt Dawson confirmed that TfNSW (formerly RMS) can be contacted at any time using 13 12 36 to report any waterway issues.

06 MEMBERSHIP OF THE COAST, ESTUARY AND FLOODPLAIN ADVISORY SUB-COMMITTEE

There was general discussion on various aspects of the report and the Charter. Alan MacIntyre queried whether committee members can liaise directly with the community on matters relating to the CE&F committee. Confirmation was provided that this is acceptable so long as confidentiality is maintained and code of conduct values are followed.

The committee requested that section 5.4 of the charter be updated as follows:

- The agenda be distributed a minimum of 14 days prior to the meeting.
- The agenda and attachments be provided separately.

Alan MacIntyre tabled an additional clause that he felt should be incorporated into the charter. Council staff will review the clause and consider the application of the clause in the charter.

There were numerous minor amendments to the Charter that Council staff will update as necessary. These include changes to sections 2.0, 3.2, 5.1, 5.3 & 5.4.

The committee agreed that the Bunyah & Birpai Local Aboriginal Land Councils (LALC) can be invited to join the committee.

Council staff will make a formal request with Birpai LALC and Bunyah LALC to gauge their interest in joining the committee. Advice from both LALC's will determine how the charter shall be updated. Council staff will provide a response to the committee at the meeting to be held on 20 February 2020.

CONSENSUS:

That the Committee:

1. Note the report.
 2. Note that Councillor Peter Alley has been appointed as Chair and Deputy Mayor Lisa Intemann has been appointed as Alternate Chair.
 3. Recommend to Council to accept the amendments to the Charter, as agreed at the 30 January 2020 Coast, Estuary and Floodplain Advisory Sub-Committee meeting.
 4. Agree to extend invitations to the Birpai and Bunya Local Aboriginal Land Council to join the Committee.
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07 FLOODPLAIN MANAGEMENT

There was general discussion on various aspects of this item.

There was discussion on funding and resourcing on restarting various projects that have been delayed as a result of the December 2018 Council decision. It was confirmed that staffing levels, competing priorities (i.e. Lake Cathie) and state government legislation changes (Coastal Management Act) have impacted Council's capacity to deliver additional project and it was likely that the delayed projects will not recommence for some time.

CONSENSUS:

That the Committee note the Floodplain Management report.

**08 NORTH BROTHER LOCAL CATCHMENTS FLOOD STUDY - STAGE 2 -
FLOODPLAIN RISK MANAGEMENT STUDY - INITIAL OPTIONS ASSESSMENT
REPORT**

Mark Edenborough provided the committee with a summary of the project and answered questions from committee members.

Committee members requested additional time to read the report and consider the options contained within.

The committee agreed that a steering group of committee members should form to discuss the Initial Options Assessment Report before placing the report on public exhibition.

In order to provide the steering group with an opportunity to discuss the options and assist in devising a community engagement strategy, a further meeting will be held on 20 February at 2-4pm. Location TBA.

CONSENSUS:

That the Committee:

1. Note the progress made in commencing the North Brother Local Catchments Floodplain Risk Management Study
 2. Endorse the North Brother Local Catchments Flood Study Working Draft Options Report.
 3. Recommend that the North Brother Local Catchments Flood Study Working Draft Options Report be deferred until the Committee Meeting to be held on 20 February 2020.
 4. That a steering group meeting be held on 20 February to provide feedback on any preferences for location/options to be included in the detailed assessment and prioritisation of options, which will ultimately be utilised to inform the Floodplain Risk Management Study phase of the project.
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09 ACTIVE COAST, ESTUARY & FLOODPLAIN PROJECTS STATUS UPDATE

Jesse Dick provided the committee with a summary of this item.

There was general discussion on various aspects of this report.

A copy of the historical Coast, Estuary & Floodplain Action Plan Items will be circulated to committee members.

CONSENSUS:

That the Committee note the status of the active Coast, Estuary & Floodplain projects.

10 LAKE INNES / LAKE CATHIE ESTUARINE SYSTEM - UPDATE

There was frustration and concern from committee members that they were not involved in discussions around the management of the Lake system over the previous 12 months.

Committee members will be involved in the management of the Lake system as the separate stakeholder and community meetings held in 2019 will no longer be occurring and that the CE&F committee will now be the main forum for discussions regarding the management of the Lake system.

CONSENSUS:

That the Committee:

1. Note the Lake Innes / Lake Cathie Estuarine System - Update report.
 2. Note the Lake Cathie and Lake Innes Acid Sulphate Soil Risk Assessment (2019).
 3. Note the Coastal Management in the Port Macquarie-Hastings timeline document.
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Item 11 Passing of Patrick McEntee and Laurie Lardner, has been addressed previously within the meeting.

12 PROPOSED COAST, ESTUARY & FLOODPLAIN ADVISORY SUB-COMMITTEE MEETING DATES FOR ENDORSEMENT

CONSENSUS:

That the Coast, Estuary and Floodplain Advisory Sub-Committee:

1. Endorse the meeting dates for 2020 as listed below:
 - Thursday 20 February, Room TBA, 2-4pm, report prepared by 6 February, Distribution of agenda 13 February.
 - Wednesday 27 May 2020, Council Chambers, 2-4pm, reports prepared by 13 May, distribution of agenda 21 May.
 - Thursday 27 August 2020, Council Chambers, 2-4pm, reports prepared by 13 August, distribution of Agenda 20 August.
 - Thursday 26 November 2020, Council Chambers, 2-4pm, reports prepared by 12 November, distribution of agenda 19 November.
 2. Note that the report preparation and agenda distribution dates nominated in this item may be subject to change pending adoption of the recommended changes to the Charter which will be presented to a future Council meeting for consideration.
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13 GENERAL BUSINESS

Nil.

The meeting closed at 4:50pm.

Item: 04
Subject: DISCLOSURES OF INTEREST

RECOMMENDATION

That Disclosures of Interest be presented

DISCLOSURE OF INTEREST DECLARATION

Name of Meeting:	
Meeting Date:	
Item Number:	
Subject:	
I, the undersigned, hereby declare the following interest:	
<input type="checkbox"/> Pecuniary: Take no part in the consideration and voting and be out of sight of the meeting.	
<input type="checkbox"/> Non-Pecuniary – Significant Interest: Take no part in the consideration and voting and be out of sight of the meeting.	
<input type="checkbox"/> Non-Pecuniary – Less than Significant Interest: May participate in consideration and voting.	
For the reason that:	
Name: Signed:	Date:
Please submit to the Governance Support Officer at the Council Meeting.	

(Refer to next page and the Code of Conduct)

Pecuniary Interest

- 4.1 A pecuniary interest is an interest that you have in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to you or a person referred to in clause 4.3.
- 4.2 You will not have a pecuniary interest in a matter if the interest is so remote or insignificant that it could not reasonably be regarded as likely to influence any decision you might make in relation to the matter, or if the interest is of a kind specified in clause 4.6.
- 4.3 For the purposes of this Part, you will have a pecuniary interest in a matter if the pecuniary interest is:
- (a) your interest, or
 - (b) the interest of your spouse or de facto partner, your relative, or your partner or employer, or
 - (c) a company or other body of which you, or your nominee, partner or employer, is a shareholder or member.
- 4.4 For the purposes of clause 4.3:
- (a) Your "relative" is any of the following:
 - i) your parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descendant or adopted child
 - ii) your spouse's or de facto partner's parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descendant or adopted child
 - iii) the spouse or de facto partner of a person referred to in paragraphs (i) and (ii)
 - (b) "de facto partner" has the same meaning as defined in section 21C of the *Interpretation Act 1987*.
- 4.5 You will not have a pecuniary interest in relation to a person referred to in subclauses 4.3(b) or (c)
- (a) if you are unaware of the relevant pecuniary interest of your spouse, de facto partner, relative, partner, employer or company or other body, or
 - (b) just because the person is a member of, or is employed by, a council or a statutory body, or is employed by the Crown, or
 - (c) just because the person is a member of, or a delegate of a council to, a company or other body that has a pecuniary interest in the matter, so long as the person has no beneficial interest in any shares of the company or body.

Non-Pecuniary

- 5.1 Non-pecuniary interests are private or personal interests a council official has that do not amount to a pecuniary interest as defined in clause 4.1 of this code. These commonly arise out of family or personal relationships, or out of involvement in sporting, social, religious or other cultural groups and associations, and may include an interest of a financial nature.
- 5.2 A non-pecuniary conflict of interest exists where a reasonable and informed person would perceive that you could be influenced by a private interest when carrying out your official functions in relation to a matter.
- 5.3 The personal or political views of a council official do not constitute a private interest for the purposes of clause 5.2.
- 5.4 Non-pecuniary conflicts of interest must be identified and appropriately managed to uphold community confidence in the probity of council decision-making. The onus is on you to identify any non-pecuniary conflict of interest you may have in matters that you deal with, to disclose the interest fully and in writing, and to take appropriate action to manage the conflict in accordance with this code.
- 5.5 When considering whether or not you have a non-pecuniary conflict of interest in a matter you are dealing with, it is always important to think about how others would view your situation.

Managing non-pecuniary conflicts of interest

- 5.6 Where you have a non-pecuniary conflict of interest in a matter for the purposes of clause 5.2, you must disclose the relevant private interest you have in relation to the matter fully and in writing as soon as practicable after becoming aware of the non-pecuniary conflict of interest and on each occasion on which the non-pecuniary conflict of interest arises in relation to the matter. In the case of members of council staff other than the general manager, such a disclosure is to be made to the staff member's manager. In the case of the general manager, such a disclosure is to be made to the mayor.
- 5.7 If a disclosure is made at a council or committee meeting, both the disclosure and the nature of the interest must be recorded in the minutes on each occasion on which the non-pecuniary conflict of interest arises. This disclosure constitutes disclosure in writing for the purposes of clause 5.6.
- 5.8 How you manage a non-pecuniary conflict of interest will depend on whether or not it is significant.
- 5.9 As a general rule, a non-pecuniary conflict of interest will be significant where it does not involve a pecuniary interest for the purposes of clause 4.1, but it involves:
- a) a relationship between a council official and another person who is affected by a decision or a matter under consideration that is particularly close, such as a current or former spouse or de facto partner, a relative for the purposes of clause 4.4 or another person from the council official's extended family that the council official has a close personal relationship with, or another person living in the same household
 - b) other relationships with persons who are affected by a decision or a matter under consideration that are particularly close, such as friendships and business relationships. Closeness is defined by the nature of the friendship or business relationship, the frequency of contact and the duration of the friendship or relationship.
 - c) an affiliation between the council official and an organisation (such as a sporting body, club, religious, cultural or charitable organisation, corporation or association) that is affected by a decision or a matter under consideration that is particularly strong. The strength of a council official's affiliation with an organisation is to be determined by the extent to which they actively participate in the management, administration or other activities of the organisation.
 - d) membership, as the council's representative, of the board or management committee of an organisation that is affected by a decision or a matter under consideration, in circumstances where the interests of the council and the organisation are potentially in conflict in relation to the particular matter
 - e) a financial interest (other than an interest of a type referred to in clause 4.6) that is not a pecuniary interest for the purposes of clause 4.1
 - f) the conferral or loss of a personal benefit other than one conferred or lost as a member of the community or a broader class of people affected by a decision.
- 5.10 Significant non-pecuniary conflicts of interest must be managed in one of two ways:
- a) by not participating in consideration of, or decision making in relation to, the matter in which you have the significant non-pecuniary conflict of interest and the matter being allocated to another person for consideration or determination, or
 - b) if the significant non-pecuniary conflict of interest arises in relation to a matter under consideration at a council or committee meeting, by managing the conflict of interest as if you had a pecuniary interest in the matter by complying with clauses 4.28 and 4.29.
- 5.11 If you determine that you have a non-pecuniary conflict of interest in a matter that is not significant and does not require further action, when disclosing the interest you must also explain in writing why you consider that the non-pecuniary conflict of interest is not significant and does not require further action in the circumstances.
- 5.12 If you are a member of staff of council other than the general manager, the decision on which option should be taken to manage a non-pecuniary conflict of interest must be made in consultation with and at the direction of your manager. In the case of the general manager, the decision on which option should be taken to manage a non-pecuniary conflict of interest must be made in consultation with and at the direction of the mayor.
- 5.13 Despite clause 5.10(b), a councillor who has a significant non-pecuniary conflict of interest in a matter, may participate in a decision to delegate consideration of the matter in question to another body or person.
- 5.14 Council committee members are not required to declare and manage a non-pecuniary conflict of interest in accordance with the requirements of this Part where it arises from an interest they have as a person chosen to represent the community, or as a member of a non-profit organisation or other community or special interest group, if they have been appointed to represent the organisation or group on the council committee.

SPECIAL DISCLOSURE OF PECUNIARY INTEREST DECLARATION

*This form must be completed using block letters or typed.
If there is insufficient space for all the information you are required to disclose,
you must attach an appendix which is to be properly identified and signed by you.*

By <i>[insert full name of councillor]</i>	
In the matter of <i>[insert name of environmental planning instrument]</i>	
Which is to be considered at a meeting of the <i>[insert name of meeting]</i>	
Held on <i>[insert date of meeting]</i>	
PECUNIARY INTEREST	
Address of the affected principal place of residence of the councillor or an associated person, company or body <i>(the identified land)</i>	
Relationship of identified land to councillor <i>[Tick or cross one box.]</i>	<input type="checkbox"/> The councillor has interest in the land (e.g. is owner or has other interest arising out of a mortgage, lease, trust, option or contract, or otherwise). <input type="checkbox"/> An associated person of the councillor has an interest in the land. <input type="checkbox"/> An associated company or body of the councillor has interest in the land.
MATTER GIVING RISE TO PECUNIARY INTEREST¹	
Nature of land that is subject to a change in zone/planning control by proposed LEP <i>(the subject land²)</i> <i>[Tick or cross one box]</i>	<input type="checkbox"/> The identified land. <input type="checkbox"/> Land that adjoins or is adjacent to or is in proximity to the identified land.
Current zone/planning control <i>[Insert name of current planning instrument and identify relevant zone/planning control applying to the subject land]</i>	
Proposed change of zone/planning control <i>[Insert name of proposed LEP and identify proposed change of zone/planning control applying to the subject land]</i>	
Effect of proposed change of zone/planning control on councillor or associated person <i>[Tick or cross one box]</i>	<input type="checkbox"/> Appreciable financial gain. <input type="checkbox"/> Appreciable financial loss.

[If more than one pecuniary interest is to be declared, reprint the above box and fill in for each additional interest]

Councillor's Signature: **Date:**

This form is to be retained by the council's general manager and included in full in the minutes of the meeting

Last Updated: 3 June 2019



Important Information

This information is being collected for the purpose of making a special disclosure of pecuniary interests under clause 4.36(c) of the Model Code of Conduct for Local Councils in NSW (the Model Code of Conduct).

The special disclosure must relate only to a pecuniary interest that a councillor has in the councillor's principal place of residence, or an interest another person (whose interests are relevant under clause 4.3 of the Model Code of Conduct) has in that person's principal place of residence.

Clause 4.3 of the Model Code of Conduct states that you will have a pecuniary interest in a matter because of the pecuniary interest of your spouse or your de facto partner or your relative or because your business partner or employer has a pecuniary interest. You will also have a pecuniary interest in a matter because you, your nominee, your business partner or your employer is a member of a company or other body that has a pecuniary interest in the matter.

"Relative" is defined by clause 4.4 of the Model Code of Conduct as meaning your, your spouse's or your de facto partner's parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descendant or adopted child and the spouse or de facto partner of any of those persons.

You must not make a special disclosure that you know or ought reasonably to know is false or misleading in a material particular. Complaints about breaches of these requirements are to be referred to the Office of Local Government and may result in disciplinary action by the Chief Executive of the Office of Local Government or the NSW Civil and Administrative Tribunal.

This form must be completed by you before the commencement of the council or council committee meeting at which the special disclosure is being made. The completed form must be tabled at the meeting. Everyone is entitled to inspect it. The special disclosure must be recorded in the minutes of the meeting.

¹ Clause 4.1 of the Model Code of Conduct provides that a pecuniary interest is an interest that a person has in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to the person. A person does not have a pecuniary interest in a matter if the interest is so remote or insignificant that it could not reasonably be regarded as likely to influence any decision the person might make in relation to the matter, or if the interest is of a kind specified in clause 4.6 of the Model Code of Conduct.

² A pecuniary interest may arise by way of a change of permissible use of land adjoining, adjacent to or in proximity to land in which a councillor or a person, company or body referred to in clause 4.3 of the Model Code of Conduct has a proprietary interest

Item: 05

Subject: BUSINESS ARISING FROM PREVIOUS MINUTES

Not applicable for this meeting.

Item: 06

Subject: NORTH BROTHER LOCAL CATCHMENTS FLOODPLAIN RISK
MANAGEMENT STUDY - INITIAL OPTIONS ASSESSMENT REPORT -
REVIEW OF DRAFT OPTIONS AND COMMUNITY ENGAGEMENT
STRATEGY

Presented by: Development and Environment, Melissa Watkins

RECOMMENDATION

That the Committee:

1. Endorse the *North Brother Local Catchments Flood Study Working Draft Options Report*.
2. Recommend that the *North Brother Local Catchments Flood Study Working Draft Options Report* be placed on public exhibition for 2 Months.
3. Provide feedback on any preferences for location/options to be included in the detailed assessment and prioritisation of options, which will ultimately be utilised to inform the Floodplain Risk Management Study phase of the project.

Discussion

At the January 2020 Coast, Estuary and Floodplain Advisory Committee meeting, the North Brother Local Catchments Flood Study Working Draft Option Report was presented for consideration and endorsement by the sub-committee, prior to proceeding to planned community consultation.

At that time, the committee resolved to defer review of the report and its contents until a further meeting to be held on 20 February 2020, with the committee recommendations as follow:

CONSENSUS:

That the Committee:

1. Note the progress made in commencing the North Brother Local Catchments Floodplain Risk Management Study
2. Endorse the North Brother Local Catchments Flood Study Working Draft Options Report.
3. Recommend that the North Brother Local Catchments Flood Study Working Draft Options Report be deferred until the Committee Meeting to be held on 20 February 2020.
4. That a steering group meeting be held on 20 February to provide feedback on any preferences for location/options to be included in the detailed assessment and prioritisation of options, which will ultimately be utilised to inform the Floodplain Risk Management Study phase of the project.

This report re-submits the North Brother Local Catchments Flood Study Working Draft Option Report and the prior associated Committee Report (both attached) for consideration. The committee is requested to:

1. Provide feedback on any preferences for additional locations/options to be included, or current locations/options to be excluded from the detailed assessment and prioritisation, and
2. Provide endorsement of the report to be placed on public exhibition for shortlisting.

Furthermore, discussions at the January 2020 Committee Meeting revolved in part around the Council's proposed community engagement strategy for the proposed upcoming public exhibition and review period. In particular, the Committee sought information regarding Council's proposed approach in order to ensure that all affected/interested residents and landowners were informed and given the best opportunity to contribute.

Council's Senior Stormwater Engineer and Community Participation Manager have been liaising regarding the proposed community engagement phase. At the time of writing, a consultation strategy is being formulated. An update and summary of the proposed strategy will be tabled at the meeting on 20 February.

It is anticipated that consultation will include the following elements:

- o Targeted mail out to community members who have been previously involved in the project and those landowners/residents of properties impacted by modelled flood flows.
 - o Mail out to local chamber of commerce and relevant state emergency agencies.
 - o Advertising of the exhibition period via notices in the local newspapers, and Council's social media channels.
- 5.

The above measures will invite the community to participate via multiple avenues including:

- o Updated project website,
 - o Attending one of various targeted site meetings/discussions with residents/landowners on a sub-catchment/neighbourhood basis.
 - o Community drop-in type sessions at the Laurieton Library.
 - o Contacting project staff directly by email or phone.
- 6.

Attachments

- 1 [↓](#). Copy of Earlier Committee Report presented January 2020
- 2 [↓](#). North Brother FRMS Working Draft Options Report

AGENDA COAST, ESTUARY & FLOODPLAIN ADVISORY SUB-COMMITTEE
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Item: 08

Subject: **NORTH BROTHER LOCAL CATCHMENTS FLOOD STUDY - STAGE 2
- FLOODPLAIN RISK MANAGEMENT STUDY - INITIAL OPTIONS
ASSESSMENT REPORT**

Presented by: Development and Environment, Melissa Watkins

RECOMMENDATION

That the Committee:

1. Note the progress made in commencing the North Brother Local Catchments Floodplain Risk Management Study
2. Endorse the *North Brother Local Catchments Flood Study Working Draft Options Report*.
3. Recommend that the *North Brother Local Catchments Flood Study Working Draft Options Report* be placed on public exhibition for 28 days.
4. Provide feedback on any preferences for location/options to be included in the detailed assessment and prioritisation of options, which will ultimately be utilised to inform the Floodplain Risk Management Study phase of the project.

Discussion

Following the adoption of the North Brother Local Catchments Flood Study by Council in July 2019, Council has entered Phase 2 of this ongoing project, being the completion of the North Brother Local Catchments Floodplain Risk Management Study (FRMS).

In this regard, the development of Floodplain Management Plans follow guidelines established in the *NSW Government's Floodplain Development Manual (2005)*.

The manual outlines the steps involved in the process, and the activities required to develop a Floodplain Management Plan in flood affected areas.

The Floodplain Risk Management process involves the following stages:

STAGE	DESCRIPTION
1. Flood Study - Adopted by Council 19 July 2019	Determines the nature and extent of the flood problem.
2. Floodplain Risk Management Study - Presently Underway	Evaluates management options for the floodplain in respect of both existing and proposed developments.
3. Floodplain Risk Management Plan	Involves formal adoption by Council of a plan of management for the floodplain.
4. Implementation of Plan	Results in construction of flood mitigation works to protect existing development and the application of environmental and planning

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	controls to ensure that new development is compatible with the hazard.
--	--

Following the completion of the Flood Study Phase and in commencing the FRMS phase of this project, Council, via consultants Jacobs Pty Ltd have completed the following:

Flood Level Survey

Based on an analysis of the impacts of the flooding identified by the Flood Study, a floor level survey was undertaken in October 2019 for selected properties in the study area. This involved the survey of the minimum habitable floor level of some 270 buildings which were identified based on the presence of potential high hazard flooding to the dwelling in the modelled 1% AEP storm event. A map of the surveyed properties is included at Attachment 1.

The floor level of remaining properties (those located clear of modelled high hazard flooding to the dwelling in the modelled 1% AEP) were estimated to be 200mm above the height of the ground level at the dwelling.

Determination of Above Flood Level Flooding

Utilising the floor level information obtained above, mapping of above floor level flooding in the 0.2EY, 5%, 2%, 1%AEP and PMF flood events was undertaken to visually identify those properties impacted by flooding of varying magnitudes. A copy of the 'above-floor flooding at dwellings' mapping is included within the attached North Brother Local Catchments Flood Study Working Draft Options Report, Attachment 2.

The mapping illustrates priorities for flood mitigation works by identifying vulnerable properties and areas within the catchment.

Of particular interest, the mapping illustrates the following:

- **462 residential properties** are at risk of habitable floor flooding during a **1% AEP storm event** in the catchment,
- A further **27 non-residential/commercial** properties are also modelled to be subject to inundation of habitable floor levels during a **1% AEP** storm event.
- If the required freeboard height is added to the flood levels, those figures jump to 834 and 89 respectively.
- More significantly and in reflection of the scale of inadequacy of existing infrastructure and controls, **161 residential properties and 10 non-residential/properties** are identified as being at risk of over floor level flooding during a comparatively common **20% AEP storm event** (334 and 31 respectively when the required freeboard height is added to the flood levels).
- Properties identified as being at risk of above floor level flooding are not confined to one area, and are spread throughout the catchment, demonstrating that multiple solutions of varying scales will be required.

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Whilst only a snapshot of the figures presented in the report, the mapping and above figures clearly outlines the scale of the significant stormwater related issues impacting the catchment.

Identification of Sensitive Properties and Critical Infrastructure

In addition to determining the quantum of properties impacted by above floor level flooding generally, sensitive properties and critical infrastructure within the study area were also identified and mapped. Sensitive properties and critical infrastructure includes schools, pre-schools, aged care facilities, emergency services and the like.

Utilising the mapping, Flood Study phase outcomes and floor level data, the sensitive properties and critical infrastructure identified as being directly affected by overland flooding are summarised below:

Name	Flood Hazard	
	1% AEP	PMF
Sensitive Properties		
Stockland Camden View Retirement Village	H6	H6
Kids Haven Pre School	H1	H5
Laurieton Public School	H1	H2
Laurieton Retirement Village	Mostly H1 – H3	H6
St Josephs Primary School	H2	H5
St Josephs Early Childhood Services	H4	H5
Stockland Queens Lake Retirement Village	Mostly H1/H2	H5
Laurieton Lakeside Aged Care Residence	Mostly H1	H5
Kids Haven Early Learning Centre	H1	H1
Camden Haven High School	Mostly H1	Mostly H1, up to H4 in low-lying southern part of school
Critical Facilities and Infrastructure		
NSW Ambulance Laurieton	H1	H3
NSW SES Camden Haven unit	H1	H3
Laurieton Police Station	H1	H2
Fire station Laurieton	H3	H4
Laurieton sewage pumping station	H4	H6

For reference, the flood hazard categories are as follow:

- H1 – Generally safe for people, vehicles and buildings
- H2 – Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles. Buildings require special engineering design and construction
- H6 – Unsafe for people or vehicles. All buildings types considered vulnerable to failure.

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Jacobs then undertook a Flood Damages Assessment in accordance with the procedures outlined in the *Floodplain Development Manual, NSW Government, 2005*. Details of the procedures followed can be found in the attached Working Draft Options Report, however the table below summarises the estimated tangible flood damages due to overland flooding as identified by the North Brother Local Catchments Flood Study:

Event	Based on Floor Level*		Based on Protection Level (Floor Levels minus Freeboard)*	
	Number of properties flooded above floor level	Estimated Flood Damage	Number of properties flooded above protection level	Estimated Flood Damage
Residential				
20% AEP	161	\$15.7M	344	\$40.3M
5% AEP	222	\$21.1M	429	\$50.8M
2% AEP	378	\$34.9M	677	\$80.4M
1% AEP	462	\$41.9M	834	\$98.4M
PMF	1,613	\$155.4M	2,059	\$274.1M
AAD		\$7.3M		\$17.6M
Commercial/Non-Residential				
20% AEP	10	\$1.0M	31	\$4.2M
5% AEP	14	\$1.4M	35	\$5.3M
2% AEP	25	\$2.1M	50	\$7.3M
1% AEP	27	\$2.2M	53	\$7.5M
PMF	76	\$11.3M	89	\$20.3M
AAD		\$0.5M		\$1.7M

* Damages estimate based on Protection Level is to be adopted. Estimate based on floor level used as a sensitivity check.

The values in the table above reflect the Annual Average Damage (AAD). The AAD is equal to the total damage caused by all floods over a long period of time divided by the number of years in that period. The AAD for the existing case then provides a benchmark by which to assess the merit of flood management options.

Key findings are:

- The residential AAD for the study area is **\$17.6 million**.
- The commercial/non-residential AAD is \$1.7 million.

While flood damage estimates for the study area are indicative only, they are useful in the evaluation of flood management options, aimed at reducing flood damage estimates while being economically viable to implement.

Identification of Floodplain Risk Management Measures

Following completion of the Damages Assessment the next stage of the project is to identify, assess and compare various floodplain risk management options to deal

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with the identified flood risks in the study area considering and assessing their social, economic, ecological and cultural impacts and their ability to mitigate flood impacts.

Utilising the list of flooding hotspots identified by the Flood Study in combination with the information summarised above, Jacobs have identified an **initial priority list of 16 key locations** for flood mitigation works as outlined below:

1. Black Swan Terrace, West Haven
2. Ringtail Close and Sirius Drive, Lakewood
3. Lilli Pilli Close, Lakewood
4. Mission Terrace, Lakewood
5. Kirmington Terrace to Pelican Court, West Haven
6. Flinders Drive Estate, West Haven
7. Tunis Street Overland Flow Path, Laurieton
8. Quarry Way Overland Flow Path, Laurieton
9. Lake Street at Seymour Street, Laurieton
10. St Joseph's School, Laurieton
11. Harbourside Crescent Villas and Bold Street, Laurieton
12. Norman Street and Mill Street, Laurieton
13. Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood
14. Elouera Place, West Haven
15. Sandpiper Close, Lakewood
16. Ocean Drive East of Hoschke Road, West Haven

Conceptual mitigation options at each of these locations vary, however generally include such measures as open channel construction and augmentation, provision of new/upgraded stormwater pipe/culvert infrastructure, provision of protection berms/bunds upstream of property, stormwater detention facilities, verge modifications to deflect water and kerb inlet improvements.

Furthermore, and specifically with reference to potential private property impact, there are two locations where voluntary property acquisitions are identified as potential options (Pelican Court and Kermington Terrace), and three locations where block walls, structural works and flood proofing is an option within allotments (Harbourside Crescent Villas, Laurieton RSL and Laurieton Hotel/Bottle Shop).

Each of the identified preliminary options identified has also been assessed, with a priority assigned based on factors including:

- Identification of locations as critical flood problem areas
- Areas of high flood hazard
- Areas with above-floor flooding of dwellings particularly in more frequent events
- Presence of flood problems on sensitive properties
- Perceived difficulties or constraints in implementing the options e.g. environmental constraints, works required on private property, presence/conflicts with existing structures and utilities, etc.

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- Lower priority sites could potentially be raised in priority if low-cost options are identified for flood mitigation.

Table 3-5 of the attached "North Brother Local Catchments Flood Study - Working Draft Options Report" summarises the options identified, any constraints, benefits, opportunities and defines the preliminary priority assigned for detailed assessment.

Preliminary High Priority Options

As can be seen in the attached report, options identified at **four of the 16 locations** have been assigned a preliminary **High priority** for further assessment. The report also notes that Council is currently designing and planning to implement flood mitigation measures at Black Swan Terrace as the **highest priority** site, in addition to the four listed in the report.

Those High priority options are defined further below for reference.

a. Kirmington Terrace to Pelican Court, West Haven

This area is identified as a critical flood problem area with significant flooding of properties in Koonwarra Street, Captain Cook Bicentennial Drive villas, Ocean Drive and Pelican Court. The flood hazard is high to very high (H4, some H5) on properties and on roads in the 1% AEP event. The area is highly affected in frequent events such as the 0.2EY event.

Five options have been identified to mitigate the flooding and risks at this location, with three of those assessed as a high priority, being:

- Option 4A - voluntary acquisition of at least one property in Koonwarra Street (number 53, and possibly number 51) which has floodway and H5 flood hazard conditions.
 - High property prices are listed as a constraint for this option, however proceeding with this option would realise the removal of at least one property from a high hazard floodway and result in substantial improvements to five other nearby properties in Koonwarra Terrace.
- Option 4B - new additional trunk drainage pipelines (2x 1200mm diameter), intercepting flows at the downstream end of the channel on Captain Cook Bicentennial Drive villas, running across Ocean Drive and under The Gateway, discharging to receiving waterway to the north of Pelican Court.
 - Potential service clashes and conflicts with existing infrastructure will constrain the development of this option, however the proposal would result in a reduction in 1%AEP flows in Pelican Court by 25%.
- Option 4C - voluntary acquisition of one property, either 7 or 9 Pelican Court, adjacent to the access road to form a larger flow path and provide additional capacity for flows out of Pelican Court sag.
 - Similarly, to Option 4A, high property prices are listed as a constraint for this option, however proceeding with this option would realise the removal of at least one property from a high hazard floodway and

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result in substantial improvements to ten other nearby properties in Pelican Court.

See Attachment 2 for more detail.

b. Lake Street at Seymour Street, Laurieton

This corner property receives significant overland flows and trunk drainage flows from the Quarry Way flow path. There is an open channel and flow path through this property, where the dwelling is surrounded by high hazard flooding to depths of over 1m in the 1% AEP event. The floodwaters pond behind the raised road crest in Lake Street before overflowing over the road and around the southern side of the Laurieton United Services Club. It is identified as being affected by above-floor flooding.

Three options have been identified to mitigate the flooding and risks at this location, with one of which being assessed as a preliminary high priority:

- Option 8B – Installation of a debris inlet control structure at the culvert inlet.
 - There are no significant constraints to the implementation of this option, however as with any inlet protection, regular inspection and maintenance is required to ensure reliability. This option results in a lowering of the floor levels over Lake Street and resultant reduction in flooding within the upstream private property.

See Attachment 2 for more detail.

c. St Joseph's School, Laurieton

Flooding at the school results from a number of natural flow paths being directed down to Ocean Drive to three culvert crossings and into the school property. Flows exceed 0.5m deep in the 1% AEP event with areas of very high (H5) flood hazard.

Three options have been identified to mitigate the flooding and risks at this location, with two options, assessed as a preliminary high priority:

- In this scenario, both Options 9A and 9B consist of the same scope of works at alternate alignments some 60m apart - being the construction of new trunk drainage culverts along the length of the flow path (2x 3m x 1.2m box culvert) OR works to widen an existing open channel at each location.
 - Both of these options are constrained by service/utility clashes in upstream Ocean Dr and disruptions to traffic and school operations during works, however bot also result in significant reductions in overland flooding within the school and reduced exposure of students and staff to flood flows.

See Attachment 2 for more detail.

d. Harbourside Crescent Villas and Bold Street, Laurieton

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This property is listed as the Stockland Camden View Retirement Village and is located adjacent to a major natural overland flow path which flows down from North Brother Mountain, crossing Bold Street via an existing 1500mm diameter pipe. Flooding over Bold Street is significant with 0.2EY event flood depths over 0.5m and 1% AEP event flood depths of 0.6 – 0.8m and a very high H5 hazard rating.

Two options have been identified to mitigate the flooding and risks at this location, with one of which identified as a preliminary high priority:

- Option 10A - Upgrade existing 1500mm diameter cross drainage pipe to 2x 3m x 1.5m box culverts and provision of debris control screen upstream.
 - These works are constrained by potential service clashes in Bold Street and the potential for significant traffic disruptions to that road during construction. However, the works do result in the provision of a 5% AEP capacity road drainage system and a significant reduction in risk to flooding of downstream villas within the Harbourside Crescent Villas.

See Attachment 2 for more detail.

In addition to the above and as noted, Black Swan Terrace has also been identified as a high priority location for investigation and concept design, however this location has been excluded from the assessment on the basis that it is currently the subject of a separately funded design and construction project being coordinated by Council. The works proposed by Council at this location include the construction of a stormwater basin, inlet protection device and diversion bund that function to both increase the capacity of the existing downstream piped drainage network and divert any remaining overland flows around those flood impacted properties in Black Swan Terrace.

Conclusions and Next Steps

The committee is requested to:

1. Consider both the long list of options and locations nominated in the attached report and the preliminary high priority options listed for potential mitigation works.
2. Select a short list of options for further detailed assessment with the assistance of Jacobs.
3. Request Jacobs to undertake assessment of the short-listed options in the TUFLOW flood hydraulic model in addition to cost-benefit and multi-criteria analyses for evaluation of the options. Final testing of options will include combinations of options, which are likely to complement each other.

Accordingly, the Coast, Estuary and Floodplain Advisory Sub-Committees endorse the Working Draft Options Report (Attachment 2) and any feedback on the committee's preferences for additional locations/options to be included, or

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**COAST, ESTUARY & FLOODPLAIN ADVISORY SUB-COMMITTEE
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current locations/options to be excluded from the detailed assessment and prioritisation of options are now sought.

Pending no objections to the report, the Committees endorsement to place the identified options on public exhibition for shortlisting is requested.

Attachments

1. Map of Properties for Floor Level Survey
2. North Brother Local Catchments Flood Study - Working Draft Options Report



North Brother Local Catchments Flood Study

Port Macquarie Hastings Council

Working Draft Options Report

Revision A

9 December 2019

IA157500



Working Draft Options Report



North Brother Local Catchments Flood Study

Project no: IA157500
 Document title: Working Draft Options Report
 Document No.: 1
 Revision: A
 Date: 9 December 2019
 Client name: Port Macquarie Hastings Council
 Project manager: Lih Chong
 Author: Lih Chong
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Document history and status

Revision	Date	Description	By	Review	Approved
A	9/12/2019	Working Draft Options Report	L Chong	A Hossain	A Hossain

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Working Draft Options Report



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Foreword

The primary objective of the New South Wales Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods, wherever possible. Under the Policy, the management of flood prone land remains the responsibility of local government.

The policy provides for a floodplain management system comprising the following five sequential stages:

1. **Data Collection** Involves compilation of existing data and collection of additional data
2. **Flood Study** Determines the nature and extent of the flood problem
3. **Floodplain Risk Management Study** Evaluates management options in consideration of social, ecological and economic factors relating to flood risk with respect to both existing and future development
4. **Floodplain Risk Management Plan** Involves formal adoption by Council of a plan of management for the floodplain
5. **Implementation of the Plan** Implementation of flood, response and property modification measures (including mitigation works, planning controls, flood warnings, flood preparedness, environmental rehabilitation, ongoing data collection and monitoring by Council

Port Macquarie Hastings Council is undertaking this study for the North Brother Local Catchments study area to investigate the existing and future flood risks in accordance with the NSW Government's *Floodplain Development Manual*. The study identifies and assesses potential flood mitigation options and guides land use planning and future development on the floodplain in the study area.

This study represents stages 1 to 4 of the management process and has been prepared for Council by Jacobs. This report is a progress report documenting the options identification of the floodplain risk management stage of the study.

Working Draft Options Report**JACOBS****Important note about this report**

The sole purpose of this report and the associated services performed by Jacobs is to undertake a flood study for the North Brother Local Catchments study area located in New South Wales in accordance with the scope of services set out in the contract between Jacobs and Port Macquarie Hastings Council (the Client). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client, third parties, and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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Topographic data used in this study included that sourced from a LiDAR survey and ground survey which were undertaken by third parties. Undertaking independent checks on the accuracy of the data was outside Jacobs's scope of work for this study.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 General

This report describes the potential works-based flood mitigation options identified for the North Brother local catchments study area for discussion and consideration by Port Macquarie Hastings Council and the floodplain advisory sub-committee ("committee"). Preliminary recommendations for options to be analysed in further detail in the TUFLOW hydraulic model of the catchment are made, for approval by Council and the committee. The options aim to alleviate flooding at identified flooding trouble spots particularly where properties are at risk to flooding of elevated hazard.

The content of this report will be included in the subsequent Options Evaluation Report and Draft Floodplain Risk Management Study (FRMS) report.

1.2 Consultation

The options, or a selected list of the options, described in this report are to be discussed with Council, the committee and stakeholders and landowners as a part of the options development process. Community consultation is scheduled to occur on a finalised list of the options during public exhibition.

2. The Existing Flooding Problem

2.1 Summary of Flood Problem Areas

Flooding hot spots are identified in the flood study, confirming problem areas previously identified by Council. The hot spots are summarised in Table 2-1 below. Critical areas with consideration of high flood depths, velocities or hazard are highlighted with orange cell or text shading. In summary, the identified critical locations include:

- Black Swan Terrace, West Haven.
- Kirmington Terrace, Koonwarra Street, Captain Cook Bicentennial Drive villas and Ocean Street property and Pelican Court, West Haven.
- Bold Street, Laurieton
 - Laurieton Hotel and adjoining areas
 - Harbourside Crescent villas.
- Lake Street property, Laurieton. Corner Seymour Street.
- St Joseph's School, Laurieton.
- Lilli Pilli Close, Lakewood (road flooding).
- Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood (road flooding).
- Ocean Drive between Fairwinds Avenue and Mission Terrace (road flooding).
- Pelican Court, West Haven (road flooding).
- Waterview Crescent, Kirmington Terrace and Koonwarra Drive, West Haven (road flooding).
- Bold Street between Laurie Street and Mill Street (road flooding).
- Lord Street at Seymour Street, Laurieton (road flooding).

Table 2-1 Description of Flooding Hot Spots

Location	Description
Property flooding	
Black Swan Terrace, West Haven	Flow depths on properties up to 0.5m in the 0.2EY event and up to 0.7m in the 1% AEP event. Swift flows of 2m/s. Flood hazard up to H5 rating in the 1% AEP event.
Ringtail Cl, Lakewood	Overflows from open channel onto properties with flooding in backyards to depths 0.2 – 0.3m in the 1% AEP event. Relatively low flooding impact.
Lilli Pilli Cl, Lakewood	Flooding in backyards to depths of 0.3 – 0.5m in the 1% AEP event from open drain overflows. Flooding in cul-de-sac to depths up to 0.8m. Also significant flooding of car park around Lakewood shopping centre.
Mission Terrace, Lakewood	Overflows with depths of 0.1 – 0.3m in the 1% AEP event from cul-de-sac onto downhill property. Overflows from the overland flow path running through properties on the uphill side of the road with depths up to 0.2m
Kirmington Terrace to Pelican Court, West Haven	Flows through properties on low side of Koonwarra Street of 0.3m in the 0.2EY event and exceeding 0.5m in the 1% AEP event. Velocities up to 2m/s in the 1% AEP event. Flood

	<p>hazard up to H4 (some localised H5) rating in the 1% AEP event.</p> <p>Flow depths 0.5m in the 0.2EY event and up to 0.8m in the 1% AEP event on Captain Cook Bicentennial Drive villas and Ocean Drive property, at dwellings. Flood hazard up to H4 rating in the 1% AEP event.</p> <p>Flood depths of 0.6 – 0.8m in the 0.2EY event within Pelican Court roadway and pedestrian walkway. Depths up to 0.6m at dwellings in 1% AEP event. Flood hazard up to H4 rating on properties and H5 on roadway in the 1% AEP event.</p> <p>Groundwater springs occur in this area but are not directly related to the surface water flood risk. These springs appear to be a spatially random occurrence.</p>
Flinders Dr Estate, Laurieton	<p>Overflows from drainage easement swale onto properties with depths to 0.3m in the 0.2EY event and 0.5m in the 1% AEP event.</p> <p>Overflows from Reliance Crescent sag point onto properties to depths of 0.2m in the 0.2EY event and 0.4m in the 1% AEP event.</p>
Bold Street area, Laurieton	<p>Significant flows through Laurieton Hotel with H4 hazard rating.</p> <p>Trapped drainage point on western side of commercial properties with significant depths, though local drainage may be present which would mitigate the flood depths.</p> <p>Overflows down fire trail at Norman Street/ Mill Street affecting properties with depths up to 0.3m in the 1% AEP.</p> <p>Overflows onto units on Harbourside Crescent from trunk drainage channel to depths exceeding 0.5m in the 1% AEP event, with H5 hazard rating.</p>
Quarry Way, Laurieton	<p>Overflows from flow diversion drain to depths of 0.5m in the 1% AEP event on properties. The drain is reported to be affected by significant debris blockage.</p>
Lake Street, Laurieton	<p>Flood depths up to 1m in the 1% AEP event affecting dwelling on the corner of Lake Street and Seymour Street.</p> <p>Overflows from Lake Street onto properties between Ocean Drive and Castle Street to depths of 0.3m in the 1% AEP.</p>
St Joseph’s School, Laurieton.	<p>Swift flows in overland flow paths to depths of 0.8m and velocities exceeding 2m/s in the 1% AEP event.</p> <p>Flows between buildings are 0.4m in the 0.2EY event and 0.6m in the 1% AEP event, with velocities up to 2m/s. Flood hazard rating of H4 in pedestrian walkways and H5 in overland flow paths in the 1% AEP event.</p>
Properties adjacent to Stingray Creek and Camden Haven River, Laurieton	<p>Numerous properties on low-lying land at risk of oceanic inundation during storm surge events. Estimated depths on the flood mapping expected to be conservative due to likely attenuation of ocean inflows through the river mouth.</p>
Blackbutt Crescent and Peach Grove, Laurieton	<p>Overflows from flow diversion drain to depths of 0.5m in the 1% AEP event on properties. The drain cross-sectional profile and capacity significantly reduces near its discharge point onto Peach Grove at Tunis Street. Flows into the drain originate from natural watercourse further uphill, which is significantly affected by rubble and debris blockage.</p>
Elouera Place, West Haven	<p>Overflows from watercourse and diversion drain. Depths over 0.3m in the 0.2EY event and 0.5m in the 1% AEP event.</p>

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Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood	Flood depths on properties 0.3 – 0.5m in the 1% AEP event, built up from road ponding areas.
Sirius Drive and Oak Close, Lakewood	Depths 0.3 – 0.4m and velocities 1m/s in the 1% AEP event.
Sandpiper Close	Overflows from concrete channel along Ocean Drive. Depths 0.3 – 0.4m and velocities 1m/s in the 1% AEP event.
Properties on lower side of Ocean Drive, 200m east of Hoschke Road, West Haven	Road low point overflows onto properties with depths of 0.5m and velocities of 1m/s in the 1% AEP event.
Roads	
Ocean Drive west of Lakewood shopping centre	5% AEP event flood depths of 0.4m 1% AEP event flood depths of 0.5m, H3 hazard rating
Botanic Drive, Lakewood	1% AEP event flood depths of 0.4m, H2 hazard rating
Lilli Pilli Close, Lakewood	5% AEP event flood depths of 0.6m 1% AEP event flood depths of 0.7m, H3 hazard rating
Ocean Drive east of Lakewood shopping centre	5% AEP event flood depths of 0.3m 1% AEP event flood depths of 0.35m, >H4 hazard rating
Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood	0.2EY event flood depths of 0.6 – 0.7m 1% AEP flood depths 1m, H3 hazard rating
Ocean Drive between Fairwinds Avenue and Mission Terrace	0.2EY events flood depths of 0.5m 1% AEP event flood depths of 0.7m, >H4 hazard rating
Ocean Drive and Mission Terrace intersection	0.2EY event flood depths of 0.4m 1% AEP event flood depths of 0.6m, H3 hazard rating
Ocean Drive near Waterview Crescent	5% AEP event flood depths of 0.2 – 0.3m 1% AEP event flood depths of 0.3m, low hazard rating but long section of flooding
Ocean Drive near Pelican Court	5% AEP event flood depths of 0.3m 1% AEP event flood depths of 0.4m, H3 hazard rating
Pelican Court, West Haven	0.2EY event flood depths 0.6m 1% AEP event flood depths of 1m, H5 hazard rating
Waterview Crescent, Kirmington Terrace and Koonwarra Drive, West Haven	0.2EY event flood depths of 0.2m with 2m/s velocity; max 0.6m depths (low velocity) 1% AEP event flood depths up to 0.7m, H5 – H6 hazard rating
Ocean Drive east of Hoshcke Road	0.2EY event flood depths of 0.4m 1% AEP event flood depths of 0.5m, H3 hazard rating
Ocean Drive east of Flinders Drive	5% AEP event flood depths of 0.3m 1% AEP event flood depths of 0.4m, H3 hazard rating
Kew Road/Bold Street near Tunis Street, Laurieton	1% AEP event flood depths of 0.5m, H2 hazard rating
Bold Street between Laurie Street and Mill Street	0.2EY event flood depths over 0.5m 1% AEP event flood depths 0.6 – 0.8m, H5 hazard rating

Bold Street north of Hanley Street, Laurieton	0.2EY event flood depths of 0.3m with 1m/s velocity 1% AEP event flood depths up to 0.5m, H3 hazard rating
Lord Street at Seymour Street, Laurieton	0.2EY event flood depths of 0.5m 1% AEP event flood depths up to 0.7m, H3 hazard rating
Flinders Drive, Laurieton Tunis Street, Laurieton Rosewood Court and Mission Terrace, Lakewood Diamantina Way, Lakewood	H5 hazard rating on steep sections of road (1% AEP event)

2.2 Above-Floor Property Flooding

A floor level survey was undertaken in October 2019 for selected properties in the study area, which were identified based on presence of high hazard flooding at the dwelling in the 1% AEP event. The minimum habitable floor level was surveyed at a total of approximately 270 buildings. Floor levels for the remaining 2,000 (approximately) properties in the study area were estimated based on an assumed 0.2m height above the maximum ground level at the dwelling.

Above-floor flooding in the 0.2EY, 5%, 2% and 1% AEP and PMF flood events is mapped on Figure 2-1. The buildings shown on the map were selected as those affected by main flow paths and bodies of flooding, and exclude those affected by minor ponding. This selection process was done for each flood AEP and was also used in the flood damages assessment (see Section 2.4).

Above-floor flooding is expected to incur significantly greater flood damages to the building and contents compared to yard (i.e. below floor level) flooding. The map indicates the spatial distribution of properties with above-floor flooding and their relative vulnerability, with properties affected in frequent events such as the 0.2EY event being more vulnerable than those affected only in rarer events such as the 1% AEP event.

The mapping illustrates where flood mitigation works could be prioritised. Targeting improvements to flooding conditions in areas with clusters of more vulnerable properties (e.g. above-floor flooding in the 0.2EY event) could provide relatively greater benefits compared to targeting areas with few or no properties affected in rare flood events. Note that other factors may be considered in prioritising flood mitigation works, such as the presence of high hazard flood conditions on sensitive properties including schools.

2.3 Sensitive Properties and Critical Infrastructure

Sensitive properties and critical infrastructure have been identified in the catchment. Certain types of properties may require specific evacuation considerations due to the vulnerability of their occupants, such as schools and pre-schools, and aged care facilities. Critical infrastructure impacted by flooding may have effects on the recovery and functioning of the community following a flood event.

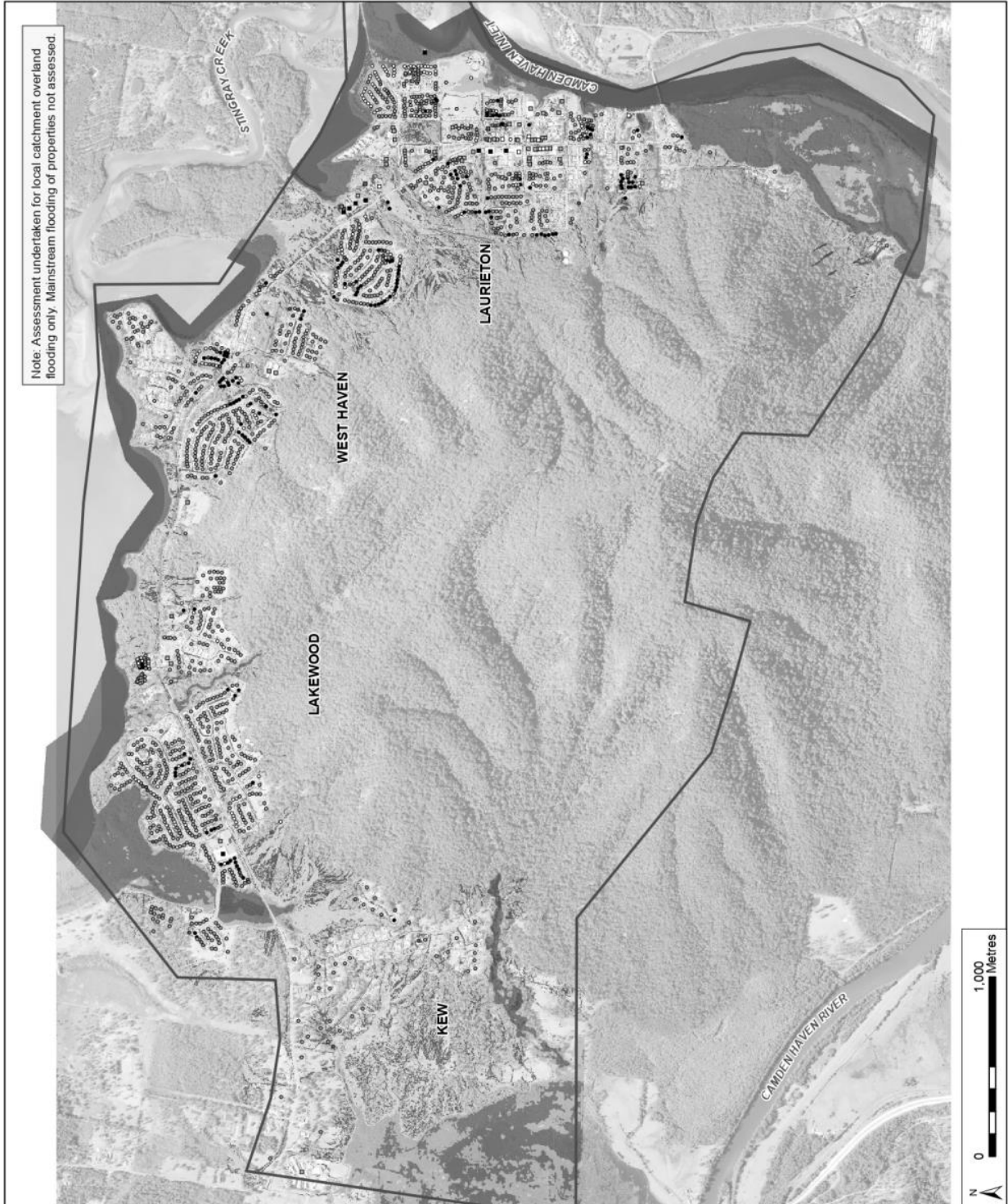
The sensitive properties and critical infrastructure are mapped on Figure 2-2. The flood hazard in the PMF event is mapped on the figure.

- Legend**
- Design Flood when Floor Becomes Inundated
- 0.2EY
 - 5% AEP
 - 2% AEP
 - 1% AEP
 - PMF
- Property Type
- Residential
 - Non-residential
- Peak Flood Depth (m)
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0
 - Study Area

GDA 1994 MGA Zone 56
Scale: A3
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant the accuracy, currency and accuracy of information contained in this map.



TITLE	Above-Floor Flooding at Dwellings
PROJECT	North Brother Local Catchments Flood Study
FIGURE #	FIGURE 2-1
DATE	31/12/2019



Legend

- Child Care Centre
 - ★ Critical Infrastructure
 - Emergency Services
 - School
 - Aged Care Facility
 - Study Area
- Flood Hazard Category**
- H1 - Generally safe for vehicles, people and buildings.
 - H2 - Unsafe for small vehicles.
 - H3 - Unsafe for all vehicles, children and the elderly.
 - H4 - Unsafe for all people and all vehicles.
 - H5 - Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
 - H6 - Unsafe for Vehicles and people. All building types considered vulnerable to failure.

GDA 1994 MGA Zone 56
Scale: A3

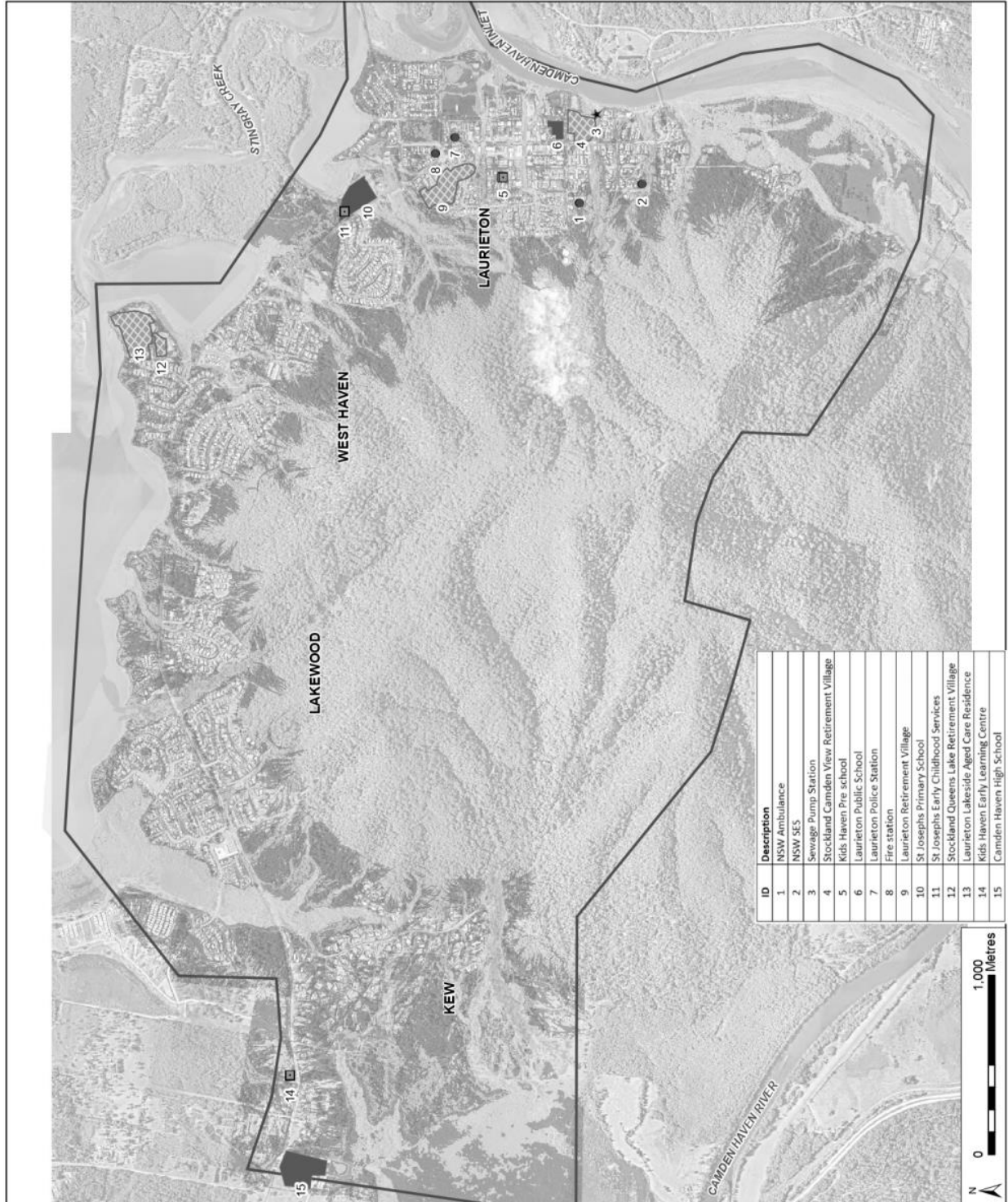
Data Sources: LPI, OEH, Council
LIMITATIONS: This mapping is based on data and assumptions identified in the North Brother Local Catchments Flood Study prepared by Jacobs. Jacobs does not warrant the accuracy, reliability or representativeness of the data and accuracy information contained in this map.



TITLE Sensitive Properties and Critical Infrastructure

PROJECT North Brother Local Catchments Flood Study

FIGURE # 2-2
DATE 01/12/2019



The sensitive properties and critical infrastructure identified as being directly affected by overland flooding are summarised in Table 2-2 with the flood hazard on each site indicated. Note that the list is based on the overland flood modelling in this study, and a number of sites may be impacted by mainstream flooding which is not assessed.

Table 2-2 List of flood-affected sensitive properties and critical infrastructure

Name	Flood Hazard	
	1% AEP	PMF
Sensitive Properties		
Stockland Camden View Retirement Village	H6	H6
Kids Haven Pre School	H1	H5
Laurieton Public School	H1	H2
Laurieton Retirement Village	Mostly H1 – H3	H6
St Josephs Primary School	H2	H5
St Josephs Early Childhood Services	H4	H5
Stockland Queens Lake Retirement Village	Mostly H1/H2	H5
Laurieton Lakeside Aged Care Residence	Mostly H1	H5
Kids Haven Early Learning Centre	H1	H1
Camden Haven High School	Mostly H1	Mostly H1, up to H4 in low-lying southern part of school
Critical Facilities and Infrastructure		
NSW Ambulance Laurieton	H1	H3
NSW SES Camden Haven unit	H1	H3
Laurieton Police Station	H1	H2
Fire station Laurieton	H3	H4
Laurieton sewage pumping station	H4	H6

The flood hazard is classified according to flow depths and velocities based on *Australian Disaster Resilience Handbook 7. Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017a) and *Guideline 7-3 Flood Hazard* (AIDR, 2017b). The flood hazard categories according to the AIDR definition are:

- H1 – Generally safe for people, vehicles and buildings
- H2 – Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles. Buildings require special engineering design and construction
- H6 – Unsafe for people or vehicles. All buildings types considered vulnerable to failure.

2.4 Flood Damages Assessment

2.4.1 Overview

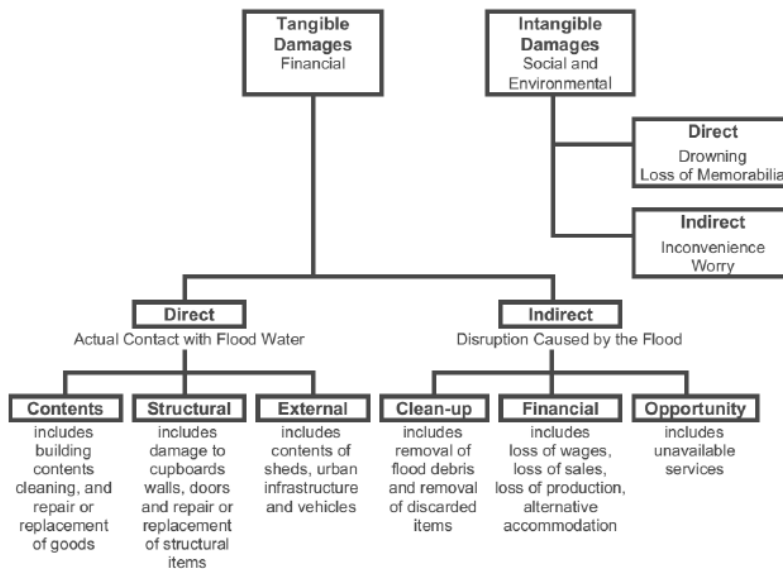
Flood events may cause damage to property with significant costs to property owners and insurers. The damage may occur due to floodwaters affecting the building façade and interior (weatherboard exterior, gyprock interior walls, carpets), electrical wiring and building contents and other property outside the dwelling (vehicles, contents of sheds and garages, etc). Structural damage to the dwelling can also occur due to extreme flood hazard conditions.

The cost of flooding is estimated to identify the magnitude of the event to a community, and subsequently provide a benchmark for the viability of potential measures for mitigating the impacts of flooding. This section describes the estimation of flood damage costs in the study area, focussing on residential and commercial properties.

2.4.2 Flood Damages Categories

The type of damages associated with floods is shown in Figure 2-3 (*Floodplain Development Manual, NSW Government 2005*). The cost of damage caused by floods may include tangible and intangible components. Tangible damage costs include the direct material damage and rebuilding costs to existing homes, property and infrastructure, and also the indirect costs associated with the social disruption of the floods, such as: clean-up; lost income during and after the flood event; and the cost of alternative accommodation for people displaced by the floods. A monetary value can be readily placed on the direct damages, which are the focus of this assessment.

Figure 2-3 Types of Flood Damage



Other social and environmental damages to which a monetary value cannot readily be placed are intangible damages, which include emotional stress of the flood event, injury and loss of life. While these damages cannot readily be incorporated into an economic feasibility assessment of mitigation options, it is still important to consider the potential for these intangible damages, particularly if there is an elevated risk of loss of life.

2.4.3 Estimation of Direct Tangible Flood Damage Costs

2.4.3.1 Property Information

Residential and commercial properties were identified and characterised based on knowledge and site observations of the study area.

Residential house types in the study area are generally a mixture of one and two storey houses, in addition to a number of villa and apartment complexes. In floodplains with deep flooding (riverine floodplains) two storey houses would experience a second increment of flood damages as floodwaters rise and affect the second storey. While some properties in the low-lying areas adjacent to the rivers and lakes would be affected by riverine flooding, the focus of this study is on overland flows from the local catchments, affecting up to the first storey of the house only. For the purposes of this assessment all houses were assumed to be single storey.

Flood damages are estimated based on flood level in relation to building floor level, with the damages increasing as the flood levels increase. The floor levels of approximately 270 buildings, selected based on high hazard flooding in the 1% AEP event, were surveyed. The floor levels of remaining buildings were estimated based on LiDAR ground levels plus and assumed 0.2m above the highest ground level at the building.

Affected buildings for the flood damages assessment were selected based on interpretation of overland flood extents from the flood mapping, to include only those properties affected by main flow paths and significant ponding shown on the mapping so as not to overestimate the flood damages. The affected properties were selected for each event assessed in the flood damages estimation, i.e. the 0.2EY, 5%, 2% and 1% AEP and PMF events. This approach was taken so as not to overestimate the flood damages.

2.4.3.2 Residential Property Damages

Residential flood damages guidelines and a calculation spreadsheet was developed by the NSW Office of Environment and Heritage (OEH, 2016b). The calculation spreadsheet includes a representative stage-damage curve derived for typical house types in the study area to estimate structural, contents and external damage. The amount of damage is based on the flood inundation depth, for a suite of annual exceedance probability events ranging from the 20% AEP event up to the PMF. These values are then summed to provide a total damage for each flood event analysed. The AEP of the PMF in the study area is assumed to be 1 in 10,000,000.

The stage-damage curves assume some flood damages for flood levels below the floor level. A minimum damage value of \$12,060 (2018 dollars) is assumed to occur at a level 0.5m below the floor level. This approach accounts for flood damages to parts of the dwelling and property below the floor level and ensures that damages are not underestimated.

Various input parameters are used to define the flooding and location characteristics which derive a location specific damage curve. The parameters adopted for the study area are presented in Table 2-3. Unless otherwise stated, default parameters have been used (as recommended in the *Residential Flood Damage Guidelines* (OEH, 2016b)).

The DECCW stage-damage curves within the spreadsheet are derived for late 2001, and have been updated using an Average Weekly Earnings (AWE) factor to the current day values. AWE is used to update residential flood damage curves rather than the inflation rate measured by the Consumer Price Index (CPI). The most recent AWE value from the Australian Bureau of Statistics (ABS, 2019) at the time of the assessment was November 2018, however, this resulted in a multiplication factor on 2001 dollars of 2.37, which was significantly out of step from the factor value derived from November 2017 AWE of 1.76 and from previous recent years. On this basis, a factor of 1.9 was assumed for up to August 2019 to keep in trend with AWE increases for the years prior to November 2017.

Table 2-3 Input parameters for damage calculations

Parameter	Value	Comment
Regional Cost Variation Factor	1.0	Appropriate value for a major city (Sydney) and surrounds
Post flood inflation factor	1.15	
Typical duration of immersion	1 hour	
Building damage repair limitation Factor	0.85	Represents short duration flood (<12 hours) where some materials can recover from short periods of flooding and may not need replacement
Typical free-standing house size	240m ²	
Contents damage repair limitation Factor	0.75	Guidelines suggest a value of 0.75 for short duration floods
Effective warning time (hrs)	0	Only marginal improvement in damages cost when effective warning time is increased to 1 hour as a sensitivity assessment
Level of flood awareness	Low	Flood warning times are nil and it is assumed that residents are typically not aware of potential damage of flood waters and the measures to minimise damages (e.g. elevated storage of goods).

2.4.3.3 Commercial Property Damages

No information on commercial property flood damage costs in NSW was found during a literature search. The most relevant information obtained was published in the Queensland Government Natural Resources and Management Department's *Guidance on the Assessment of Tangible Flood Damages* (2002). This document contains flood damage curves for commercial properties over a range of property footprint areas and degrees of susceptibility to flooding and is based on information published in *ANUFLOOD: A Field Guide* (Centre for Resource and Environmental Studies (Australian National University), 1992). Different types of commercial and non-residential properties were assigned a susceptibility rating, as illustrated in Figure 2-4.

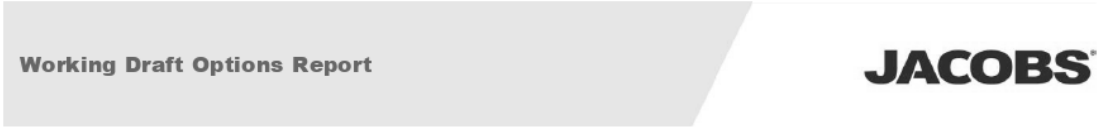
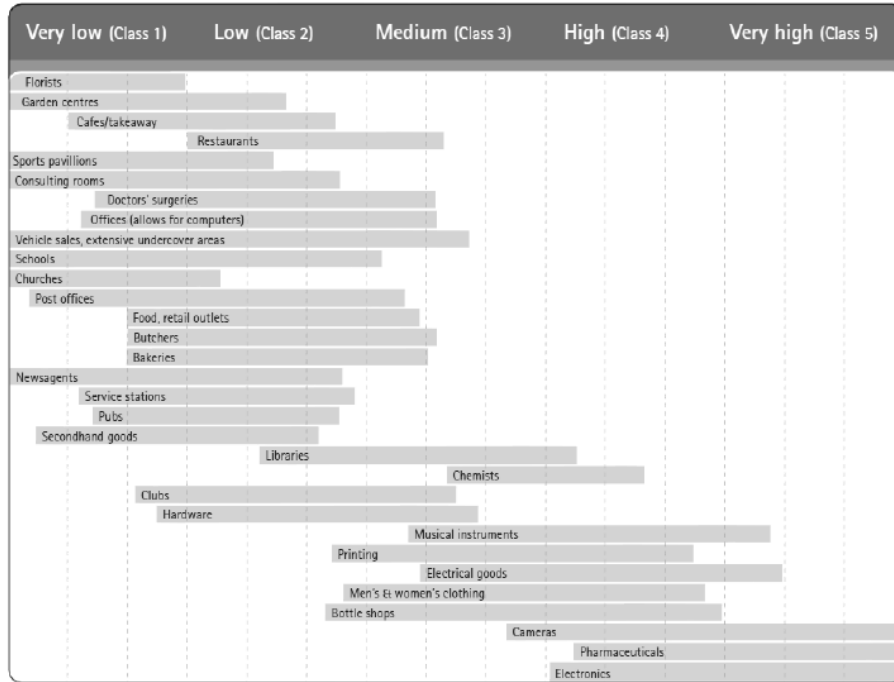


Figure 2-4 Damage categories for commercial properties (reproduced from *Guidance on the Assessment of Tangible Flood Damages* (Qld. Government, 2002))



The stage-damage data were factored up by a value of 1.9 from late 2001 dollars to current values based on Average Weekly Earnings (AWE), similar to the approach adopted for the residential flood damages.

An additional multiplication factor of 1.6 was applied based on guidance in *Rapid-Appraisal Method (RAM) for Floodplain Management* (Victorian Government Natural Resources and Environment, 2000), which suggests that the ANUFLOOD values are underestimated and should be increased by 60%.

A total of 89 commercial and non-residential premises/buildings which are potentially flood-affected were identified. Detached buildings on non-residential properties were assessed individually e.g. on school grounds. Individual shops within an overall commercial building complex were also assessed separately where possible. The results of the commercial and non-residential property flood damages assessment are provided in Section 2.4.3.5.

2.4.3.4 Damages to Utilities and Infrastructure

Utilities and infrastructure in the study area which are susceptible to flooding may include roads and other public infrastructure such as sewage pumping stations, electrical transformer boxes, etc.

The potential cost of damage to roads is difficult to estimate for the study area, as the nature of flooding in a significant portion of study area is typically due to relatively shallow, short-duration flows, although road damage is possible for roads conveying higher velocity flows.

The roads damages guidance published in the references cited in this study are based on longer-duration mainstream flooding damages and hence are likely to overestimate the flood damages to roads in the study area. Hence these costs have not been included in this assessment.

2.4.3.5 Damage Assessment Results

The most convenient way to express flood damage for a range of flood events is by calculating the Annual Average Damage (AAD). The AAD is equal to the total damage caused by all floods over a long period of time divided by the number of years in that period. The AAD for the existing case then provides a benchmark by which to assess the merit of flood management options.

The AAD value is determined by multiplying the damages that can occur in a given flood by the probability of that flood actually occurring in a given year and then summing across a range of floods. This method allows smaller floods, which occur more frequently to be given a greater weighting than the rarer catastrophic floods.

Table 2-4 summarises the residential damages and the commercial and non-residential damages. The residential and commercial property flood damages include direct damages to property such as structural, external and contents damage, and indirect damages such as clean up costs and accommodation/ loss of rent costs. Infrastructure damage, vehicular damage and intangible damages are not included.

The OEH (2016b) guidelines recommend that the adopted freeboard in the flood planning level (0.5m) be considered in the flood damages estimation. This gives the "Protection Level" which reduces the floor level relative to the flood levels in the calculations which are adopted as the damages estimates. Calculations of damages based on floor level (no freeboard adjustment applied) are also provided as a sensitivity check.

The flood damages here are "potential flood damages", which may be reduced with increased flood awareness and preparedness in the community. The Net Present Value of the flood damages assumes a 7% discount rate over a 50 year life, as per the OEH (2016b) guidelines. The damages are in 2019 dollar values.

Table 2-4 Estimated Tangible Flood Damages due to Overland Flooding

Event	Based on Floor Level*		Based on Protection Level (Floor Levels minus Freeboard)*	
	Number of properties flooded above floor level	Estimated Flood Damage	Number of properties flooded above protection level	Estimated Flood Damage
Residential				
20% AEP	161	\$15.7M	344	\$40.3M
5% AEP	222	\$21.1M	429	\$50.8M
2% AEP	378	\$34.9M	677	\$80.4M
1% AEP	462	\$41.9M	834	\$98.4M
PMF	1,613	\$155.4M	2,059	\$274.1M
AAD		\$7.3M		\$17.6M
Commercial/Non-Residential				
20% AEP	10	\$1.0M	31	\$4.2M
5% AEP	14	\$1.4M	35	\$5.3M
2% AEP	25	\$2.1M	50	\$7.3M
1% AEP	27	\$2.2M	53	\$7.5M
PMF	76	\$11.3M	89	\$20.3M
AAD		\$0.5M		\$1.7M

* Damages estimate based on Protection Level is to be adopted. Estimate based on floor level used as a sensitivity check.

2.4.4 Application of Flood Damage Curves to the Study Area

It should be noted that the flood damages estimated for the study area need to be considered with care. The OEH residential stage-damage curves recommended for use in NSW have been developed based on flood damages from low-land mainstream/ flooding, where flood surface gradients are relatively flat and the depth of flooding within a dwelling is fairly uniform. Due to the steep terrain in parts of the study area and the generally shallow nature of overland flows (particularly in the more frequent flood events), flood levels may vary greatly on a property and damage may be concentrated on one side of a dwelling. Flood depths are also relatively shallow so the damage incurred may be less than those suggested by the curves. Nevertheless, the stage-damage curves provide the best guidance available for estimating flood damages given the scarcity of actual flood damage data to residential properties on highland overland flow paths and have been adopted for the purposes of this study.

2.4.5 Summary

Flood damages in the study area is primarily attributed to residential dwellings that are impacted by overland flooding. The estimates based on Protection Level are to be adopted. The flood damages estimates were based on properties selected based on their affectation from main areas of flooding, and excludes those affected by localised minor ponding. The residential AAD for the study area is \$17.6 million. The commercial/non-residential AAD is \$1.7 million.

There are 489 residential and non-residential properties that are estimated to experience above floor flooding (not protection level) for the 1% AEP event. In the PMF, 1,689 properties are estimated to experience above floor flooding.

While flood damage estimates for the study area are indicative only, they are useful in the evaluation of flood management options, aimed at reducing flood damage estimates while being economically viable to implement.

3. Floodplain Risk Management Measures

3.1 Overview

One of the objectives of this Floodplain Risk Management Study is to identify and compare various floodplain risk management options to deal with existing and future flood risk in the study area, considering and assessing their social, economic, ecological and cultural impacts and their ability to mitigate flood impacts.

The *Floodplain Development Manual* (NSW Government, 2005) describes floodplain risk management measures in three broad categories as described below:

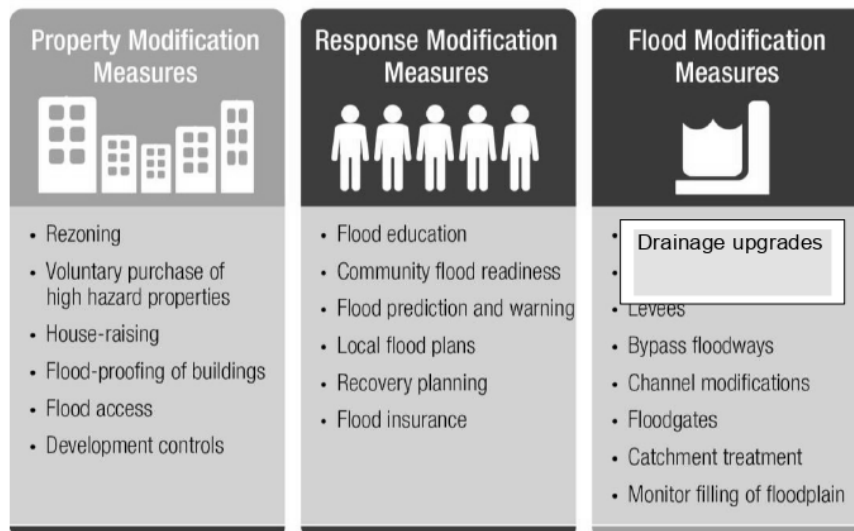
- **Property modification** measures involve modifying existing properties (for example, house-raising) and/or imposing controls on new property and infrastructure development (for example, floor height restrictions);
- **Response modification** measures involve modifying the response of the population at risk to better cope with a flood event (for example improving community flood readiness); and
- **Flood modification** measures involve modifying the behaviour of the flood itself (for example, construction of a levee to exclude floodwaters from an area or flood retarding/detention basins to store floodwaters and reduce peak outflows).

Examples of measures falling under the three categories are outlined in Figure 3-1. Some of these measures may or may not be appropriate in a particular catchment, depending on factors such as the flooding behaviour and patterns of development.

A description and qualitative evaluation of potentially suitable works-based flood modification options for specific locations, nominated for further detailed modelling assessment, is provided in Section 3.3. The identified options aim to mitigate flooding at the locations summarised in Table 2-1, in particular property flooding. A number of options are identified for each location which may be treated as alternative options or may need to be implemented in combination. Sketches are provided for each option.

Property and response modification measures will be addressed in the draft FRMS.

Figure 3-1 Floodplain Risk Management Measures (Source: *Floodplain Development Manual*, 2005)



3.2 Considerations in Options Identification and Prioritisation

In determining the nature and priority of potential options for further detailed assessment, the following factors have been considered:

- The identified mitigation options are aimed at improving flooding conditions due to local catchment flooding. Riverine flood levels exceed the local catchment flood levels by a substantial amount particularly in the 1% AEP event and inundate low-lying areas of the study area. The local catchment flood mitigation options in these areas should be designed not to worsen the susceptibility of these areas to riverine flooding. For example, substantial lowering of raised berms may allow overtopping of river floodwaters in more frequent events.
- Design river tailwater conditions due to elevated ocean levels are up to 2.1m AHD in the 1% AEP event. Some low-lying areas on properties and roads have a ground level of approximately 2.6m AHD and would be difficult to drain via underground pipes.
- The effectiveness of mitigation options during future climate change scenario is to be considered. The design river tailwater conditions due to elevated ocean levels would increase to 3.0m AHD in the 1% AEP event in a climate change scenario, with 0.9m of sea level rise.
- The design riverine flood levels are 2.3 – 2.4m AHD in the 5% AEP event and 2.9 – 3.0m AHD in the 1% AEP event in the current climate. The flood levels in a climate change scenario are expected to increase by up to 0.8m in the 1% AEP event as a result of 0.9m sea level rise and 10% increase in rainfall (Patterson Britton and Partners, 2013).
- Given the low elevation of a number of identified sites for potential mitigation, it is expected that the effectiveness of the mitigation options would be reduced if local overland flooding coincided with a mainstream flood peak. Some contingency will be incorporated into the options modelling with adoption of elevated, but not peak, river tailwater levels.

Preliminary priority has been assigned to mitigation of flooding at each identified location based on factors including:

- Identification of locations as critical flood problem areas
- Areas of high flood hazard
- Areas with above-floor flooding of dwellings particularly in more frequent events
- Presence of flood problems on sensitive properties
- Perceived difficulties or constraints in implementing the options e.g. environmental constraints, works required on private property, presence/conflicts with existing structures and utilities, etc.
- Lower priority sites could potentially be raised in priority if low-cost options are identified for flood mitigation.

Several sub-options have been identified at most locations and may be considered alternative options from each other or may need to be implemented in combination.

3.3 Description of Proposed Options

The identified options for flood mitigation are discussed on a location-basis in this section.

3.3.1 Black Swan Terrace, West Haven

Council commissioned, separately from this study, a design for an improved trunk drainage pipe inlet arrangement and high-flow diversion to the street. Additional works in the street including raising of the road verge and driveways is proposed. Details of the design were provided following the final flood study, hence it has not been incorporated into the design flood modelling and mapping. Since the design development of mitigation works at this location are already well-advanced, further mitigation options are not proposed in this study.

It is proposed to retain the pre-developed conditions in the mitigation case modelling. Post-development hydraulic modelling is being undertaken by others on behalf of Council. Flow conditions in Koonwarra Street, downstream of the works, are not expected to be significantly changed as a result of the works, hence omission of the works from the mitigation case modelling should not affect the assessment of other mitigation options.

3.3.2 Ringtail Close and Sirius Drive, Lakewood

Overflows from an adjacent open channel affect yards to depths 0.2 – 0.3m in the 1% AEP event. Total flows in the 5% AEP event are around 8.7m³/s and in the 1% AEP are around 11.4m³/s. The existing channel has a capacity of approximately 0.2EY capacity (about 5m³/s). There is a water main pipe crossing the lower end of Ringtail Close channel, with about 0.5m clearance under the pipe, which is likely to obstruct flows. The channel then turns west along Ocean Drive with a width of about 6m and depth around 0.5m. Overflows exceeding the channel capacity spill over Ocean Drive into Sirius Drive and adjacent properties (up to 5m³/s in the 1% AEP).

Potential Options

- Option 1A – localised channel enlargement. Increase channel width to 10m (currently 6m) to provide for 1% AEP capacity. This option would be relatively low cost and provide local benefits to the properties in Ringtail Close only. Deepening (up to 0.5m) and widening of channel under water pipe crossing. Removal of existing trees and other vegetation would be required (not listed as EEC). New structural support for the water main would be required if the channel is widened/deepened under the pipe.
- Option 1B – localised channel enlargement as per Option 1A, plus Ocean Drive (south side) channel enlargement particularly where the Ringtail Close channel tails out at its downstream end. It is proposed to deepen the Ringtail Close and Ocean Drive channels by about 0.5m (up to 1m where possible) including steepening of side slopes. Existing underground utilities along Ocean Drive and telegraph poles are likely constraints on widening Ocean Drive channel in addition to the existing vegetation. Enlargement of Ocean Drive channel would divert some flows away (up to 5m³/s in the 1% AEP depending on constraints) from affected properties in Sirius Drive, Banks Street, Honeysuckle Avenue etc. Deepening the channel would allow more flow under the pipe and reduce overflows onto Ringtail Close properties.
- Option 1C – localised channel enlargement as per Option 1A plus trunk drainage pipe conveying some flows in this flow path. The pipe would cross Ocean Drive and run down Sirius Drive, before turning through a park to the north of Botanic Drive and discharge into the downstream wetland area. There is an existing 525mm pipe through the park, draining Banks Street. Existing utilities and existing vegetation are potential constraints. There are Endangered Ecological Communities (EECs) and SEPP 14 wetlands at and downstream of the proposed discharge point. Assuming twin 1050mm diameter pipes could be installed, this could reduce the flows currently conveyed to the Honeysuckle Avenue area by about 5m³/s.
- Option 1D – construct an earth bund or block wall along footpath, up to 0.5m high approximately, to direct Ocean Drive overflows into Sirius Drive and away from properties.

Refer to Figure 3-2 for illustration of options. Options 1B and 1C are alternatives to each other, and would not be required in combination. Either of 1B or 1C may negate the need for Option 1D. Option 1D could be selected if 1B or 1C are not feasible.

Priority

Option 1A is rated as a **low** priority, as it offers localised improvements to properties with only yard flooding. Options 1B and 1C are rated as **medium** priority as it has potential to provide improvements to properties further downstream from Ringtail Close by bypassing flows away from Honeysuckle Drive and adjacent properties. Option 1D is rated as **medium** priority as it could benefit up to eight properties at relatively low cost, although checks for downstream flood impacts in Sirius Drive is required.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
- 1% AEP Peak Flood Depth (m)
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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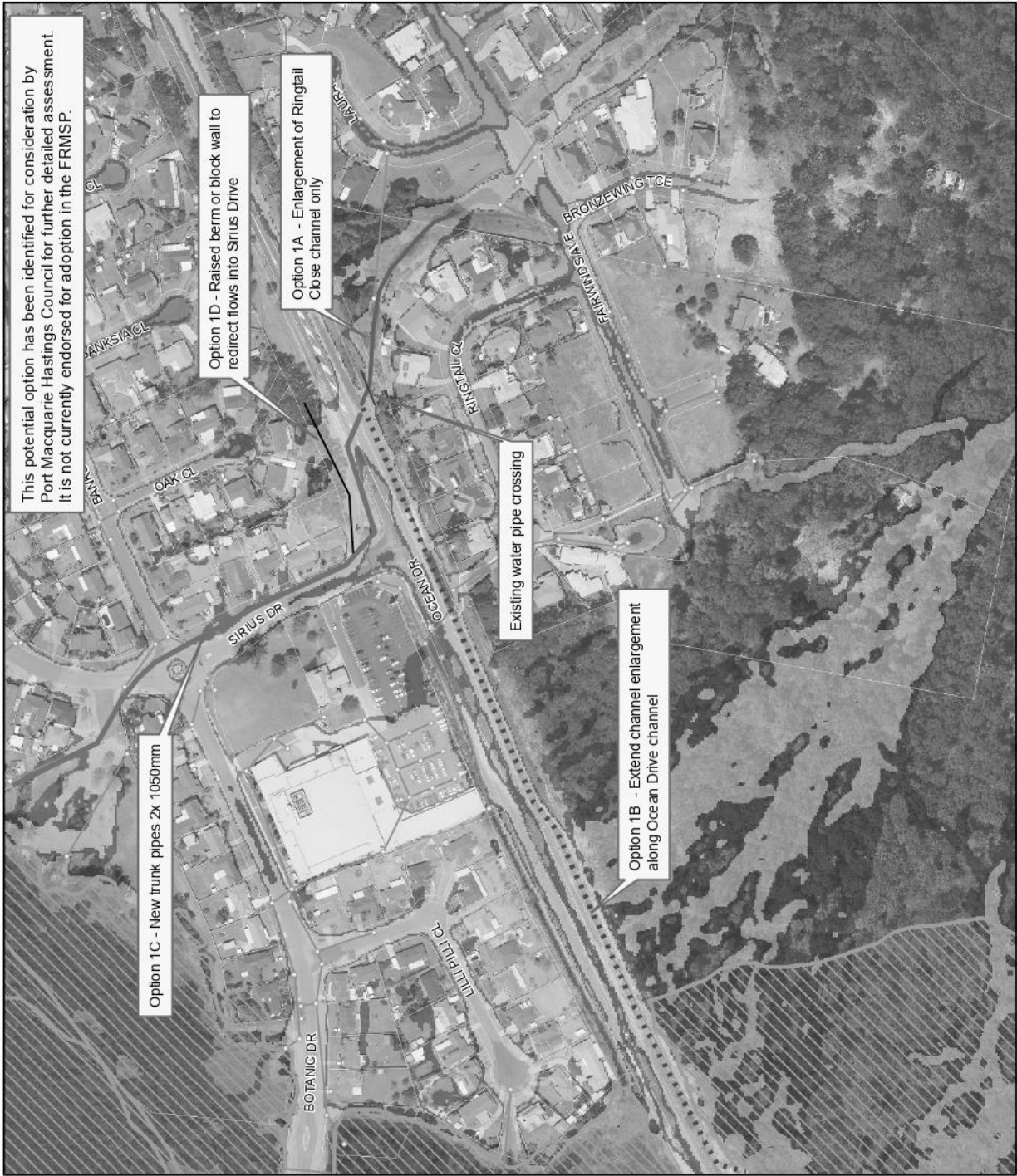
TITLE
GDA 1994 MGA Zone 56

Option 1 Ringtail Close and Sirius Drive, Lakewood Identified Options

PROJECT
North Brother Local Catchments Flood Study

PROJECT # / MAP #
IA157500 /
DATE
12/11/2019

FIGURE 3-2



3.3.3 Lilli Pilli Close, Lakewood

Flooding occurs in backyards to depths of 0.3 – 0.5m in the 1% AEP event from open drain overflows. Flooding occurs in the cul-de-sac to depths up to 0.8m in the 1% AEP event. Existing drainage in the cul-de-sac is limited to a single kerb inlet pit with approximately 2m lintel length and a 375mm diameter pipe which discharges to a downstream vegetated area. Overflows from the cul-de-sac are conveyed through an easement between properties.

The existing constructed open channel along Ocean Drive conveys flows discharged from a 750mm pipe in addition to overflows over Ocean Drive from the southern side of the road. The channel is unlined with vegetation growing in the channel. It conveys approximately 2.5m³/s in up to the 1% AEP. The northern bank of the channel 1m above the channel invert and is lower than the road level by over 1m and flows are able to spill into the backyards of properties.

Potential Options

- Option 2A – channel upgrade to concrete-lined box channel. Northern side of the channel could have a raised lip to above the adjacent backyard levels, to increase flow capacity. Existing telegraph poles along Ocean Drive limit options for widening the channel and structural design of the channel would need to consider the stability of the poles. A block wall along the upstream end of the channel, bordering the Lakewood shopping centre property, would be required to prevent water overflowing around the western corridor of that property.
- Option 2B – increase cul-de-sac pipe drainage capacity from existing 375mm diameter to 600mm (or larger) diameter pipe. Drainage capacity would be increased by a factor of 2.5.
- Option 2C – lower the ground level of the easement at the cul-de-sac head to reduce the overflow weir level. The current ground level is at 3.4m AHD. Lowering the level to 3.1m AHD could reduce flood levels by about 0.2m and would be above the design 1% AEP overland flood tailwater level of 3m AHD (current climate).

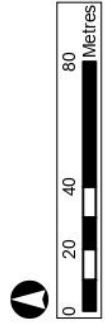
Refer to Figure 3-3 for illustration of options.

Priority

The priority for Option 2A is rated as **medium to high**. Not critical location (no high hazard flooding in 1% AEP) but a number of properties with above-floor flooding between Lilli Pilli Close and Ocean Drive.

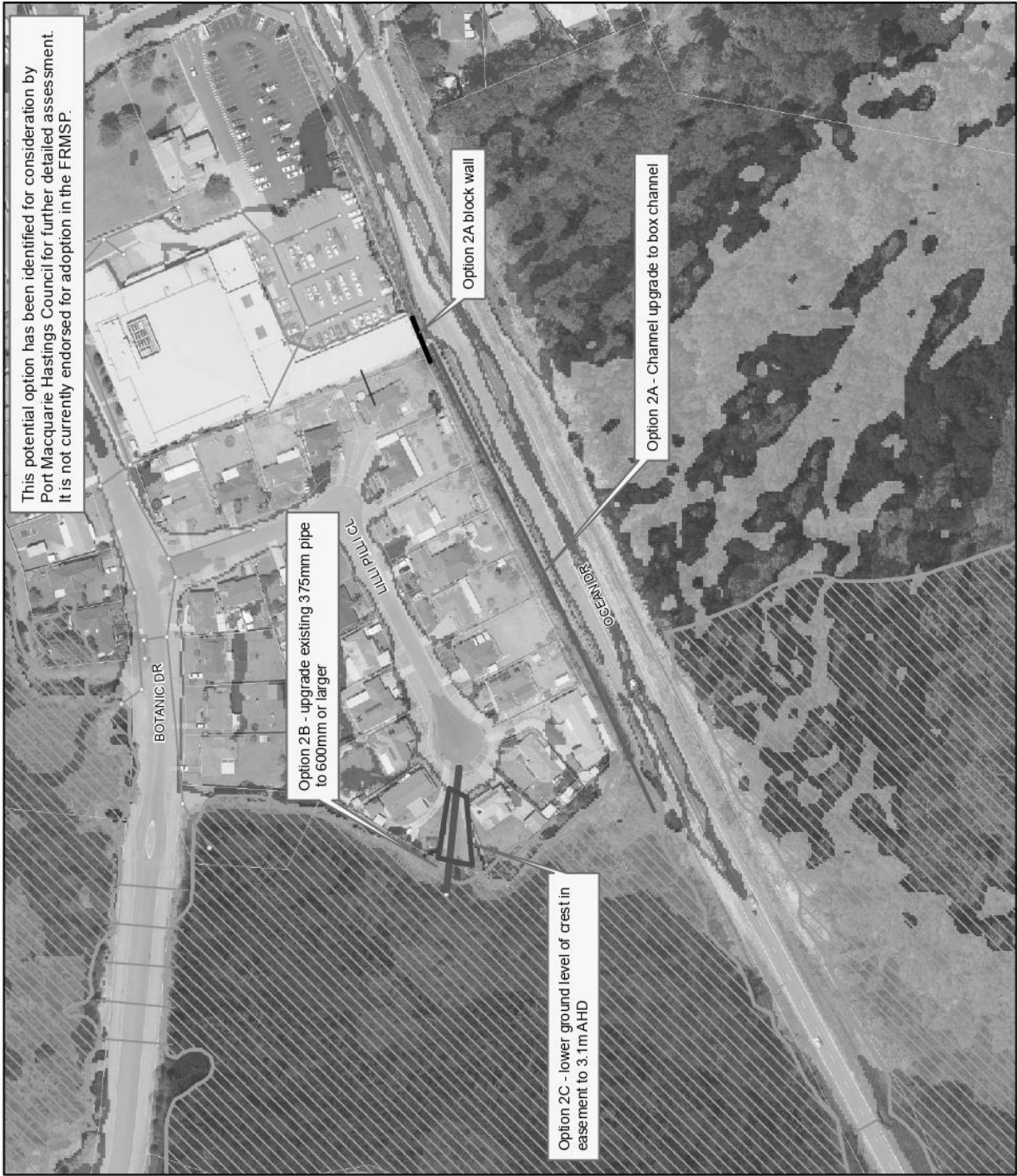
Options 2B and 2C are rated as **medium**. Flood depths are substantial in the roads though this area was not listed as a critical location and there are no properties with above floor flooding in the 1% AEP event.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
- 1% AEP Peak Flood Depth (m)
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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TITLE	GDA 1994 MGA Zone 56
PROJECT	Option 2 Lilli Pilli Close, Lakewood Identified Options
PROJECT #	MAP #
PROJECT #	IA157500
DATE	12/11/2019
FIGURE 3-3	



3.3.4 Mission Terrace, Lakewood

An overland flow path spills floodwaters onto the cul-de-sac of Mission Terrace, which then overflows onto properties on the downstream side of the road to depths of over 0.2m in up to the 1% AEP event. Properties on the high side of the road are adjacent to the flow path and affected to over 0.2m depth in the 1% AEP event. The overland flow path is intercepted by a 600mm diameter pipe which drains into the Mission Terrace drainage network but this pipe's capacity is exceeded in the 0.2EY event. Additionally, a substantial portion of flows bypass this pipe.

Potential Options

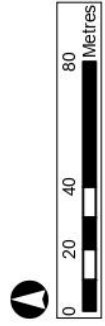
- Option 3A – construct an open channel to formalise the overland flow path. Direct the flow path around the eastern sides of properties on Mission Terrace. Size the channel for the 1% AEP flood, for a flow of approximately 3m³/s (approximate sizing 3m wide by 1m deep). Works would need to be done on private property. A culvert would need to be installed under a private property internal road. Additional works may be required at Ocean Drive to mitigate any resultant impacts, although the overland flows currently drain down to Ocean Drive already, in an informal manner.
- Option 3B – raise road verge and driveway to protect one property on lower side of road. This option would likely provide benefits for frequent flood events only. Driveway grading needs to be checked for vehicle underside scraping, in relation to raising of the driveway crest.

Refer to Figure 3-4 for illustration of options.

Priority

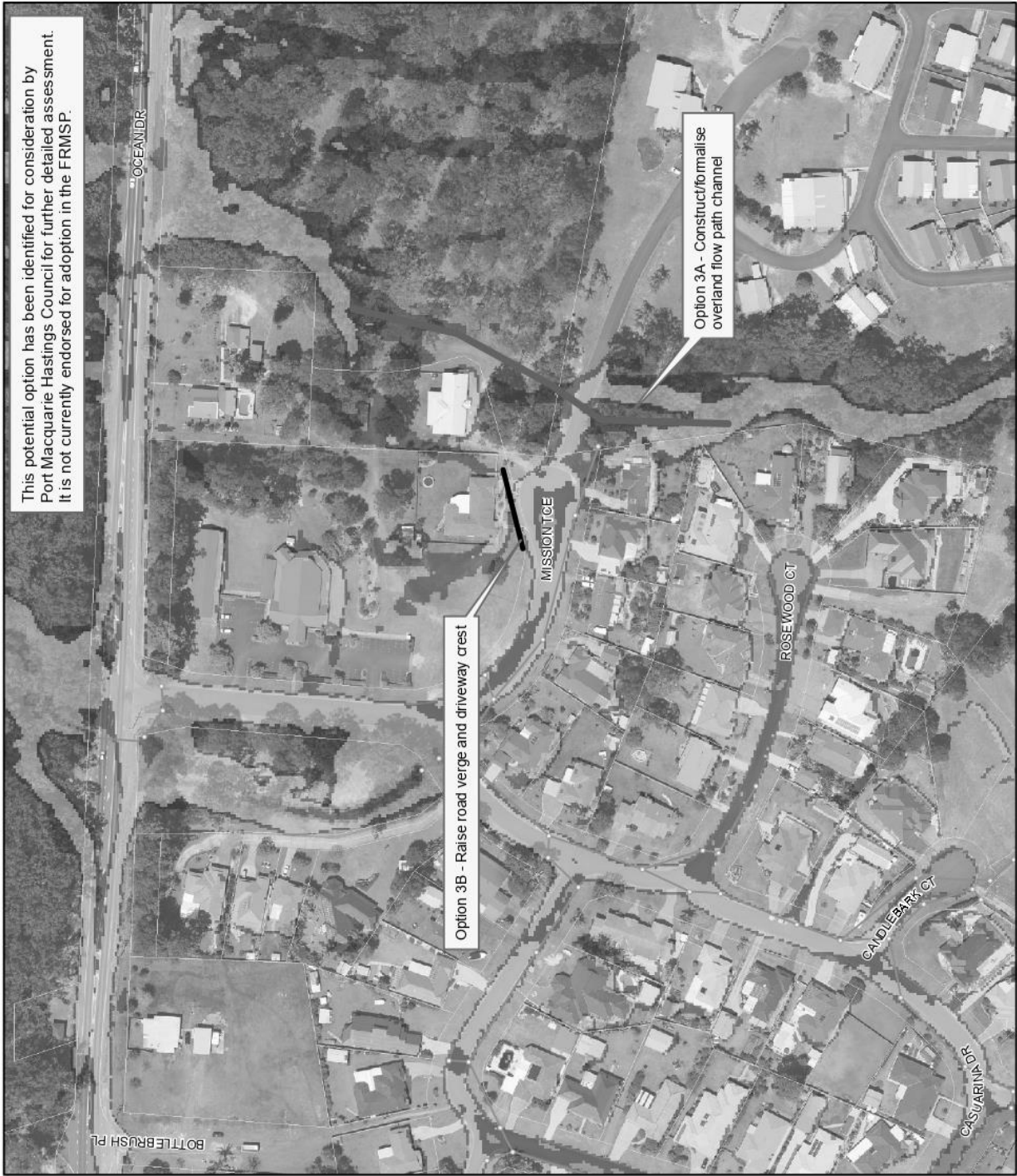
The options for this site are considered **low** priority given the number of affected properties affected by shallow flooding. However, the **priority could be raised** as the options could reduce flood damages at about two properties with above floor flooding in the 0.2EY event at relatively low cost.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
- 1% AEP Peak Flood Depth**
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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TITLE	GDA 1994 MGA Zone 56
Option 3 Mission Terrace, Lakewood Identified Options	
PROJECT	North Brother Local Catchments Flood Study
PROJECT #	MAP #
IA157500	
DATE	12/11/2019
FIGURE 3-4	



This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.

Option 3B - Raise road verge and driveway crest

Option 3A - Construct formalised overland flow path channel

3.3.5 Kirmington Terrace to Pelican Court, West Haven

This area is identified as a critical flood problem area with significant flooding of properties in Koonwarra Street, Captain Cook Bicentennial Drive villas, Ocean Drive and Pelican Court. The flood hazard is high to very high (H4, some H5) on properties and on roads in the 1% AEP event. The area is highly affected in frequent events such as the 0.2EY event.

Flooding originates from three separate overland flow paths, including one from Black Swan Terrace, a second near Kirmington Terrace and a third from near Hoschke Road. Flow paths 1 and 2 converge in Koonwarra Street and then flow path 3 converges at Pelican Court. Overland flows are about 15m³/s in flow paths 1 and 2 in total in the 1% AEP downstream of Koonwarra Street, and 20m³/s in combined flow paths 1, 2 and 3 in Pelican Court. Existing pipe flows in Pelican Court are 3m³/s in the 1% AEP event in addition to the overland flows. The existing pipes in the network run full in the 0.2EY event. Flow paths 1 and 2 affect a number of properties throughout this area.

Flow path 3 directly affects two dwellings on Ocean Drive (numbers 384 and 386) near Hoschke Road in addition to contributing to flows in Pelican Court. It includes a 2m wide drainage channel through properties on the higher side of Ocean Drive, draining to a 2.4m x 0.9m box culvert under Ocean Drive, which is the main flow constraint. The culvert conveys 3.7m³/s in the 1% AEP while another 3.7m³/s overflows over Ocean Drive. It discharges to the formed swale on the low side of the road before the flows enter Pelican Court.

Floodwaters pond in Pelican Court and overflow overland via an access road in addition to through properties to discharge to Queens Lake.

Potential Options

- Option 4A – voluntary acquisition of at least one property in Koonwarra Street (number 53, and possibly number 51) which has floodway and H5 flood hazard conditions. Regrade the site to form a flow path which should help to relieve flood conditions in the road and on adjacent properties. Consider raising the road verge on the adjacent properties to direct flows to the flow path.
- Option 4B – new additional trunk drainage line 2x 1200mm diameter pipes, intercepting flows at downstream end of channel on Captain Cook Bicentennial Drive villas, cross Ocean Drive and run under The Gateway and discharge to receiving waterway to the north of Pelican Court. This proposed pipe capacity would be approximately 5m³/s which would reduce the total overland flow in Pelican Court by about 25% in the 1% AEP event. An inlet basin/rock debris trap similar to that proposed at Black Swan Terrace would be required. Existing underground utilities in Ocean Drive and available space in The Gateway road corridor (including significance of existing vegetation in the road corridor) are likely constraints. The potential impacts to existing flooding conditions around The Gateway needs to be checked.
- Option 4C – voluntary acquisition of one property, either 7 or 9 Pelican Court, adjacent to the access road to form a larger flow path and provide additional capacity for flows out of Pelican Court sag.
- Option 4D – construct a 10,000m² flood detention basin by excavation and raising of existing berms by about 1.5m in the vegetated open space between Koonwarra Street and Ocean Drive, to the west of Captain Cook Bicentennial Drive to detain flows from flow paths 1 and 2. Points of discussion are provided below:
 - Approximately 10,000 – 15,000m³ of storage could be provided.
 - The spillway could be placed opposite the St Albans Way intersection with Ocean Drive.
 - The existing 900mm pipe crossing Captain Cook Bicentennial Drive would be upgraded to 1050 – 1200mm as the low flow pipe for the basin. Retain existing 900mm pipe draining into St Albans Way easement as a second low flow outlet.
 - Preliminary assessment in DRAINS indicates this basin could reduce flows from flow paths 1 and 2 into Pelican Court from about 15m³/s to about 7m³/s in the 1% AEP event (about 35% reduction in total flows to Pelican Court). Further sizing assessment required to confirm performance.
 - Significant area of vegetation including trees to be removed, although this is not a listed EEC.

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- The basin should not be revegetated significantly in order to allow for periodic maintenance.
 - The basin should be clay-lined to minimise collection and then infiltration of runoff into the sub-soil water flows. Similarly, the clay lining may minimise interception of groundwater flows. Geotechnical and groundwater specialist advice needs to be obtained.
 - There is a risk that the basin could redistribute overland flows to St Albans Way and cause flood impacts, if not configured properly.
 - The basin embankment would probably need to be listed as a prescribed dam under the NSW Dams Safety Act 2015, with significant engineering design, construction and maintenance required over its life.
 - A basin fully in cut could be considered as an alternative and would not be required to be listed as a prescribed dam. However, it is expected that the achievable storage volumes would be markedly reduced.
- Option 4E – duplicate the existing box culvert under Ocean Drive to the east of Pelican Court which would reduce the afflux of floodwater on the high side of Ocean Drive with benefits to two properties.

Refer to Figure 3-5 for illustration of options.

A detention basin on flow path 3 near Hoschke Road was not considered since the peak flows in that flow path are a relatively small portion of the overall flows in Pelican Court (5m³/s in the 1% AEP event, compared to 20m³/s total).

Capacity upgrade of the trunk drainage line through Pelican Court was not considered as the space in the easement is limited and additional pipes could not be fit along that alignment.

Priority

This area covers a number of identified critical flood trouble spots and the overall priority for this site is high. A combination of Options 4A to 4D should be considered. Options 4A to 4C are **high** priority. Option 4D is **medium-high** priority, with a reduced rating due to perceived construction and operation challenges of a detention basin in this location, such as provision of suitable spillway flow path through existing development and construction and maintenance of a raised basin embankment. Selection of options is to be undertaken in consultation with Council.

Option 4E is classed as a **low to medium priority** as the affected properties have elevated habitable floors but which are affected by above-floor flooding in moderate events including the 5% AEP and rarer.

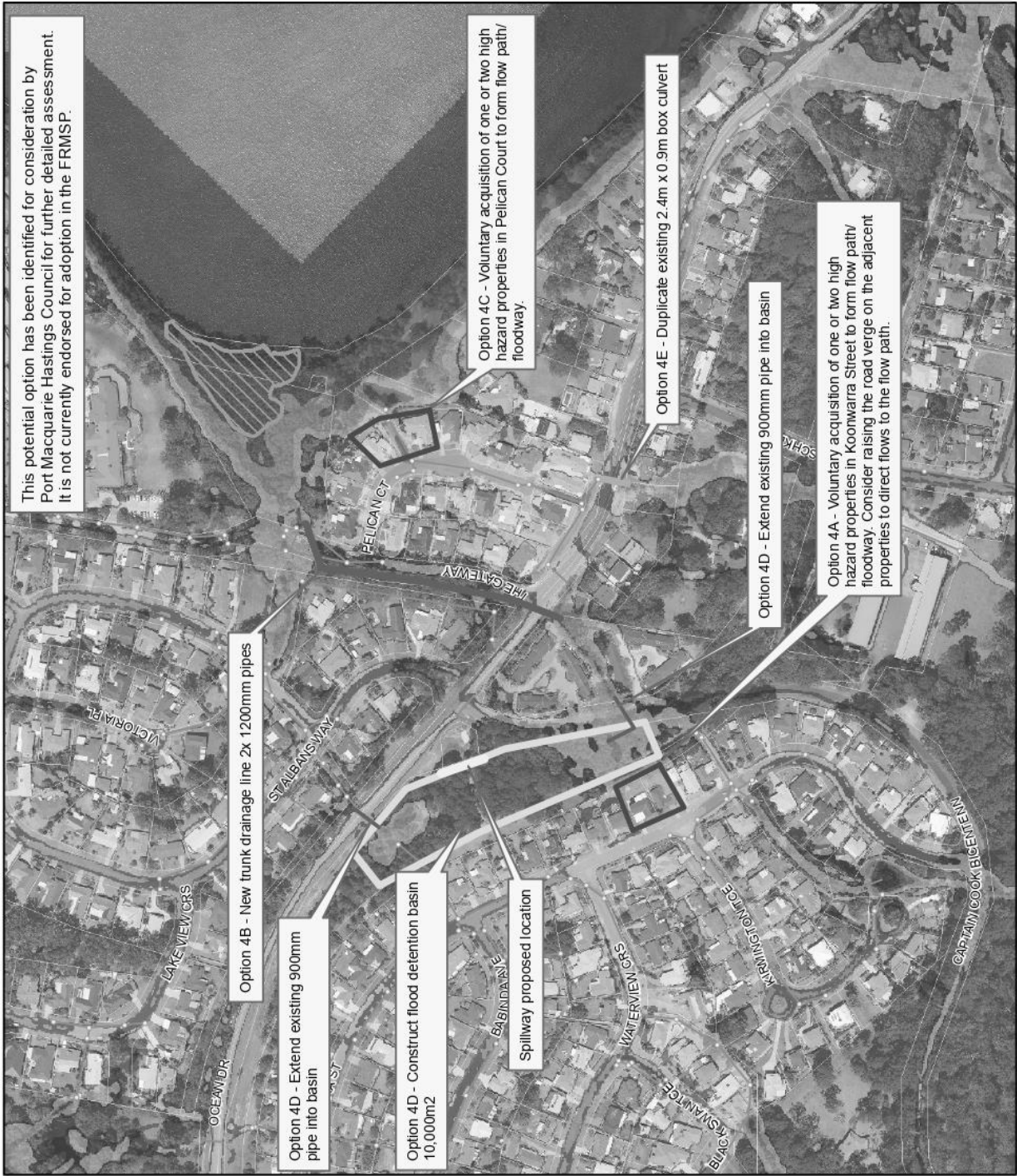
- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
- 1% AEP Peak Flood Depth**
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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TITLE	GDA 1994 MGA Zone 56
PROJECT	Option 4 Koonwarra Street to Pelican Court, West Haven Identified Options
PROJECT #	MAP #
PROJECT #	IAI 57500
DATE	12/11/2019
FIGURE 3-5	



3.3.6 Flinders Drive Estate, West Haven

The Flinders Drive residential estate is bound by flood diversion channels on its western and southern sides. The channels overflow onto a number of properties, with floodwaters then spilling onto and are conveyed in Flinders Drive. The floodwaters then flow onto other properties at the northern portion of the estate before reaching Ocean Drive. At the north-western corner of the estate the western channel cuts across the corner of two properties, affecting yards but also potentially the dwellings in the rare flood events.

The western channel conveys about 9m³/s at the upstream end in the 1% AEP event, but about 4m³/s overflows through properties. The channel corridor is quite wide so it is expected it could contain the entire flow without overflows. Similarly the southern channel carries a maximum of 3m³/s in the 1% AEP event and 1.5m³/s overflows. The western and southern channels are shallow, approximately 0.7m deep through the drainage easement around the estate and as little as 0.4m deep on properties.

There are two sag points at either end of Reliance Crescent which capture the channel overflows in addition to local runoff. The sag points overflow in events as frequent as the 0.2EY event and flood properties. The sag points are both drained by 375mm pipes.

The sag point at the northern section of Flinders Drive, to the west of Investigator Way, also overflows in events as frequent as the 0.2EY event and flood properties. The sag point is drained by a 450mm pipe.

Potential Options

- Option 5A – upgrade a section of the western channel to contain flows in up to the 1% AEP event. The channel passes through private properties on the south-western corner of the estate hence works on private property would be required. Consider rerouting the channel around the north-western corner of the estate outside of private properties to reduce their flood-affectation
- Option 5B – upgrade southern channel to contain existing flows in up to the 1% AEP event, and potentially supplement the western channel capacity. Works are outside private property. This option would direct more flows down to St Joseph's School, which is already a flood trouble spot. This option would need to be combined with drainage upgrade options at the school.
- Option 5C – upgrade Reliance Crescent eastern sag drainage from existing 375mm to a proposed 900mm pipe, including pits. Extend upgrades down Flinders Drive. Flows could be allowed to surcharge in Flinders Drive downstream of Bass Avenue. It is understood the verge and driveway has recently been raised by Council to help to contain flows in the street.
- Option 5D – new drainage line in Flinders Drive west, uphill of Reliance Drive to capture road overland flows. Turn new drainage west through easement to western diversion channel, allow to surcharge. Propose 2x 1050mm pipes and required pits to capture 5% AEP flow of 3.6m³/s.
- Option 5E - upgrade Flinders Drive northern sag drainage. Upgrade of the pipe capacity would need to extend down into Investigator Way. Existing overflows are 4m³/s in the 1% AEP event.

Refer to Figure 3-6 for illustration of options.

Rerouting the western channel around the south-western corner of the estate was not considered due to the high ground elevations and required 6m deep channel.

Priority

A combination of options 5A to 5D are recommended as **medium to high** priority for this known flood problem area. This location is not listed as a critical flood problem area. Option 5E is listed as a **low** priority.

Recommended selected order of options is from upstream to downstream and also based on relative ease of implementation. Options 5A and 5B are relatively easy channel surface works and upstream of sites. Option 5C and 5D are next in line in the downstream direction, and option 5E last in order. Sizing of options 5C to 5E are dependent on the flow reductions from the upstream options.

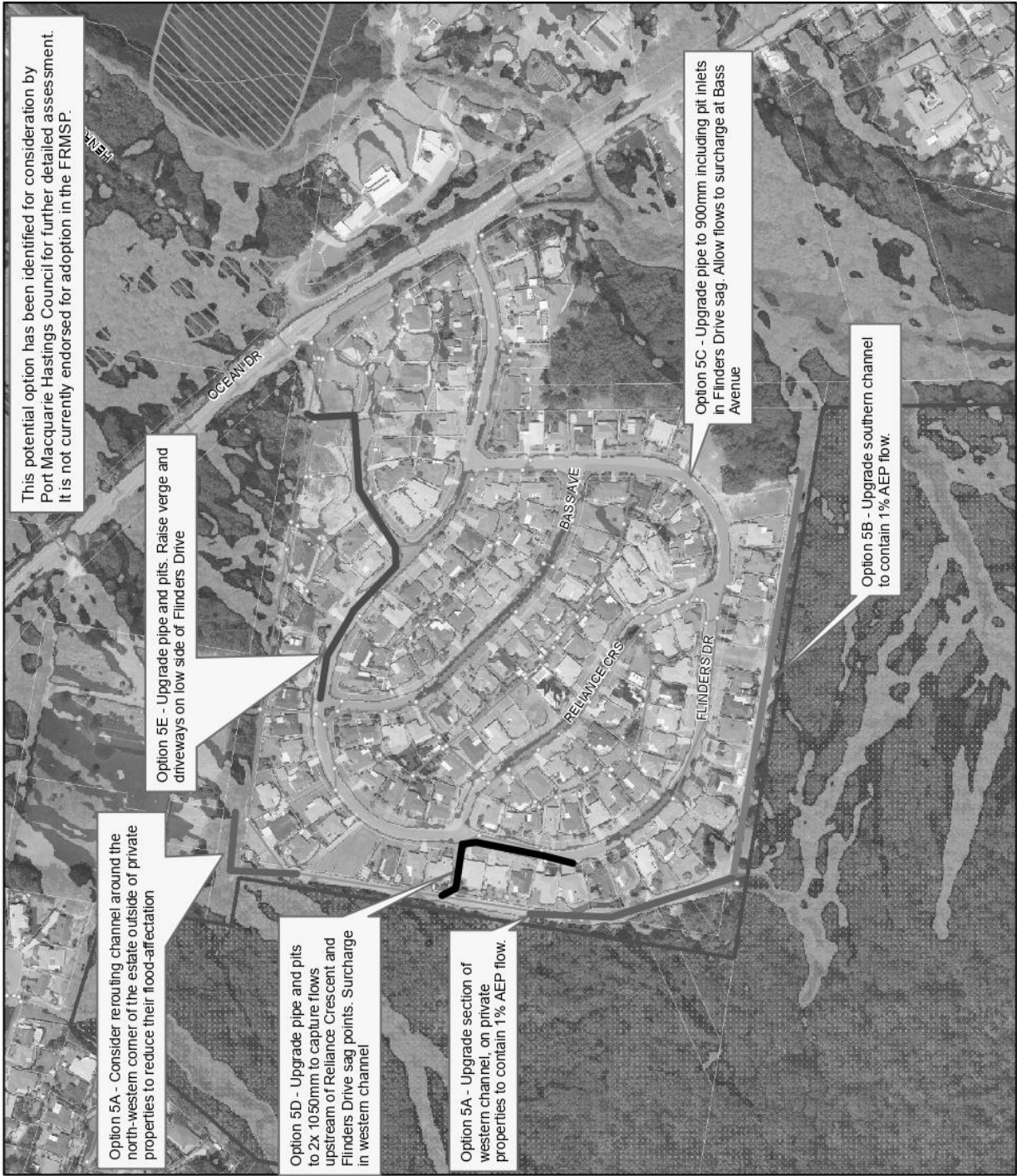
- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▣ National Park
 - ▨ EECs and SEPP14
 - 1% AEP Peak Flood Depth (m)
 - 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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TITLE	GDA 1994 MGA Zone 56
PROJECT	Option 5 Flinders Drive Estate, West Haven Identified Options
PROJECT #	MAP #
PROJECT #	IA157500
DATE	12/11/2019
FIGURE 3-6	



3.3.7 Tunis Street Overland Flow Path, Laurieton

This overland flow path originates above Blackbutt Crescent and Peach Grove, where a natural gully overflows into a constructed diversion channel which skirts around properties on Blackbutt Crescent and conveys flows through an easement to Peach Grove at Tunis Street. There is an existing low capacity pipe (375mm diameter) draining the flows in the easement to the existing drainage system. Flows in excess of the overland flow path spill out onto properties on Peach Grove and contribute to flooding at the main complex at Laurieton retirement village, although flooding at this complex is exacerbated by partially-trapped drainage low points.

The main flow path splits around Gow Place and Norman Street/Tunis Street intersection, with the northern branch flowing through the Laurieton retirement village villas and exiting around Kew Road at Castle Street, and the southern branch draining to the sag point on Bold Street at Tunis Street, and then joining a separate flow path through commercial and residential properties on Bold Street to McLennan Street.

The main stormwater drainage line consists of up to 900mm pipe in Tunis Street, draining to the river.

Overland flows in these flow paths are summarised in Table 3-1.

Table 3-1 Flood flows at Tunis Street overland flow path

Location	Event AEP		
	0.2EY	5% AEP	1% AEP
Upstream of Peach Grove	5.2	9.4	14.1
Tunis Street at Peach Grove	3.5	6.2	9.2
Gow Street branch	1.8	3.2	5.0
Tunis Street and natural gully at Lord Street	2.1	4.1	7.1

Potential Options

- Option 6A – construct/raise berm between the natural flow path and the diversion channel above Blackbutt Crescent to reduce overflows into the diversion channel and hence reduce flows through the properties downstream. However, this would increase the flows being directed toward St Josephs School, and works would need to be conducted within the national park area. Periodic maintenance may be required.
- Option 6B – increase the existing diversion channel capacity behind Blackbutt Crescent properties to reduce overflows onto properties. This could be achieved by a combination of excavating the channel, raising the banks (e.g. block retaining wall along the property boundaries) and clearing of vegetation in the channel. Works would need to be undertaken in part on national park land.
- Option 6C – construct new, or enhance existing, diversion channel behind Peach Grove properties north of Tunis Street to direct flows south to the easement at the end of Tunis Street. This is outside of the national park.
- Option 6D – install new trunk drainage line from the easement down Tunis Street to discharge to the river. A system capacity of approximately 5% AEP (about 9.5m³/s) would require a box culvert 3m x 1.2m, or 3 x 1.35m diameter pipes, and would reduce the 1% AEP overland flows through downstream properties by about 67% which would result in similar flooding to the 0.2EY event, although there would still be flooding

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on Gow Place properties and retirement village villas to depths of up to 0.5m. Increasing the capacity to 1% AEP could be considered. There are potential clashes with existing underground utilities in Bold Street, and there would be disruptions to traffic in Bold Street during construction including trucks delivering to Coles Supermarket. A rock debris trap/basin would need to be constructed at the trunk drainage inlet to reduce the inlet blockage risk.

- Option 6E – upgrade drainage in Gow Place cul-de-sac and raise road verge and driveways to reduce overflows through properties and the retirement village villas. The existing drainage consists of a 450mm pipe which drains through an easement and discharges to open space between Gow Place and Tunis Street. However, this would discharge more flows onto non-residential properties (service station/mechanic, café) on Kew Road/Bold Street at Tunis Street. A connection to the new trunk drainage line or a separate parallel line could be installed to run down Tunis Street to mitigate the increased flows onto these non-residential properties. This overall option would be a secondary measure and would need to be installed following Option 6D. Sizing depends on upstream measures.

Refer to Figure 3-7 for illustration of options.

Priority

This is not identified as a critical flood problem area as there are generally no high hazard flows on properties, although there are dwellings with above-floor flooding in the 0.2EY event. It has a general medium priority.

Option 6A has a **low** priority due to potential impacts from redistribution of flows, increased mitigation requirements elsewhere, in addition to significant works required within the national park.

Options 6B to 6E have **medium-high** priority for protection of properties with frequent above-floor flooding (0.2EY event). Option 6D is expected to have high implementation cost, which may reduce its feasibility and priority.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
- 1% AEP Peak Flood Depth (m)**
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make any representations regarding the currency and accuracy of information contained in this map.

TITLE	GDA 1994 MGA Zone 56
Option 6 Tunis Street Flow Path, Laurieion Identified Options	
PROJECT	North Brother Local Catchments Flood Study
PROJECT #	MAP #
IA157500	
DATE	12/11/2019

FIGURE 3-7



3.3.8 Quarry Way Overland Flow Path, Laurieton

This flow path originates above Quarry Way and Laurie Street, with a main diversion channel overflowing to a second minor channel at the back of properties on Quarry Way. The main channel is reported to be blocked by debris which is a main cause of the overflows. The overland flows are conveyed in Quarry Way, then through open space to Seymour Street and Lord Street and onto and through Laurieton Hotel. Flows then continue through residential and commercial properties to McLennan Street, joining flows from the Tunis Street flow path,

There are existing trunk drainage pipes and connected street drainage network in Seymour Street consisting of up to two 1.2m diameter pipes which discharge into the open channel on the property at the corner of Lake Street and Seymour Street, which is also a critical flood problem site.

The road verge in Lord Street already has a raised berm constructed to help direct water into the existing stormwater pits and reduce overflows into the Laurieton Hotel. There is existing grassed open space uphill of the hotel which could be used for flood mitigation infrastructure e.g. trunk drainage inlet works.

Overland flows in these flow paths are summarised in Table 3-2.

Table 3-2 Flood flows in Quarry Way overland flow path

Location	Event AEP		
	0.2EY	5% AEP	1% AEP
In Quarry Way	2.2	3.3	4.6
Peach Grove at Quarry Way	2.5	4.3	6.0
Lord Street	2.2	4.5	6.5
Bold Street near Seymour Street	2.3	5.3	7.5

Potential Options

- Option 7A – remove blockages from diversion channel, upgrade main and secondary channels to reduce overflows onto Quarry Way properties. Works will be in the national park. Additional flows (3.5m³/s) would be directed to the natural flow path south of Laurie Street, which drains towards Harbourside Crescent villas, another problem area. Additional mitigation may be required at that site (refer to Section 3.3.11).
- Option 7B – new trunk drainage line from Norman Street down Seymour Street, discharging to the river. This would need to replace, and provide capacity in addition to the existing trunk drainage in Seymour Street (up to two existing 1.2m pipes carrying about 4m³/s). Total capacity of close to the 1% AEP event would be ideal as properties are significantly flood-affected in even the 0.2EY event. Indicative sizing of 3.6m x 1.2m box culvert would have sufficient capacity for approximately the 1% AEP total flow (if Option 7A not implemented). Inlets to the trunk drainage line would be required in Lord Street sag, Laurieton Hotel rear car park and Bold Street, by upgrading the existing street drainage. The grassed area immediately west of the Laurieton Hotel rear car park could be used for large inlet works. Note that there appears to be minimal street drainage on the eastern side of Bold Street, north of Seymour Street, which contributes to the flooding issues.

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- Option 7C – provide drainage in Bold Street eastern side to direct flows into Seymour Street drainage line. There is currently limited drainage in Bold Street.
- Option 7D – localised flood-proofing such as concealed or inflatable flood barriers could be installed at the rear of the Laurieton Hotel to prevent floodwaters from entering the building itself, and directing it through the bottle shop drive-through. Inspection of the site is required to assess feasibility.

Refer to Figure 3-8 for illustration of options.

Priority

This area includes a number of critical flood problem locations/properties and is rated as overall high priority.

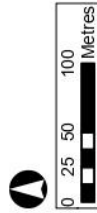
Option 7A has **medium-high** priority for improvement to flooding on properties with frequent above-floor flooding (0.2EY event). No high hazard flooding on these properties.

Option 7B is **medium-high** priority, based on management of significant overland flow path through main developed area of the study area. Potential to significantly improve flooding on a high number of properties including critical properties. However, the high cost of this option is likely to reduce its feasibility.

Option 7C is rated as **low-medium** priority, with main benefits to a number of commercial properties with above-floor flooding in the 2% AEP event, and potentially minor benefits to other downstream properties. Need for this option may be negated if Option 7B is implemented.

Option 7D is rated as **medium** priority as benefits are localised to one commercial property. The rating is elevated from low-medium due to potential co-funding from Laurieton Hotel owners.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
- 1% AEP Peak Flood Depth (m)
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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TITLE	GDA 1994 MGA Zone 56
Option 7 Quarry Way Flow Path, Laurieton Identified Options	
PROJECT	North Brother Local Catchments Flood Study
PROJECT #	MAP #
IAI 57500	
DATE	13/11/2019

FIGURE 3-8



3.3.9 Lake Street at Seymour Street, Laurieton

The corner property at this location receives overland flows and trunk drainage flows from the Quarry Way flow path. There is an open channel and flow path through this property, where the dwelling is surrounded by high hazard flooding to depths of over 1m in the 1% AEP event. The floodwaters pond behind the raised road crest in Lake Street before overflowing over the road and around the southern side of the Laurieton United Services Club. It is identified as being affected by above-floor flooding.

The drainage at this location includes 2x 1.5m x 0.75m box culverts at the inlet at the downstream end of the channel through this property, turning into 2x 1200mm pipes crossing Lake Street, which then increase to 2x 1500mm pipes on the low side of the road and discharging to a channel on the southern side of the Services Club.

Flood mitigation works proposed for the Quarry Way flow path as described in Section 3.3.8 would mitigate flooding at this location. Further works could be provided for additional mitigation.

Potential Options

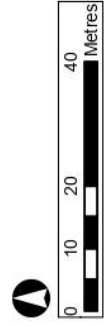
- Option 8A – upgrade culverts crossing Lake Street up to 2x 1500mm pipe or equivalent, to match the outlet pipe capacity.
- Option 8B – the culvert inlet is currently unscreened and has been modelled as 50% blocked due to likely debris blockage. A large-faced screen and other debris controls could be installed to reduce the risk of blockage. Could be used to retrofit existing culvert or improve proposed culvert upgrade.
- Option 8C – regrade (lower) the road verge on eastern side of Lake Street to allow road sag to drain more freely. Create a new or widen the existing flow path from the road and down the southern side of the Services Club. There are existing utilities associated with the Club in this location which are surrounded by a block wall structure and which could not be identified from site photos. Relocation of these utilities and lowering the ground in this area would allow water to flow off the road more freely, in addition to directing flows away from the Club's understorey car park.

Refer to Figure 3-9 for illustration of options.

Priority

This site is identified as a critical flood problem location and is rated as a high priority. Option 8B is rated as **high** priority for assessment. Options 8A and 8C are rated as a **low** priority for assessment due to high cost and with the main benefit is to a commercial property with no above-floor flooding in up to and including the 1% AEP event.

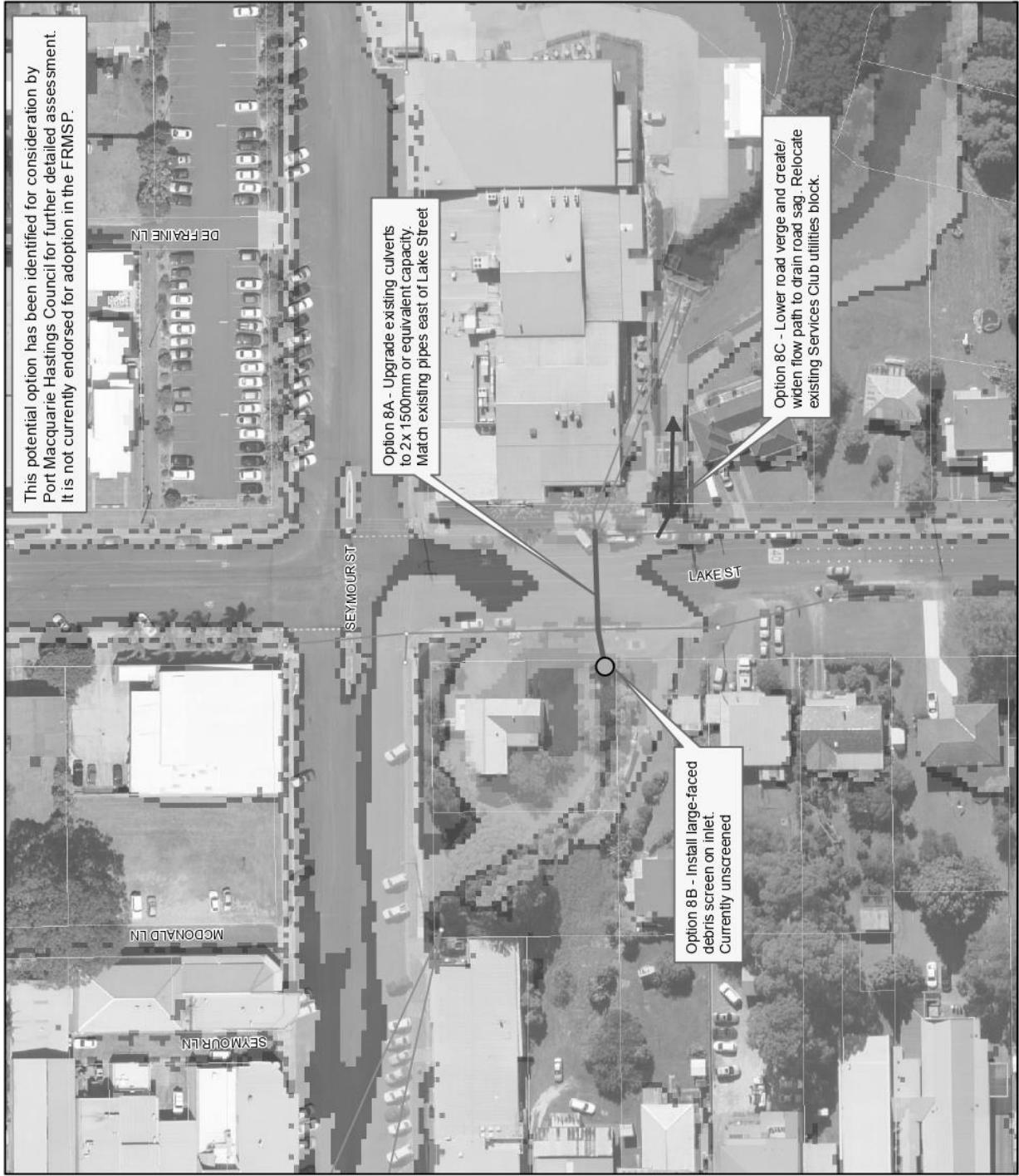
- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
 - 1% AEP Peak Flood Depth (m)
 - 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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TITLE	GDA 1994 MGA Zone 56
PROJECT	Option 8 Lake Street at Seymour Street, Laurieton Identified Options
PROJECT #	MAP #
PROJECT #	IA157500
DATE	12/11/2019
FIGURE 3-9	



3.3.10 St Joseph’s School, Laurieton

Flooding at the school results from natural flow paths being directed down to Ocean Drive to three culvert crossings. The culverts discharge on the low side of the road and along with road overflows, overland flooding passes through the school in three main flow paths, including one through the main cluster of school administration and classroom buildings. There is no existing underground trunk drainage conveying flows through the school grounds. Flows exceed 0.5m deep in the 1% AEP event with areas of very high (H5) flood hazard.

Overland flows in these flow paths are summarised in Table 3-3.

Table 3-3 Flood flows in overland flow paths at St Joseph’s School

Location	Event AEP		
	0.2EY	5% AEP	1% AEP
Northern flow path (admin bldg.)	4	5.5	8
Middle flow path	5.5	6.5	8.5
Southern flow path	8.5	10	12.5
Total	17.5	22	29

Potential Options

- Option 9A – provide underground box culvert trunk drainage through the school. Approximately 2x 3m x 1.2m box culverts would have capacity to convey the 1% AEP flows in the middle and southern flow path. The southern flow path and road cross culvert is the main flow path and there is a formalised open channel provided for this flow path. It appears preferable and least disruptive to the school grounds to install the culverts in/along the southern flow path as there is a wider corridor between existing buildings. However, the open channel and its banks appear to be landscaped with well-established gardens, which are likely to be of high value to the school and adjacent church. Alternatively, widening the existing channel could be considered. Further investigation required to check for clashes with existing buildings.
- Option 9B – alternatively, the box culverts could be placed in the middle flow path, since the southern flow path open channel has nearly sufficient capacity for 1% AEP flows conveyed in that channel. Additionally, the road cross culvert for the middle flow path is actually at lower elevation than the southern flow path/ culvert, and it may be possible to capture more of the road overflow as this is a lower point of the road compared to the southern flow path. The existing middle flow path through the school is relatively low (less than 3m AHD ground surface) and would need to be back-filled to provide cover over the culvert. This would mean loss of an overland flow path or replacement with a lower capacity one. The culverts would need to be fit between existing school buildings.
- Option 9C – upgrade and extend the northern road cross culvert by 160m to discharge to the area behind the school. This existing 1.5m x 0.6m culvert does not appear to be connected to internal school drainage, or, the school drainage is unlikely to have sufficient capacity for this culver flow. The culvert currently conveys only 1.5m³/s and could be upgraded to carry higher flows to protect the school administration building and adjacent buildings. Sizing would depend on the performance of Options 9A or 9B. Indicative sizing for existing flows is 3m x 1.2m box culvert. There are possible impacts to EEC/SEPP14 wetlands, as a new tail-out channel may need to be excavated to discharge to the downstream lake.

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Both Option 9A and 9B would require a constructed inlet basin as a rock debris trap at their inlets. There are existing underground utilities and telegraph poles on the southern side of Ocean Drive which need to be considered with the upgrade of road cross culverts. A number of trees and existing pavement in the school car park and grounds would need to be removed and replaced.

Expanding the existing southern flow path channel through the school to convey the southern/middle flow path flood flows was not considered in detail. The channel would need to be widened by approximately 60% to convey the 1% AEP flows and there appear to be space constraints on the site with existing buildings, car parks etc. However, further assessment could be made if requested. The road culvert crossing would also need to be upgraded.

Refer to Figure 3-10 for illustration of options.

Priority

This location is a high priority site for mitigation given its known historic flooding problems and susceptibility of its occupants (i.e. primary school children).

Option 9A or 9B (both **high priority**) should be trialled first before trialling of Option 9C (**medium-high priority**) if additional flow conveyance capacity is required.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
 - 1% AEP Peak Flood Depth (m)
 - 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



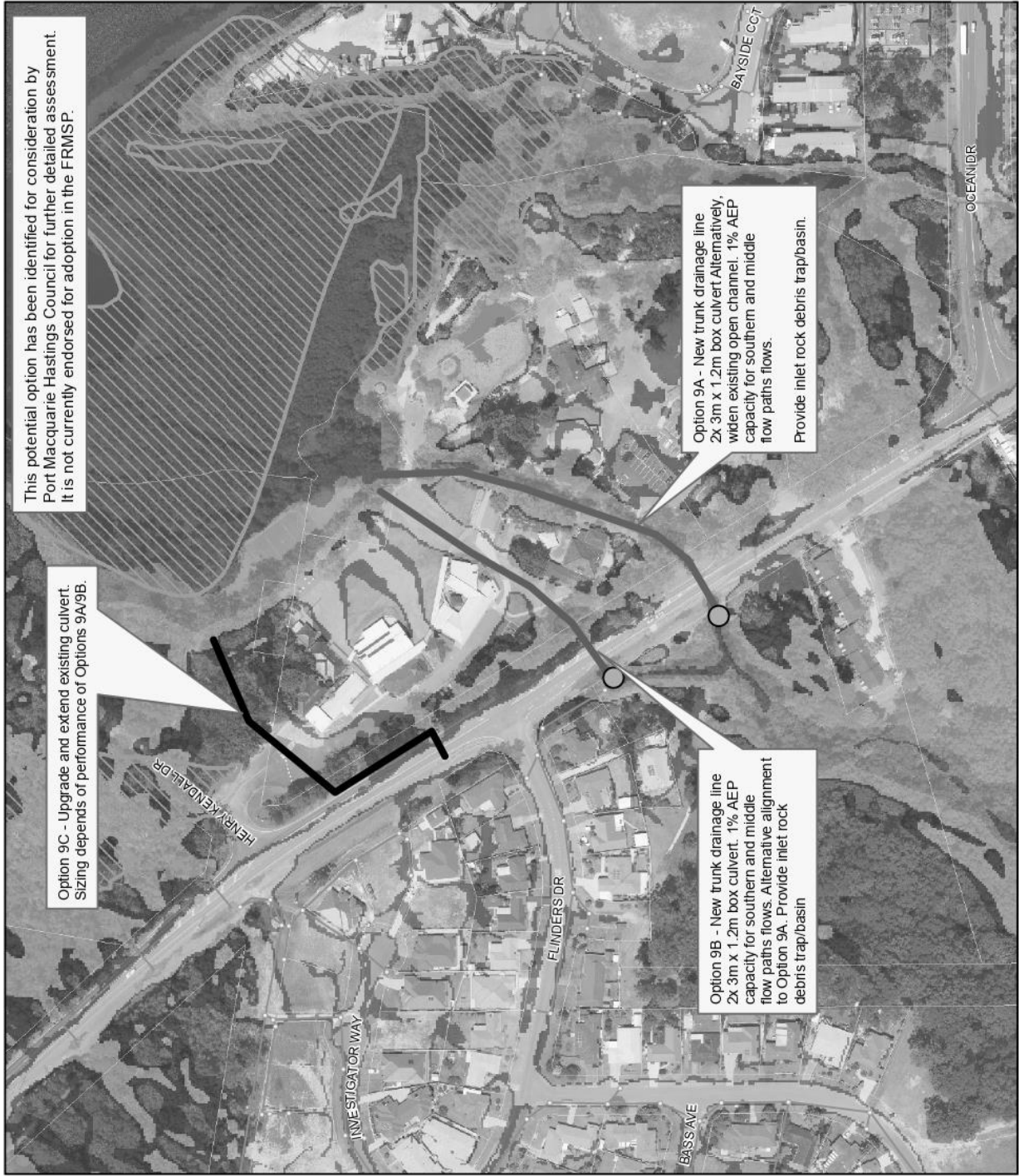
Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make a representation regarding the currency and accuracy of information contained in this map.

TITLE
Option 9 St Joseph's School,
Laurieton
Identified Options

PROJECT
North Brother Local Catchments
Flood Study

PROJECT # / MAP #
IA157500 /
DATE
9/12/2019

FIGURE 3-10



3.3.11 Harbourside Crescent Villas and Bold Street, Laurieton

This property is listed as the Stockland Camden View Retirement Village and is located adjacent to a major natural overland flow path which flows down from North Brother Mountain, crossing Bold Street via an existing 1500mm diameter pipe as well as over the road crossing. The flows discharge into an 8m wide open channel which then discharges to the river. Flooding over Bold Street is significant with 0.2EY event flood depths over 0.5m and 1% AEP event flood depths of 0.6 – 0.8m and a very high H5 hazard rating. While this site is along the Camden Haven River, it is situated above the current climate 1% AEP mainstream flood level (about 3m AHD). Parts of the site would be affected by the 1% AEP mainstream flood level (about 3.8m AHD) under future climate change scenario.

Flood flows in these flow paths are summarised in Table 3-4.

Table 3-4 Flood flows at Harbourside Crescent Villas and Bold Street

Location	Event AEP		
	0.2EY	5% AEP	1% AEP
Pipe crossing of Bold Street	4	4	4
Bold Street overflows	11	18	27
Total	15	22	31

The existing open channel is either unlined or shotcrete-lined with some sparse vegetation on its base and tree/shrub vegetation on its banks. It appears to have sufficient capacity to convey the 1% AEP flow, but floodwaters overtopping Bold Street bypass around the upstream side of the channel and flow onto the Harbourside Crescent villas, causing above-floor flooding in the 0.2EY event and rarer.

Potential Options

- Option 10A – upgrade Bold Street cross drainage pipe with 2x 3m x 1.5m box culverts. This should have capacity for over the 5% AEP event flow. A large screened inlet or other vegetation debris control should be considered. The existing inlet is unscreened. A constructed inlet basin as a rock debris trap at the culvert inlet should be considered depending on expected rock debris loads in flood flows. The site is located some distance from the foot of North Brother Mountain and rock debris loads may be deposited further upstream.
- Option 10B – install block wall up to 1m high along property boundary on low side of Bold Street, north of open channel, to reduce overflows onto Harbourside Crescent villas property and direct road overflows into the open channel. The wall may need to extend onto the property along the bank of the channel to focus the flows into the channel. There is an existing concrete wall along this side of the channel which may need to be raised and/or extended.

Refer to Figure 3-11 for illustration of options.

Priority

This location is listed as a critical site for property and road flooding due to high depths of flooding and high hazard on property and hence is rated as a high priority location. Option 10A is rated as **high** priority for assessment while Option 10B is a **medium-high** priority for assessment due to potential upstream flood impacts.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
- 1% AEP Peak Flood Depth (m)
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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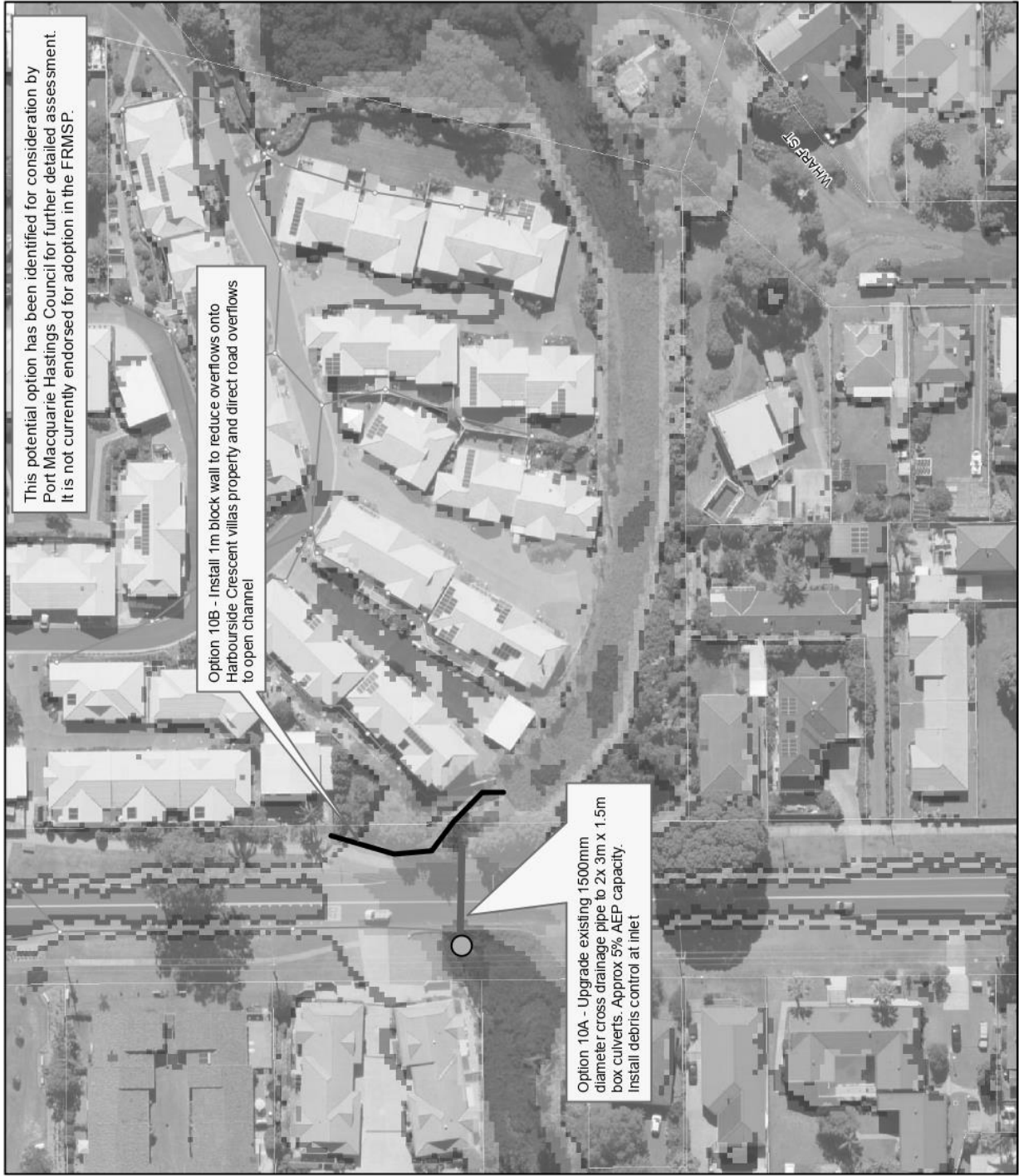
TITLE
GDA 1994 MGA Zone 56

Option 10 Harbourside Crescent Villas and Bold Street, Laurieton Identified Options

PROJECT
North Brother Local Catchments Flood Study

PROJECT # | MAP #
IA157500
DATE
12/11/2019

FIGURE 3-11



3.3.12 Norman Street and Mill Street, Laurieton

Overland flows are directed onto residential properties on Norman Street and Mill Street due to a fire trail crossing a natural gully in the bushland to the west of this site. Flows in excess of the fire trail culvert crossing are conveyed down and along the fire trail and onto the residential area. Properties are affected by over-floor flooding in the 0.2EY event and this is a known problem area with previous reports from residents. Flows are around 5.5m³/s in the 1% AEP event.

Potential Options

- Option 11A – construct a diversion channel through the bushland to direct flows in up to the 1% AEP event from the fire trail to a second natural gully to the south near Hanley Street. Regrade fire trail to redirect flows into channel. These works are not within the national park. This would increase flows in the Hanley Street flow path by about 25% from existing. Flood flows are generally contained within the Hanley Street flow path, but the proposed case flows would need to be monitored for increases in flood levels and resultant above-floor flooding on properties downstream.

Refer to Figure 3-12 for illustration of options.

Retaining the overflows in the original gully is not considered, as this gully flow down to the Harbourside Crescent villas location, which already experiences flooding problems.

Priority

This is listed as a **medium** priority location and option. It is not a critical flood area due to lower flood hazard on properties but is a previously reported overland flow problem site.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
 - 1% AEP Peak Flood Depth (m)
 - 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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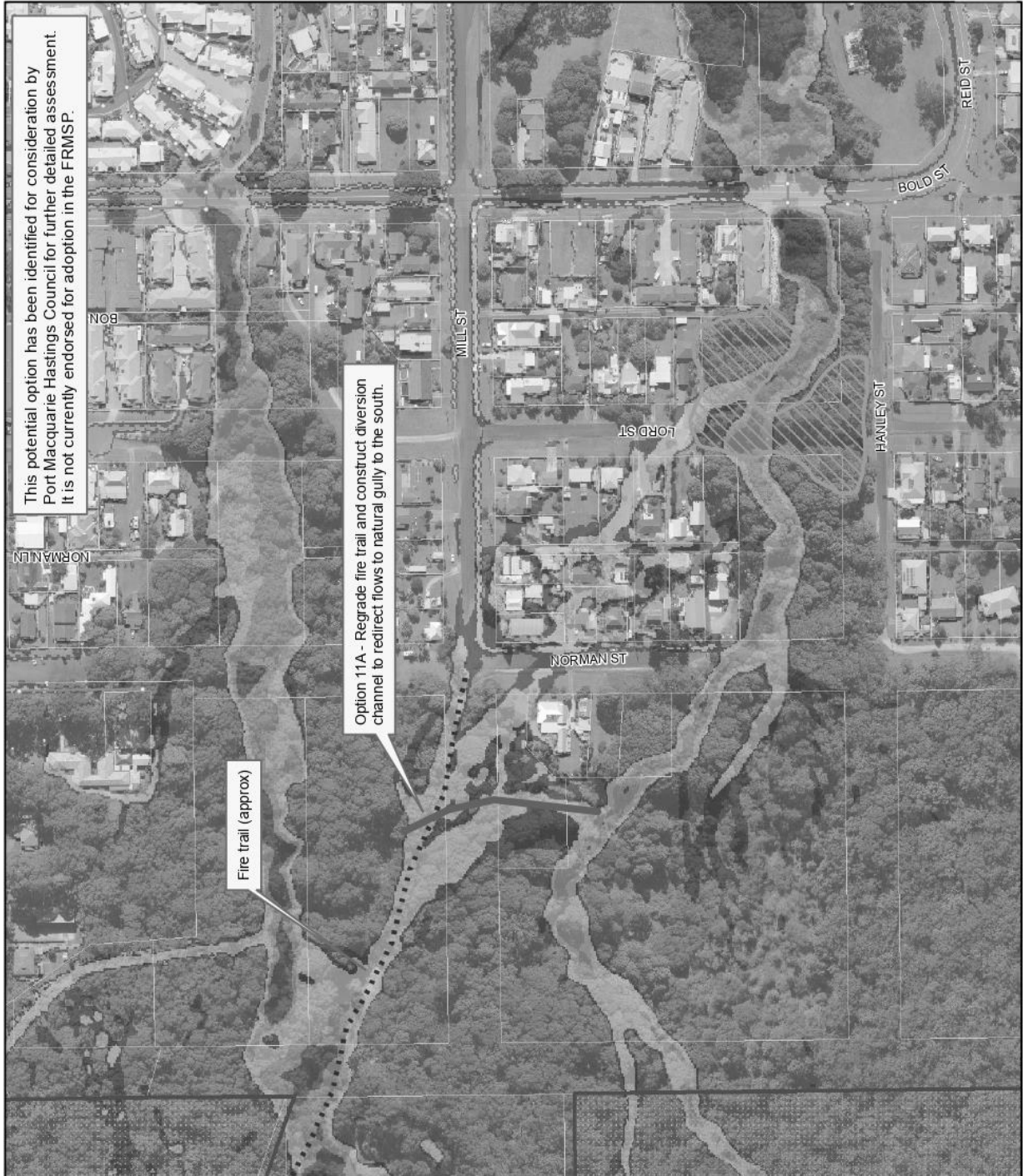
TITLE
GDA 1994 MGA Zone 56

Option 11 Norman Street and Mill Street, Laurieton Identified Options

PROJECT
North Brother Local Catchments Flood Study

PROJECT # | MAP #
IA157500 |
DATE |
12/11/2019

FIGURE 3-12



3.3.13 Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood

Flooding occurs to depths on properties of 0.3 – 0.5m in the 1% AEP event, as a result of floodwaters ponding in the roads. There are three main ponding areas, one in each of these roads. There is one property with above-floor flooding in the 0.2EY event in Mahogany Close and three on Sirius Drive. The road sag elevations are low, down to 2.4m AHD which presents challenges with drainage considering high tailwater levels, particularly in a future climate change scenario.

The Honeysuckle Avenue and Mahogany Close sag points are drained by two 450mm pipes and a 375mm pipe, respectively. Property ground levels are built up to 3.0 – 3.1m AHD, typically, which prevents free surface drainage of the sag to the downstream waterway. The 450mm pipes draining Honeysuckle Avenue run through properties, while the 375mm pipe draining Mahogany Close runs through an easement. A levee was proposed as a recommended measure in the Camden Haven Floodplain Risk Management Plan (Bewsher Consulting, 2004), to be installed behind the properties in this location, refer to Section 2.8 of the FRMP report. Overland flood mitigation measures should have consideration of the function of this proposed levee, which may be constructed in the future. The flooding at this location may benefit from mitigation works upstream, at Ringtail Close (see Section 3.3.2).

The Sirius Drive sag is a major sag point with depths of flooding in the road over 1m in the 1% AEP event and affecting a number of properties with above-floor flooding in addition to flooding of other streets. The sag is drained by 2x 1050mm pipes through a 4m wide easement. The easement ground level is built up to 3.3m AHD.

The site is affected by the current climate 1% AEP mainstream flood level, and would also be affected in the future climate change scenario.

Potential Options

- Option 12A – upgrade existing pipes in Honeysuckle Avenue and Mahogany Close including through properties. Sizes of up to 750mm diameter are suggested. Pit inlet capacities including additional street pits would be required. Works through properties would be disruptive to the residents. One-way flap gate at outlet to prevent backwater flooding through drainage pipes. Duplication of existing pipes was considered but given the small existing pipe sizes would not provide a significant increase in capacity.
- Option 12B – upgrade existing pipes draining Sirius Drive. Installing a 2.4m x 1.2m box culvert would increase drainage capacity by about 67%. A 3m x 1.2m culvert would more than double the capacity but works would likely extend onto properties. Additional pits or drainage network upgrades would be required. Lower the ground level in the easement to 3.1m AHD. One-way flap gate at outlet to prevent backwater flooding through drainage pipes. Installation of an additional 1050mm pipe to the existing twin pipes could be considered if there is sufficient space.

The option of running an upgraded pipe line from Honeysuckle Avenue sag down to Mahogany Close and out through the easement, a distance of 240m, was initially considered. However, given the low ground elevations there would not be sufficient fall or grade for such a pipe. Assuming the existing outlet level of 1m AHD, the 240m run at 0.5% grade would result in an upstream invert level of 2.2m AHD, which is near the surface level. Lowering the outlet level and a flatter pipe grade of 0.3% could be considered.

Purchase of properties to create a floodway to drain the sag points via the surface would relieve flood levels in the roads but is likely to be prohibitively costly. The properties are not high hazard in the 1% AEP and would not qualify for funding through NSW Government voluntary purchase scheme.

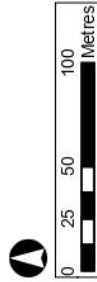
Refer to Figure 3-13 for illustration of options.

Priority

This site is listed as a **medium priority**. It is not listed as a critical location for property flooding in Section 2.1.

Option 12B should be considered first priority due to the greater flood depths and higher flood impacts to adjacent properties.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▣ National Park
 - ▣ EECs and SEPP14
 - 1% AEP Peak Flood Depth (m)
 - 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



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GDA 1994 MGA Zone 56

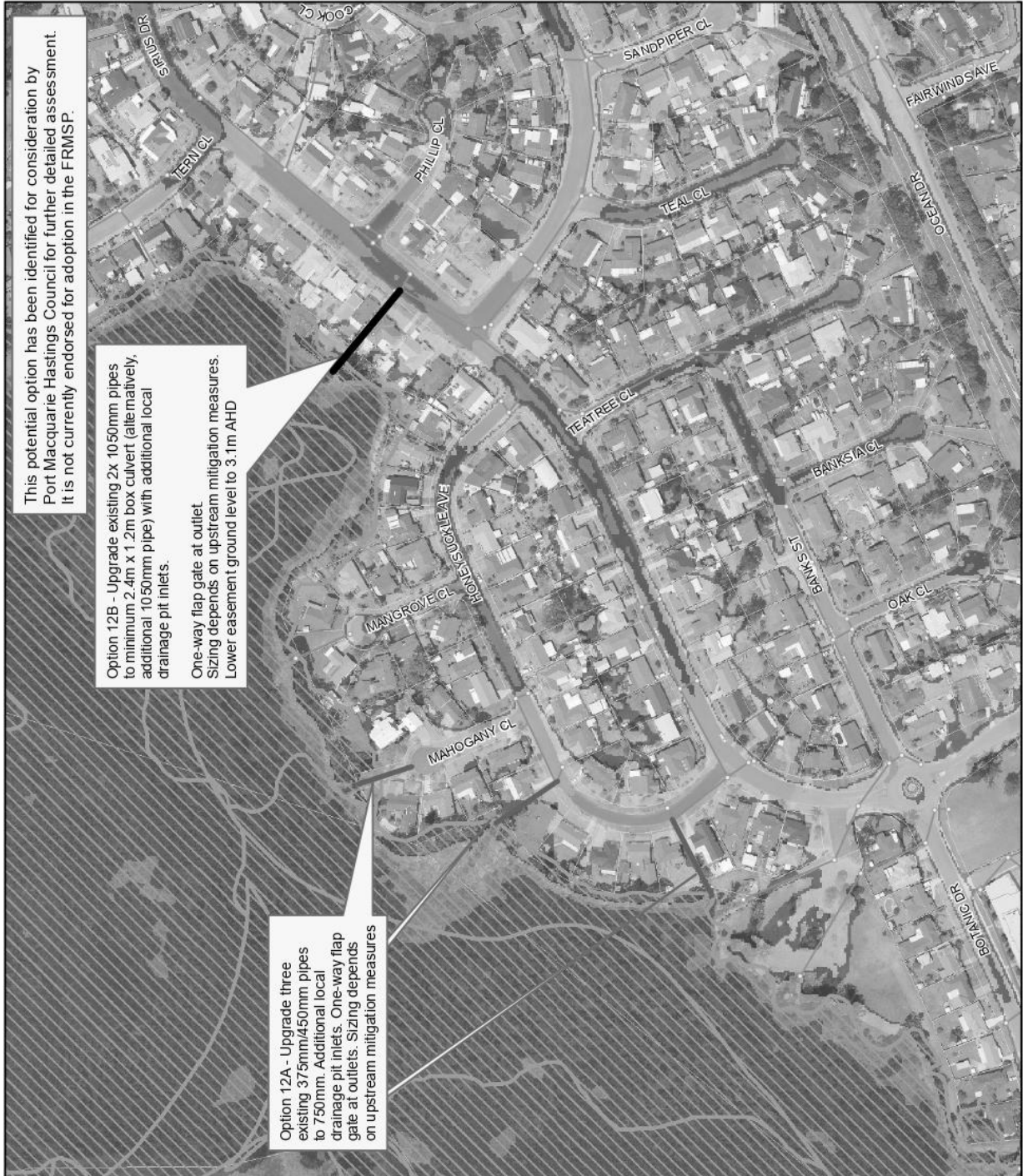
TITLE
Option 12 Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood

Identified Options

PROJECT
North Brother Local Catchments Flood Study

PROJECT # | MAP #
IA157500
DATE
9/12/2019

FIGURE 3-13



3.3.14 Elouera Place, West Haven

Two dwellings are affected with above-floor flooding in the 0.2EY event with an additional two properties in the 5% AEP event due to overflows from a natural gully spilling onto the properties. The total flow is 11m³/s in the 1% AEP event with about 6.5m³/s overflowing through properties. There is an existing diversion channel upstream of properties on the south side of the cul-de-sac but this is only 2m wide and shallow.

The existing culvert crossing Elouera Place is a 2x 0.9m x 0.6m culvert. Overflows over the road affect two properties with above-floor flooding in the 5% AEP event.

Potential Options

- Option 13A – construct/upgrade diversion channel approx. 7m wide and 1m deep along high side of properties in the bushland/open space area. Discharge to the area to the east, which is where the existing overland flows through the properties is currently conveyed to. Potential downstream flood impacts need to be confirmed.
- Option 13B – upgrade the road cross culvert to reduce road overflows onto properties. It may be possible to fit 2x 1.8m x 1.2m culverts which would have about 1% AEP capacity. An inlet debris screen or other debris control should be installed. Potential downstream flood impacts need to be confirmed.

Refer to Figure 3-14 for illustration of options.

Priority

This site is not identified as a critical flood problem location. There are only localised patches of high hazard flooding in the 1% AEP event. The site is rated with a medium priority due to presence of dwellings with frequent above-floor flooding. Option 13A has a **medium** priority due to potentially lower cost and potential benefits to four properties (two with above-floor flooding in the 0.2EY event). Option 13B has a **low** priority due to potential effectiveness of Option 13A upstream, and benefit to only two properties.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▭ National Park
 - ▨ EECs and SEPP14
- 1% AEP Peak Flood Depth (m)**
- 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



JACOBS

Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make any representations regarding the currency and accuracy of information contained in this map.

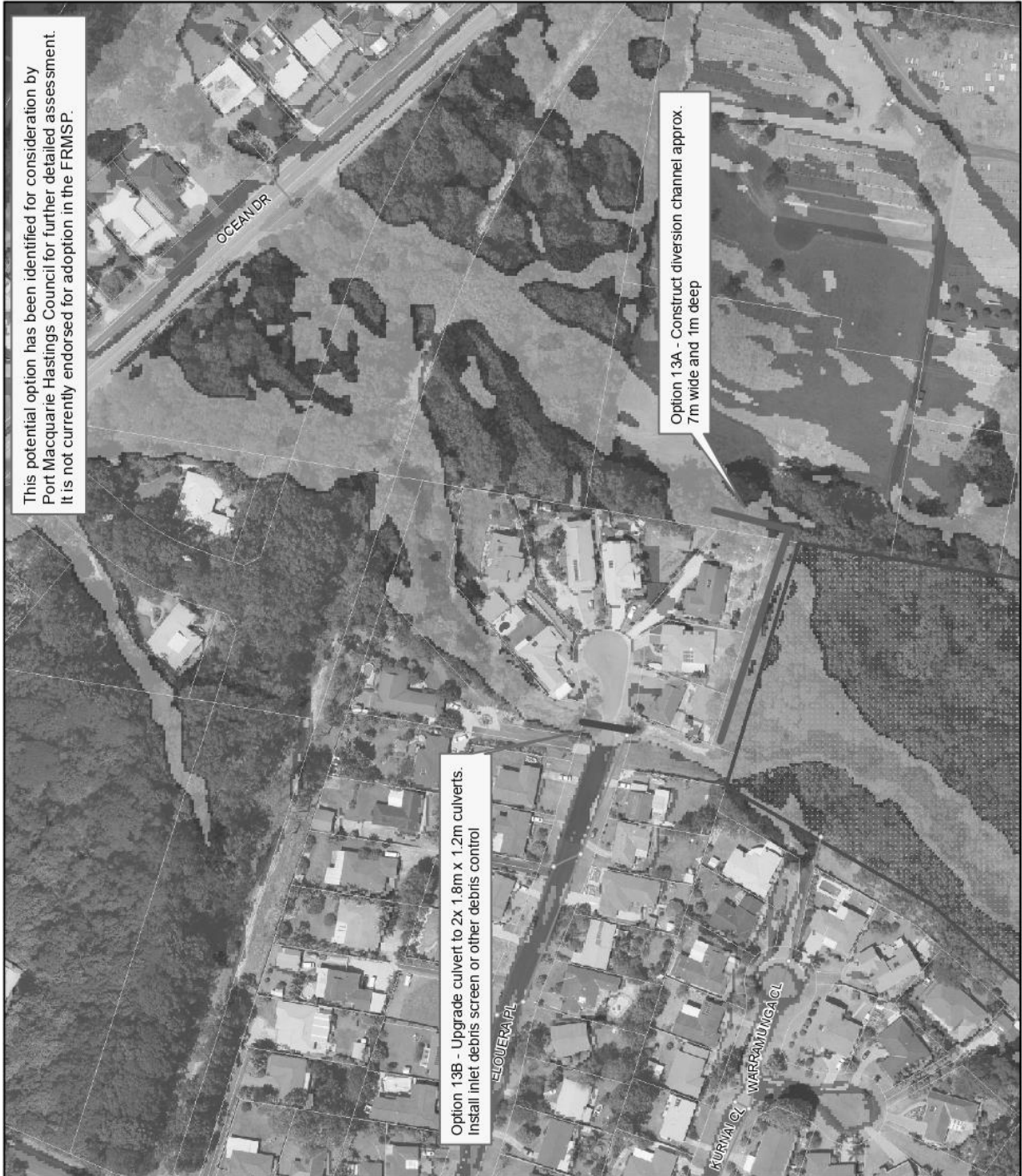
TITLE
GDA 1994 MGA Zone 56

Option 13 Elouera Place,
West Haven
Identified Options

PROJECT
North Brother Local Catchments
Flood Study

PROJECT # | MAP #
IA157500 |
DATE |
12/11/2019 |

FIGURE 3-14



3.3.15 Sandpiper Close, Lakewood

Flooding has historically occurred on these properties due to the existing concrete rectangular channel capacity being exceeded, allowing floodwater to overflow into the yards and buildings on properties. The existing concrete box section of the channel is about 1.8m wide and 0.6m deep, with a low earth berm on the lower side up to about 0.3m high. The channel capacity is about 1.6m³/s while the overflow onto properties is about 1.2 m³/s in the 0.2EY event, 4m³/s in the 5% AEP event and 5.5m³/s in the 1% AEP event. There is a 6m setback between the existing channel bank and the property boundary. A number of properties are flooded above-floor in the 0.2EY event.

Potential Options

- Option 14A – reconstruct the concrete channel to convey the 5% AEP flow, including widening and deepening the channel. A box section 4m wide x 1.2m would have about the 5% AEP capacity and reduce the 1% AEP overflows onto properties by about 70%. Tail-out works at the discharge point would be required to accommodate the deeper channel and higher flows. Mitigation at this site would markedly reduce the volume of flow conveyed to the Sirius Drive sag point.
- Option 14B – new 1200mm pipe on southern side of Ocean Drive. Although 5% AEP flow capacity is not expected to be achieved with this option, this could convey flows and mitigate flooding of properties in the 0.2 EY event and larger.

Refer to Figure 3-15 for illustration of options.

Priority

This site is classed as a **medium to high** priority. Although not listed as a critical location with high hazard flooding, a number of dwellings are affected by above-floor flooding, including seven dwellings in the 0.2EY event.

Option 14A is rated as a **medium** priority, with a reduced rating due to likely high costs. Option 14B is potentially a lower cost option and is given a **medium-high** priority.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▣ National Park
 - ▨ EECs and SEPP14
 - 1% AEP Peak Flood Depth (m)
 - 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



JACOBS

Disclaimer: Flood mapping is based on available assumptions identified in this report. Jacobs does not warrant, guarantee or make any representations regarding the currency and accuracy of information contained in this map.

GDA 1994 MGA Zone 56

TITLE
Option 14 Sandpiper Place,
Lakewood
Identified Options

PROJECT
North Brother Local Catchments
Flood Study

PROJECT # | **MAP #**
IA157500 | **FIGURE 3-15**
DATE
01/2/2019



This potential option has been identified for consideration by Port Macquarie Hastings Council for further detailed assessment. It is not currently endorsed for adoption in the FRMSP.

Option 14A - Re-construct existing concrete channel to 4m wide x 1.2m to convey the 5% AEP flow

Option 14B - New 1200mm diameter pipe to convey the 0.2EY flow

3.3.16 Ocean Drive East of Hoschke Road, West Haven

A number of properties are affected by floodwaters overflowing over Ocean Drive 200 – 400m east of Hoschke Road, with depths of 0.3 – 0.5m in the 1% AEP event on properties and with velocities of 1m/s. One property is affected by above-floor flooding in the 0.2EY event, one additional in the 5% AEP event and four additional properties in the 1% AEP event. This is also a significant location of flooding over Ocean Drive including observed flooding conditions in historic flood events.

Floodwaters drain to this area via two overland flow paths and with drainage under Ocean drive by a 2.4m x 1.2m and a 1.8m x 0.6m box culverts. Outflows from both culverts and overland flows generally drain through vacant land, although land ownership of these areas is uncertain. Total flows are 20m³/s in the 1% AEP event with 13.5m³/s overflowing Ocean Drive.

Potential Options

- Option 15A – augment eastern culvert crossing to convey 1% AEP road overflow (about 8m³/s). Install 3m x 1.2m box culvert. Retain existing culvert. Construct rock debris inlet basin upstream. Clear and widen existing downstream channel to approximately 8m wide x 1m deep to discharge to lake. Works would be on public land, however, the parcel on the downstream side appears to have been landscaped and is used by the adjacent residents.
- Option 15B – augment western culvert crossing to convey 1% AEP road overflow (about 6m³/s). Install 3m x 1.2m box culvert. Retain existing culvert. Construct rock debris inlet basin upstream. Clear and widen existing downstream channel to approximately 8m wide x 1m deep to discharge to lake. Upstream works would be on public land (paper road) although there may be space constraints. Downstream works are on a vacant but private lot (397 Ocean Drive), as this is the discharge location of the existing culvert.

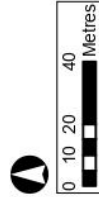
Refer to Figure 3-16 for illustration of options.

Priority

This is a medium priority location as there is only localised high hazard flooding on properties.

Option 15A is **medium** priority due to one dwelling with above-floor flooding in the 0.2EY event. Option 15B is **low** priority as the existing dwellings have raised floors and do not experience above-floor flooding in the 1% AEP event.

- Legend**
- Stormwater Pit/Node
 - Pipes and Culverts
 - ▣ National Park
 - ▨ EECs and SEPP14
 - 1% AEP Peak Flood Depth (m)
 - 0.05 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.5
 - 0.5 - 1.0
 - 1.0 - 2.0
 - > 2.0



JACOBS

Disclaimer: Flood mapping is based on data and assumptions identified in this report. Jacobs does not warrant, guarantee or make any representations regarding the currency and accuracy of information contained in this map.

TITLE
GDA 1994 MGA Zone 56

Option 15 Ocean Drive east of
Hoschke Road, West Haven
Identified Options

PROJECT
North Brother Local Catchments
Flood Study

PROJECT # | MAP #
IA157500 |
DATE |
14/11/2019

FIGURE 3-16



3.3.17 Other Locations Considered

A number of locations are identified as flood-affected in this study and listed in Table 2-1. Mitigation measures were initially reviewed but not considered in further detail due to various factors as discussed below.

- Laurieton retirement village, Peach Grove. Floodwater ponding around the main village complex is resultant from low capacity site drainage on this private property (typically 300mm diameter pipe network). There may be opportunities to regrade parts of the site to drain the trapped ponding areas by surface flows, in combination with drainage upgrades. It would be appropriate for the retirement village management to investigate drainage upgrades separate from this study.
- Residential block bounded by Lake Street, Ocean Drive, George Street and Castle Street. This block also contains the Laurieton Gardens Caravan Resort. There is a flow path draining from Lake Street and discharging to the corner of Castle Street and George Street. The site is low-lying with ground elevations down to under 2m AHD which presents challenges with drainage and mitigation of these overland flows particularly with consideration of future climate change effects of increased tailwater levels and flooding. The depths of flow are around 0.3m in the 1% AEP, while it appears that most dwellings are raised above the ground to mitigate against mainstream flooding and hence the potential for property damage from overland flows is significantly reduced. Therefore, overland flood mitigation in this area was not considered further.
- Properties adjacent to Stingray Creek and Camden Haven River, Laurieton. Numerous properties on low-lying land would be exposed to oceanic inundation during storm surge events in addition to riverine flooding. It is assumed that flood mitigation measures for these areas were previously considered in the Camden Haven Floodplain Risk Management Plan (Bewsher Consulting, 2004).

3.4 Summary of Options

The identified options are summarised in Table 3-5. A description, constraints/impacts, likely benefits and preliminary priority for detailed assessment is provided. Further detailed assessment will include testing for hydraulic performance in the TUFLOW model, cost estimation and benefit-cost assessment and multi-criteria assessment.



Table 3-5 Summary of identified flood modification options for detailed assessment

Option	Location	Description	Constraints, Impacts and Notable Issues	Likely Benefits and Opportunities	Priority for Detailed Assessment
1A		Increase channel locally width to 10m (currently 6m) to provide for 1% AEP capacity. Deepen channel under water mains crossing	<ul style="list-style-type: none"> Remove existing vegetation (not EEC) Structural support for water mains may be needed 	<ul style="list-style-type: none"> Improvements to flooding on 2 -3 properties (yard flooding) 	L
1B	Ringtail Close and Sinus Drive, Lakewood	As per Option 1A + Ocean Drive (south side) channel enlargement	<ul style="list-style-type: none"> As per Option 1A Existing underground utilities along Ocean Drive and telegraph poles 	<ul style="list-style-type: none"> As per Option 1A Reduction of flows being conveyed overland to Sinus Drive, Banks Street etc. (up to 5m³/s depending on constraints). Improvements to up to 8 properties on Sinus Drive and Banks Avenue, in addition to approx. 8 properties on Honeysuckle Drive 	M
1C		As per Option 1A + new 2x 1050mm pipes down Sinus Drive	<ul style="list-style-type: none"> As per Option 1A Crossing or existing underground utilities in Ocean Drive EECs and SEPP-14 wetlands downstream of new pipe discharge point 	<ul style="list-style-type: none"> As per Option 1A Reduction in flows being conveyed overland to Sinus Drive, Honeysuckle Ave etc. (up to 5m³/s depending on constraints). Improvements to up to 8 properties on Sinus Drive and Banks Avenue, in addition to approx. 8 properties on Honeysuckle Drive 	M
1D		Construct 0.5m high bund or block wall to redirect flows into Sinus Drive May not be required if Option 1B or 1C implemented	<ul style="list-style-type: none"> Check for downstream flood impacts required 	<ul style="list-style-type: none"> Improvements to up to 8 properties on Sinus Drive and Banks Ave. 	M
2A		Ocean Drive channel upgrade to concrete box channel. Block wall on northern side to increase capacity and prevent bypass down side of Lakewood shops	<ul style="list-style-type: none"> Existing telegraph poles limit widening. Stability of poles to be considered 	<ul style="list-style-type: none"> Improvements to 12 or more properties Improvements in road flooding on Lilli Pili Close 	M-H
2B	Lilli Pili Close, Lakewood	Upgrade Lilli Pili Close cul-de-sac drainage from existing 375mm to 600mm pipe or larger	<ul style="list-style-type: none"> No significant constraints 	<ul style="list-style-type: none"> Improvements in road flooding on Lilli Pili Close 	M
2C		Lower the ground level in Lilli Pili Close cul-de-sac easement from 3.4m AHD to 3.1m AHD	<ul style="list-style-type: none"> No significant constraints. Possible lower level for ingress of backwater flooding during mainstem flood event. 	<ul style="list-style-type: none"> Improvements in road flooding on Lilli Pili Close 	M
3A	Mission Terrace, Lakewood	Construct an open channel with 1% AEP capacity to formalise the overland flow path. Direct the flow path around the eastern sides of properties on Mission Terrace.	<ul style="list-style-type: none"> Works on private property Culvert under private property internal road required 	<ul style="list-style-type: none"> Flood improvements to two properties 	L
3B		Raise road verge and driveway of one property on Mission Terrace	<ul style="list-style-type: none"> Vehicle scraping on raised driveway – limits the height of raised driveway 	<ul style="list-style-type: none"> Flood improvements to one property 	L



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Option	Location	Description	Constraints, Impacts and Notable Issues	Likely Benefits and Opportunities	Priority for Detailed Assessment
4A		Voluntary acquisition of at least one property (53 Koonwarra Street), up to two properties (51 Koonwarra Street). Regrade site to form flow path. Consider raising road verge/driveways to direct flows into flow path	<ul style="list-style-type: none"> High property prices (~\$500K) 	<ul style="list-style-type: none"> Removal of at least one property with floodway/ very high flood hazard (H5) Improvements to flooding on adjacent properties (approx. 5) on Koonwarra Street 	H
4B		New additional trunk drainage line 2x 1200mm diameter pipes, intercepting flows at downstream end of channel on Captain Cook Bicentennial Drive villas, cross Ocean Drive and run under The Gateway. Inlet debris trap basin required.	<ul style="list-style-type: none"> Existing utilities in Ocean Drive corridor Available space in The Gateway corridor for new trunk drainage line Need to check for potential impacts to flooding around The Gateway 	<ul style="list-style-type: none"> Reduce 1% AEP flows conveyed to Pelican Court by approx. 25% 	H
4C	Kirmington Terrace to Pelican Court, West Haven	Voluntary acquisition of at one property (either 7 or 9 Pelican Court). Regrade site to form flow path.	<ul style="list-style-type: none"> High property prices (~\$500K) 	<ul style="list-style-type: none"> Removal of at least one property with floodway/ high flood hazard (H3-H4) areas on the property Improvements to flooding on adjacent properties (approx. 10) on Pelican Court and in road 	H
4D		Construct 10,000m ² detention basin between Koonwarra Street and Ocean Drive	<ul style="list-style-type: none"> Significant clearing of vegetation (not EEC), basin not to be revegetated Potential redistribution of flood flows and resultant flood impacts in rare/extreme floods, including impacts to accessibility of roads Dam safety requirements (design, maintenance, operation) 	<ul style="list-style-type: none"> Potential reduction in 1% AEP flows conveyed to Pelican Court of up to 35%. Reduction in 1% AEP flows through Captain Cook Bicentennial Drive villas of approx. 50% (to be confirmed) 	M-H
4E		Duplicate existing box culvert under Ocean Drive to the east of Pelican Court	<ul style="list-style-type: none"> Existing utilities in Ocean Drive corridor Potential flood impacts to properties in Pelican Court needs to be checked 	<ul style="list-style-type: none"> Improvements to flooding on two properties on high side of Ocean Drive 	L-M
5A		Upgrade sections of western flood diversion channel for 1% AEP capacity. Consider rerouting around north-western corner of estate	<ul style="list-style-type: none"> Works on private property – impacts to yards (deepening of channel) 	<ul style="list-style-type: none"> Improvements to flooding of approx. 5 dwellings including 2-3 with high hazard flooding/floodway 	M-H
5B	Flinders Drive Estate, West Haven	Upgrade sections of southern flood diversion channel for 1% AEP capacity. Consider higher capacity to supplement western channel	<ul style="list-style-type: none"> Potential flood impacts to St Joseph's School – reduced channel overflows and increased flows to school 	<ul style="list-style-type: none"> Improvements to flooding of approx. 10 dwellings 	M-H
5C		Upgrade Reliance Crescent eastern sag drainage from existing 375mm to a proposed 900mm pipe, including pits. Extend upgrades down and surcharge into Flinders Drive. Sizing depends on performance of Option 5B	<ul style="list-style-type: none"> Existing utilities Localised high flow conditions from surcharge pit – impacts to vehicles 	<ul style="list-style-type: none"> Improvements to flooding of approx. 6 dwellings 	M-H



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Option	Location	Description	Constraints, Impacts and Notable Issues	Likely Benefits and Opportunities	Priority for Detailed Assessment
5D		New drainage line in Flinders Drive west, uphill of Reliance Drive to capture road overland flows. Turn new drainage west through easement to western diversion channel, allow to surcharge. Propose 2x 1050mm pipes and required pits to capture 5% AEP flow. Sizing depends on performance of Option 5A/5B	<ul style="list-style-type: none"> Existing utilities Need for a number of large pit inlets to capture 5% AEP flow (3.6m³/s) 	<ul style="list-style-type: none"> Improvements to flooding of approx. 9 dwellings 	M-H
5E		Upgrade Flinders Drive northern sag drainage. Upgrade of the pipe capacity to extend down into Investigator Way. Sizing dependent on performance of Options 5A – 5D	<ul style="list-style-type: none"> Existing utilities 	<ul style="list-style-type: none"> Improvements to flooding of approx. 8 dwellings 	L
6A		Construct/raise berm between the natural flow path and the diversion channel above Blackbutt Crescent to reduce overflows into the diversion channel	<ul style="list-style-type: none"> Works in national park Periodic maintenance of berm Increased flows directed to St. Joseph's School 	<ul style="list-style-type: none"> Reduction in flows of up to 16m³/s in 1% AEP in Tunis Street flow path Improvements to flooding to >20 downstream properties 	L
6B		Increase existing diversion channel capacity behind Blackbutt Crescent properties by a combination of excavating the channel, raising the banks (e.g. block retaining wall along the property boundaries) and clearing of vegetation in the channel.	<ul style="list-style-type: none"> Limited section of works in national park Clearing of vegetation in channel – national park 	<ul style="list-style-type: none"> Improvements to flooding on approx. 15 properties on Blackbutt Crescent and Peach Grove 	M-H
6C	Tunis Street Overland Flow Path, Laurielton	Construct new, or enhance existing, diversion channel behind Peach Grove to direct flows south to the easement at the end of Tunis Street	<ul style="list-style-type: none"> Clearing of vegetation for channel 	<ul style="list-style-type: none"> Improvements to flooding on approx. 8 properties on Peach Grove 	M-H
6D		New trunk drainage line down Tunis Street, 5% AEP capacity (about 9.5m ³ /s). Box culvert 3m x 1.2m, or 3 x 1.35m diameter pipes. Inlet debris trap basin	<ul style="list-style-type: none"> Existing utilities Space constraints Traffic disruption in Tunis Street/Bold Street including Coles Supermarket truck access Requires implementation of Options 6B and 6C for maximum performance by concentrating flows at proposed trunk drainage inlet 	<ul style="list-style-type: none"> Reduce 1% AEP overland flows by up to 67% Improvements to flooding on approx. 10 residential and commercial properties Potential minor improvements to flooding on properties east of Bold Street Improvements to road flooding on Bold Street, Kew Road, Tunis Street 	M-H
6E		Upgrade drainage in Gow Place cul-de-sac and raise road verge and driveways. Connection to new trunk drainage line (if adopted). Secondary measure to Option 6D. Sizing depends on upstream measures performance.	<ul style="list-style-type: none"> Vehicle scraping (driveway raising) Existing utilities 	<ul style="list-style-type: none"> Improvements to flooding on 5 properties and 12 retirement centre villas 	M-H



Option	Location	Description	Constraints, Impacts and Notable Issues	Likely Benefits and Opportunities	Priority for Detailed Assessment
7A		Remove debris blockages from diversion channel, upgrade main and secondary diversion channels	<ul style="list-style-type: none"> Works in national park Increased flows directed to Harbourside Crescent villas. Additional mitigation may be required 	<ul style="list-style-type: none"> Improvements to flooding of 6 properties with above-floor flooding in the 0.2EY event immediately downstream of the works. Minor improvements to flooding on additional >10 residential and commercial properties downstream of Peach Grove 	M-H
7B	Quarry Way Overland Flow Path, Laurieton	New trunk drainage line from Norman Street down Seymour Street, discharging to the river. Indicative sizing 3.6m x 1.2m box culvert for 1% AEP capacity (if Option 7A not implemented). Replaces existing two 1200mm trunk pipes.	<ul style="list-style-type: none"> Likely high cost Existing utilities Potential space constraints Traffic disruption in Seymour Street, Bold Street Extensive reconstruction of existing trunk and local drainage infrastructure required 	<ul style="list-style-type: none"> Significant reduction in total 1% AEP overland flow Improvements to flooding of up to 5 properties with above-floor flooding in the 0.2EY event, including a number of critical flood problem properties Potential minor improvements to flooding on properties east of Bold Street/north of Seymour Street Improvements to road flooding on Bold Street, Norman Street, Lord Street, Seymour Street, Lake Street 	M-H
7C		Provide drainage in Bold Street eastern side to direct flows into Seymour Street drainage line. This option may not be required if Option 7B is implemented	<ul style="list-style-type: none"> Existing utilities Increased flows redirected to Lake Street/Seymour Street property, if Option 7B not implemented 	<ul style="list-style-type: none"> Improvements to flooding on commercial properties on eastern side of Bold Street including one with above floor flooding in the 2% AEP event Potential minor improvements to flooding on properties east of Bold Street/north of Seymour Street 	L-M
7D		Localised flood-proofing at Laurieton Hotel/bottle shop e.g. concealed or inflatable flood barrier	<ul style="list-style-type: none"> Potential space constraints in building Potentially significant retrofitting works to Hotel/bottle shop premises 	<ul style="list-style-type: none"> Prevention or significantly reduced ingress of floodwaters through Hotel in up to 1% AEP Potential for co-funding from Laurieton Hotel owners. 	M
8A	Lake Street at Seymour Street, Laurieton	Upgrade culverts crossing Lake Street up to 2x 1500mm pipe or equivalent	<ul style="list-style-type: none"> Existing utilities Traffic disruption on Lake Street 	<ul style="list-style-type: none"> Improvement to flooding at Lake Street/Seymour Street property and Laurieton United Services Club Improvement to road flooding in Lake Street 	L
8B		Install debris control structure at existing or proposed upgraded culvert inlet	<ul style="list-style-type: none"> No significant constraints Inspection and maintenance after storm events required to increase reliability 	<ul style="list-style-type: none"> Improvement to flooding at Lake Street/Seymour Street property and Laurieton United Services Club Improvement to road flooding in Lake Street 	H



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Option	Location	Description	Constraints, Impacts and Notable Issues	Likely Benefits and Opportunities	Priority for Detailed Assessment
8C		Regrade (lower) the road verge on eastern side of Lake Street, create/widen the existing flow path from the road and down the southern side of the Laurieton United Services Club. Relocation of existing utilities block from proposed flow path	<ul style="list-style-type: none"> Purpose of existing utilities block unknown. Difficulty in relocating utilities unknown 	<ul style="list-style-type: none"> Improvement to flooding at Laurieton United Services Club, potential minor improvement at Lake Street/Seymour Street property Improvement to road flooding in Lake Street 	L
9A		Install 2x 3m x 1.2m box culvert in the southern flow path to convey 1% AEP flows in middle and southern flow paths. Alternatively, widening the existing channel could be considered. Inlet rock debris trap basin required	<ul style="list-style-type: none"> Existing utilities in Ocean Drive Possible loss of existing landscaped open channel and gardens Some disruption to school operations expected during construction Traffic disruption in Ocean Drive Further investigation required to check for clashes with existing buildings (channel widening option) 	<ul style="list-style-type: none"> Improvements to overland flooding on school grounds. Reduced exposure of students and staff to flood flows due to conveying flows in underground structures 	H
9B	St Joseph's School, Laurieton	Install 2x 3m x 1.2m box culvert in the middle flow path to convey 1% AEP flows in middle and southern flow paths. Inlet rock debris trap basin required	<ul style="list-style-type: none"> Existing utilities in Ocean Drive Space constraints between school buildings Loss of existing overland flow path, or replaced with reduced capacity flow path Increased disruption to school during construction, compared to Option 9A Traffic disruption in Ocean Drive 	<ul style="list-style-type: none"> Improvements to overland flooding on school grounds. Reduced exposure of students and staff to flood flows due to conveying flows in underground structures 	H
9C		Upgrade and extend the northern road cross culvert by 160m. Sizing dependent on performance of Options 9A/9B. Indicative sizing for existing flows is 3m x 1.2m box culvert.	<ul style="list-style-type: none"> Disruption to school operations expected during construction – works required in car park/main school entrance Impacts to EEC/SEPP14 wetlands, new tail-out channel may need to be excavated to discharge to downstream lake Traffic disruption in Ocean Drive 	<ul style="list-style-type: none"> Improvements to overland flooding on school grounds. Reduced exposure of students and staff to flood flows due to conveying flows in underground structures 	M-H
10A	Harbourside Crescent Villas and Bold Street, Laurieton	Upgrade Bold Street cross drainage pipe with 2x 3m x 1.5m box culverts (approx. 5% AEP capacity). Large inlet debris control screen. Requirement for rock debris trap at inlet to be assessed.	<ul style="list-style-type: none"> Existing utilities in Bold Street requiring protection Traffic disruption in Bold Street during construction 	<ul style="list-style-type: none"> Improvements to flooding on Harbourside Crescent villas Improvements to road flooding in Bold Street 	H
10B		Install block wall up to 1m high along property boundary on low side of Bold Street, extend onto property if required, to reduce overflows onto Harbourside Crescent Villas property	<ul style="list-style-type: none"> Potential upstream flood impacts to be checked 	<ul style="list-style-type: none"> Improvements to flooding on Harbourside Crescent villas (>8 villa buildings) 	M-H
11A	Norman Street and Mill Street, Laurieton	Diversion channel through the bushland to direct flows in up to the 1% AEP event from the fire trail to a natural gully to the south near Hanley Street. Regrade fire trail to assist in flow diversion	<ul style="list-style-type: none"> Clearing of vegetation along diversion channel alignment (not national park) Redirection of flows – impacts to flood levels and property flooding needs to be checked. 	<ul style="list-style-type: none"> Improvements to flooding on 12 properties 	M



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Option	Location	Description	Constraints, Impacts and Notable Issues	Likely Benefits and Opportunities	Priority for Detailed Assessment
12A	Sirius Drive, Honeysuckle Avenue and Mahogany Close, Lakewood	Upgrade existing pipes in Honeysuckle Avenue and Mahogany Close including through properties. Sizes of up to 750mm diameter are suggested, depending on performance of upstream mitigation measures. Additional pits/inlets required. One-way flap gate at outlet to prevent backwater flooding through drainage pipes. Upgrade existing drainage for Sirius Drive sag to a 2.4m x 1.2m box culvert (minimum); consider up to 3m x 1.2m) and lower the easement ground level to 3.1m AHD. One-way flap gate at outlet to prevent backwater flooding through drainage pipes. Installation of an additional 1050mm pipe to the existing twin pipes could be considered if there is sufficient space.	<ul style="list-style-type: none"> Works through two properties to upgrade pipes, close proximity to existing structures Existing utilities 	<ul style="list-style-type: none"> Improvements to flooding on >10 properties including one with above-floor flooding in 5% AEP event 	M
12B			<ul style="list-style-type: none"> Space constraints in easement Existing utilities 	<ul style="list-style-type: none"> Improvements to flooding on >15 properties including four with above-floor flooding in 5% AEP event 	M-H
13A		Construct/upgrade diversion channel approx. 7m wide and 1m deep along high side of properties to south of cul-de-sac	<ul style="list-style-type: none"> Clearing of vegetation for diversion channel 	<ul style="list-style-type: none"> Improvements to flooding on four properties including two with above-floor flooding in 0.2EY event. 	M
13B	Elouera Place, West Haven	Upgrade road cross culvert with 2x 1.8m x 1.2m culverts (about 1% AEP capacity). An inlet debris screen or other debris control should be installed.	<ul style="list-style-type: none"> Existing utilities Disruption to traffic and property access 	<ul style="list-style-type: none"> Improvements to flooding on two properties above-floor flooding in 5% AEP event. 	L
14A		Reconstruct existing concrete channel including widening and deepening the channel. 4m wide x 1.2m would have about the 5% AEP capacity	<ul style="list-style-type: none"> Potential clash with existing utilities 	<ul style="list-style-type: none"> Improvement in flooding on about 11 properties including 7 with above-floor flooding in the 0.2EY event. Reduction in 4% AEP overflows onto properties by 70% (about 4m³/s) Reduction in flows conveyed to Sirius Drive sag point. 	M
14B	Sandpiper Close, Lakewood	New 1200mm pipe on southern side of Ocean Drive. Although 5% AEP flow capacity is not expected to be achieved with this option, this could convey flows and mitigate flooding of properties in the 0.2 EY event and larger.	<ul style="list-style-type: none"> Potential clash with existing utilities May need to connect existing 600mm dia pipe from Diarantina Way if clashing 	<ul style="list-style-type: none"> Improvement in flooding on about 11 properties including 7 with above-floor flooding in the 0.2EY event. Reduction in 1% AEP overflows onto properties by 70% (about 2m³/s reduction) Reduction in flows conveyed to Sirius Drive sag point. 	M-H
15A	Ocean Drive East of Hoshke Road, West Haven	Augment eastern culvert crossing with 3m x 1.2m box culvert, for 1% AEP capacity. Clear and widen existing downstream channel to approximately 8m wide x 1m deep to discharge to lake. Retain existing culvert. Install inlet rock debris trap basin and upgrade downstream channel	<ul style="list-style-type: none"> Existing utilities Disruption to traffic and property access Clearing of vegetation (no EECs), landscaping by residents Land parcel currently used by residents 	<ul style="list-style-type: none"> Improvements to flooding on approx three properties including one with above-floor flooding in 0.2EY event Improvements in road flooding on Ocean Drive 	M



Option	Location	Description	Constraints, Impacts and Notable Issues	Likely Benefits and Opportunities	Priority for Detailed Assessment
15B		Augment western culvert crossing with 3m x 1.2m box culvert, for 1% AEP capacity. Clear and widen existing downstream channel to approximately 8m wide x 1m deep to discharge to lake. Retain existing culvert. Install inlet rock debris trap basin and upgrade downstream channel	<ul style="list-style-type: none"> Existing utilities Disruption to traffic and property access Clearing of vegetation (no EECs) 	<ul style="list-style-type: none"> Improvements to flooding on three properties Improvements in road flooding on Ocean Drive 	L

4. Conclusions and Recommendations

4.1 Conclusions

A long list of mitigation options presented in this Working Draft Options Report outline a comprehensive list of identified possible mitigation works for the North Brother local catchments flood study area and include a preliminary and qualitative assessment of the options. The long list was developed to address flooding issues at the identified trouble spots discussed in Section 2.1 with a focus on property flooding. A total of 15 locations/potential schemes are identified and discussed.

Council and the floodplain advisory sub-committee should consider the long list of options and locations nominated in this report for potential mitigation works. A short list should be selected by Council with assistance from Jacobs for further detailed assessment. As per the project brief we have allowed for development and assessment of six structural management options or combined schemes of options (e.g. 7A+7B+7D). It is recommended the short-listing be undertaken on a location basis as per the locations described in Section 3.3. The main constraint on the assessment of options/schemes of options is on model runs, results processing and analysis effort. Jacobs could undertake assessment of additional schemes as a variation.

The selection of options should consider the potential benefits and opportunities and the likely costs, impacts and constraints relevant to each option. There may be constraints and other issues related to each option which may not be resolvable and may preclude some options from further assessment. Coordination between Council and Jacobs is required to agree on the configuration of the options for detailed assessment.

Following this, Jacobs will undertake assessment of the short-listed options in the TUFLOW flood hydraulic model in addition to cost-benefit and multi-criteria analyses for evaluation of the options. Final testing of options should include combinations of options which are likely to complement each other.

4.2 Recommendations

- A short-list of options for assessment in the hydraulic model, cost estimation, feasibility etc. is to be selected by Council and the committee.
- Consultation with stakeholders, landowners and community is to be undertaken on the short-listed options.

5. References

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6. 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. In this study AEP has been used consistently to define the probability of occurrence of flooding. It is to be noted that design rainfalls used in the estimation of design floods up to and including 100 year ARI (ie. 1% AEP) events was derived from 1987 Australian Rainfall and Runoff. The following relationships between AEP and ARI applies to this study (AR&R, 2016).

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.50
	1	63.2	1.58	1.00
Frequent	0.69	50.00	2	1.44
	0.5	39.35	2.54	2.00
	0.22	20.00	5	4.48
	0.2	18.13	5.52	5.00
	0.11	10.00	10.00	9.49
Infrequent	0.05	5.00	20	20.0
	0.02	2.00	50	50.0
	0.01	1.00	100	100
Rare	0.005	0.50	200	200
	0.002	0.20	500	500
	0.001	0.10	1000	1000
	0.0005	0.05	2000	2000
Extremely Rare	0.0002	0.02	5000	5000
			↓	
Extreme			PMP	

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

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	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 occurrences 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 main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
DRAINS	DRAINS is a computer program which is used to simulate local catchment rainfall-runoff and stormwater system hydraulics and is widely used across Australia.
Development	Is defined in Part 4 of the EP&A Act <u>In fill development:</u> refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development. New development: refers to development of a completely different nature to that associated with the former land use. Eg. The urban subdivision of an area previously used for rural purposes. New developments involve re-zoning and typically require major extensions of exiting urban services, such as roads, water supply, sewerage and electric power. Redevelopment: refers to rebuilding in an area. Eg. As urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either re-zoning or major extensions to urban services.
Effective Warning Time	The time available after receiving advise of an impending flood and before the 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.
Exceedances per Year (EY)	The number of times an event is likely to occur or be exceeded within any given year.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.

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Flood liable land	Is synonymous with flood prone land (i.e.) land susceptibility to flooding by the PMF event. Note that the term flooding liable land covers the whole floodplain, not just that part below the FPL (see flood planning area)
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 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 include both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defines 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 levels (FPLs)	Are the combination 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. FPLs supersede the "designated flood" or the "flood standard" used in earlier studies.
Flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings and structures subject to flooding, to reduce or eliminate flood damages.
Flood readiness	Readiness is an ability to react within the effective warning time.
Flood risk	<p>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.</p> <p><u>Existing flood risk</u>: the risk a community is exposed to as a result of its location on the floodplain.</p> <p><u>Future flood risk</u>: the risk a community may be exposed to as a result of new development on the floodplain.</p> <p><u>Continuing flood risk</u>: 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.</p>
Flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during 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

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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 situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community.
Local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
m AHD	Metres Australian Height Datum (AHD)
m/s	Metres per second. Unit used to describe the velocity of floodwaters.
m ³ /s	Cubic metres per second or "cumecs". A unit of measurement of creek or river flows or discharges. It is the rate of flow of water measured in terms of volume per unit time.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Modification measures	Measures that modify either the flood, the property or the response to flooding.
Overland flow path	The path that floodwaters can follow as they are conveyed towards the main flow channel or if they leave the confines of the main flow channel. Overland flow paths can occur through private property or along roads.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation 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.
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.
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

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consequences arising from the interaction of floods, communities and the environment.

Runoff

The amount of rainfall which ends up as a streamflow, also known as rainfall excess.

Stage

Equivalent to water level (both measured with reference to a specified datum)

TUFLOW

TUFLOW is a computer program which is used to simulate free-surface flow for flood and tidal wave propagation. It provides coupled 1D and 2D hydraulic solutions using a powerful and robust computation. The engine has seamless interfacing with GIS and is widely used across Australia.