PORT MACQUARIE HASTINGS COUNCIL

HASTINGS RIVER
FLOODPLAIN RISK MANAGEMENT PLAN

Issue 3
24th March 2014

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Project: 301015-00495 – HASTINGS RIVER FLOODPLAIN RISK MANAGEMENT PLAN

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<th>AUTHOR</th>
<th>REVIEWER</th>
<th>WORLEY-PARSONS APPROVAL</th>
<th>DATE</th>
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<td>CRT</td>
<td>14-06-2013</td>
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<td>Chris Thomas / Warick Honour</td>
<td>CRT/WJH</td>
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FOREWORD

The State Government’s Flood Policy is directed towards providing solutions to existing flooding problems in developed areas and ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas. Policy and practice are defined in the Government’s Floodplain Development Manual (2005).

Under the Policy, the management of flood liable land remains the responsibility of Local Government. The State Government subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist Local Government in the discharge of their floodplain risk management responsibilities.

The Policy provides for technical and financial support by the State Government through the following four sequential stages:

<table>
<thead>
<tr>
<th>STAGE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Flood Study</td>
<td>Determines the nature and extent of the flood problem.</td>
</tr>
<tr>
<td>2. Floodplain Risk Management Study</td>
<td>Evaluates management options for the floodplain in respect of both existing and proposed developments.</td>
</tr>
<tr>
<td>3. Floodplain Risk Management Plan</td>
<td>Involves formal adoption by Council of a plan of management for the floodplain.</td>
</tr>
<tr>
<td>4. Implementation of Plan</td>
<td>Results in construction of flood mitigation works to protect existing development and the application of environmental and planning controls to ensure that new development is compatible with the flood hazard.</td>
</tr>
</tbody>
</table>

A detailed description of the inter-relationship between these stages is provided overleaf. The link between the various outcomes of the studies involved in the floodplain risk management process and the implementation of measures (both planning and structural) to reduce flood damages is also shown.
Established by the local council, must include community groups and state agency specialists.

1. SETTING

1.1 INTRODUCTION


The Floodplain Risk Management Study documents the outcomes of a detailed assessment of the viability of a range of potential floodplain risk management options. These options were identified in consultation with the Committee and the broader community, and were targeted toward reducing existing and potential future flooding problems.

The Study also provides information on flood characteristics such as flood hazard and the hydraulic categorisation of the floodplain. This information is critical for ensuring a consistent basis for evaluating community aspirations for future land use. In this regard, the Study also considered the suitability of Council’s existing planning instruments and provided guidance for changes to policy that will be required to ensure that land use controls are consistent with the flood risk and flood hazard, as well as the potential impacts of climate change.

1.2 THE STUDY AREA

The Hastings River is located on the mid-north coast of New South Wales, approximately 300 km north of Sydney. The river rises in the Great Dividing Range near Mount Werrikimbe and discharges into the Tasman Sea at Port Macquarie, about 90 kilometres to the east. The river drains a catchment area of 3,700 km$^2$ (refer Figure 1.1).

The upper Hastings River typically flows through incised valleys, whereas the lower Hastings River, comprising the area below Wauchope meanders across a wide floodplain. The lower Hastings River is the focus of this Floodplain Risk Management Plan.

The major urban centres of the lower Hastings River valley are Wauchope (population 8,686), approximately 20 km inland and Port Macquarie (population 41,440). The area is a popular recreational and retirement destination. In 2009 Port Macquarie was identified as New South Wales’ fastest growing centre. A 35% increase in the town’s population is predicted to occur by 2027.

Flooding from the Hastings River has occurred regularly through the period of European settlement, with most floods causing substantial damage and disruption to occupants of the floodplain. The history of flooding and projected population growth has demonstrated to Council that a more systematic approach to the identification and management of flood risk is required. Accordingly, Council decided to identify these areas so that more informed decision-making can occur, particularly in relation to development proposals and building approvals.
The Hastings River Flood Study (*Issue No.3, August 2006*) defined flood characteristics for the lower Hastings River Valley extending downstream from the Bains Bridge crossing of the Hastings River near Wauchope and the Pacific Highway crossing of the Wilson River at Telegraph Point. This included information on flood flows, velocities, levels and flood extents, for a range of flood events under existing floodplain and catchment conditions. It confirmed that the existing flooding problem at the lower Hastings River valley is real and has the potential to threaten life and cause damage to public assets and private property.
2. THE EXISTING FLOODING PROBLEM

2.1 INTRODUCTION

The existing flooding problem relates to those areas where flood damages are likely to arise as a consequence of flooding. It relates to existing dwellings, industrial complexes and commercial premises that would be inundated during a flood, as well as all associated infrastructure within the floodplain, including roads, railways and utility services.

In this context, the existing flooding problem is usually addressed by structural measures which aim to modify flood behaviour and thereby reduce flood damages.

The Hastings River Flood Study (Issue No.3, August 2006) established the following characteristics of the existing flooding problem:

1. The adopted design 1% Annual Exceedance Probability (AEP) flood was based on a 1% AEP catchment flood condition occurring concurrently with an elevated ocean level of 2.2 mAH, which corresponds to a 5% AEP ocean water level condition. This design 1% AEP flood scenario will result in inundation of several developed regions of the floodplain including areas of Port Macquarie, Settlement Point, North Shore and Hibbard, as well as parts of Rawdon Island and Wauchope.

2. The peak 1% AEP flood level in the vicinity of Settlement Point and North Shore is predicted to be 2.7 mAH. There is a gradual increase in 1% AEP flood level with distance upstream along the Hastings River to the Rocks Ferry Bridge crossing (just downstream of Wauchope), where the design 1% AEP flood level is predicted to be 7.1 mAH.

3. Upstream of the Rocks Ferry Bridge crossing there is a substantial increase in the flood gradient. The peak 1% AEP flood level at the North Coast Railway bridge crossing at Wauchope is predicted to be 8.7 mAH.

4. Peak flow velocities in the 1% AEP flood are generally predicted to be below 0.5 m/s across the majority of the lower floodplain of the Hastings River. Peak in-channel flow velocities along the lower sections of the Hastings, Maria and Wilson Rivers are generally less than 2 m/s. Upstream of Sandy Point, peak flow velocities within the Hastings River channel are predicted to vary between 3 m/s and 4 m/s.

5. Floodwater depths across the floodplain are predicted to typically be around 1.5 metres at the peak of the design 1% AEP flood. Although the corresponding peak flow velocities within these areas of the floodplain are relatively low, the high depths of inundation result in the majority of the floodplain being classified as a high flood hazard area.

6. Flood hazard mapping for the 1% AEP flood demonstrates indicates that extensive areas between Wauchope and Port Macquarie are classified as being VERY HIGH or EXTREME Hazard areas (refer Figure 2.1 through Figure 2.5).
The hazard mapping demonstrates that populated areas within the floodplain would be exposed to high hazard conditions during a design 1% AEP flood. As a result, the occurrence of a design 1% AEP flood would present a direct and real risk to life. Inundation of low lying areas would impact on the ability of occupants of the floodplain and its fringes to evacuate in a flood emergency. The associated exposure of the community to the flood risk has serious implications for flood emergency response management.

2.2 FLOOD DAMAGES

The Hastings Floodplain Risk Management Study assessed the damage caused by flooding. The findings from the damages assessment is summarised in Table 1 for a range of design floods.

The total flood damages for each design event were combined with their probability of occurrence to determine an Average Annual Damage (AAD) cost. The AAD corresponds to the cost of flooding when represented on an annual basis.

The Average Annual Damage for the Hastings River floodplain is estimated to be $2.8M.

Table 1 EXISTING DIRECT AND INDIRECT FLOOD DAMAGES FOR THE HASTINGS RIVER FLOODPLAIN (2014 $)

<table>
<thead>
<tr>
<th>FLOOD EVENT</th>
<th>RESIDENTIAL ($,000)</th>
<th>COMM &amp; INDUST ($,000)</th>
<th>INFRASTRUCTURE ($,000)</th>
<th>TOTAL ($,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Indirect</td>
<td>Direct</td>
<td>Indirect</td>
</tr>
<tr>
<td>5 Year ARI Flood</td>
<td>2,772</td>
<td>139</td>
<td>253</td>
<td>126</td>
</tr>
<tr>
<td>20 Year ARI Flood</td>
<td>4,048</td>
<td>203</td>
<td>3,318</td>
<td>1,659</td>
</tr>
<tr>
<td>50 Year ARI Flood</td>
<td>6,465</td>
<td>323</td>
<td>3,698</td>
<td>1,850</td>
</tr>
<tr>
<td>100 Year ARI Flood</td>
<td>11,176</td>
<td>559</td>
<td>6,046</td>
<td>3,022</td>
</tr>
<tr>
<td>200 Year ARI Flood</td>
<td>19,596</td>
<td>980</td>
<td>13,482</td>
<td>6,741</td>
</tr>
<tr>
<td>Extreme Flood</td>
<td>196,441</td>
<td>9,822</td>
<td>95,856</td>
<td>47,928</td>
</tr>
</tbody>
</table>

2.3 OPTIONS TO ADDRESS THE EXISTING FLOOD PROBLEM

Information presented in the ‘Hastings River Flood Study’ (2006) and the damages analysis outlined above, indicates that there is potential for substantial damages and loss to be incurred by those living and working in the lower Hastings River floodplain should major flooding of the region occur. These damages would include financial losses to individual property owners and losses to the overall community as a result of damage to infrastructure and disruption to everyday life.
Flood affected areas at North Shore, Settlement Point, Hibbard and across parts of the Port Macquarie CBD, would incur the greatest proportion of this damage cost. Accordingly, it was considered appropriate to identify a range of measures that could potentially be implemented to reduce the flood damages that the community could be exposed to in the future.

A list of options was originally developed in consultation with representatives from Council, the then Department of Environment, Climate Change and Water (now the NSW Office and Environment & Heritage) and the Hastings LGA Floodplain Sub-Committee. The options were devised with a view to reducing the existing flood damages that the community could be exposed to and with a view to providing a mechanism for ensuring that the risk faced by future development was minimised.

The potential floodplain management options assessed comprise a combination of ‘flood damage reduction measures’ (structural measures) and ‘planning measures’ (non-structural measures). According to the categories outlined in the NSW ‘Floodplain Development Manual’ (2005), these measures fall into the following categories:

- **Flood Modification Measures**
  
  These are typically structural works, such as flood protection levees, flood detention basins or bypass floodways, which help to reduce flood damages.

- **Property Modification Measures**
  
  These measures typically include flood planning measures for future development, and can also include voluntary house raising and purchase, or flood-proofing of buildings.

- **Response Modification Measures**
  
  These typically include emergency response management measures, flood predictions and warnings and community flood awareness and preparedness.

The Flood Modification Measures that were adopted for investigation are listed in Table 2 and are presented graphically in Figure 2.6.

Each of these measures was investigated to assess their respective advantages and disadvantages considering issues associated with flood hydraulics, environmental constraints and economics. A consultation program was also undertaken during early 2009 to determine the views of the community on the suitability of these Flood Modification Measures.

An initial assessment of the hydraulic impact of these measures was presented to the Committee. As a result of that initial assessment, the Committee determined that it would be necessary to combine several of the measures to negate some of the adverse flood level impacts that were predicted for some of the individual measures when considered in isolation. For example, concerns were expressed that in implementing a measure for reducing flood damages at say Settlement Point, there would be an adverse impact on North Shore and / or Hibbard. As a result, three additional structural options were considered as described in Table 3.
**Table 2  INVESTIGATED FLOOD MODIFICATION MEASURES**

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>WORKS / ACTIONS ASSOCIATED WITH FLOOD MODIFICATION MEASURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Construction of a ring levee at North Shore extending around the urban area to the west of the ferry terminal.</td>
</tr>
<tr>
<td>S2</td>
<td>Construction of a ring levee at North Shore extending around the entire urban area west from Donnelly’s Creek.</td>
</tr>
<tr>
<td>S3</td>
<td>Construction of a ring levee around the urban precinct of Settlement Point.</td>
</tr>
<tr>
<td>S4</td>
<td>Filling of the urban, commercial and industrial precincts of Hibbard equivalent to construction of flood protection levee to prevent flooding from the Hastings River.</td>
</tr>
<tr>
<td>S8</td>
<td>Construction of a high flow Bypass Floodway in an area downstream from North Shore that has the capacity to connect the river to the ocean in extreme floods</td>
</tr>
</tbody>
</table>

**Table 3  FURTHER FLOOD MODIFICATION MEASURES**

<table>
<thead>
<tr>
<th>OPTION</th>
<th>WORKS / ACTIONS ASSOCIATED WITH FLOOD MODIFICATION MEASURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5</td>
<td>Construction of Options S2 and S3, in combination</td>
</tr>
<tr>
<td>S6</td>
<td>Construction of Options S2, S3 and S4, in combination.</td>
</tr>
<tr>
<td>S7</td>
<td>Construction of Options S2 and S4, in combination.</td>
</tr>
</tbody>
</table>

It is noted that none of these measures involve works to mitigate the impact of flooding in the vicinity of Wauchope. Most of the areas of existing development near Wauchope where flood affectation occurs in events up to the 1% AEP flood are inundated due to backwater flooding along Yippin and Kings Creeks. Hence, the nature of flooding at Wauchope is primarily as consequence of backwater effects and filling of flood storages.

Therefore, it was determined that it would be more appropriate to manage the existing flood hazard through appropriate planning measures, including early warning emergency response.

**2.4 METHOD OF ASSESSMENT**

The Flood Modification Measures were assessed by applying a triple bottom line analysis that considered economic, social and environmental issues. The economic assessment was based on the results of a detailed hydraulic analysis of each measure. The results of the assessment were used to develop a Floodplain Risk Management Option Assessment Matrix. This matrix provided the Committee with a mechanism for evaluating the relative importance of the range of factors that require consideration before option implementation can occur.
2.4.1 Hydraulic Assessment

The hydraulic benefit and dis-benefit that would be afforded by each option was determined using the RMA-2 flood model that was originally developed as part of the ‘Hastings River Flood Study’ (2006). Additional versions of the flood model were developed for each Flood Modification Measure and each was used to simulate flood behaviour with each of the potential measures “in place”.

Difference maps were created by comparing peak flood level and flow velocity estimates from simulations undertaken for both existing and post-development (i.e., incorporating the proposed management options) scenarios. This effectively created a contour map of predicted changes in peak flood levels and flow velocities associated with each potential Flood Modification Measure.

2.4.2 Benefit - Cost Assessment

A benefit-cost analysis was undertaken to assess the economic viability of implementing the potential Flood Modification Measures. The cost of construction works was estimated and compared with the predicted monetary benefit offered by each measure in terms of the potential reduction in flood damage across the range of events.

Direct and indirect costs were included in all damage cost estimates. The damage costs are all current as of January 2014.

For consistency, all documented values in this report are based on 2014 dollars, including cost estimates for options. In this way, a relative comparison of benefits and costs is provided and therefore the results of the analysis are considered to also reflect what the benefit-cost would be in today’s dollars.

The reduction in flood damages has been determined on the basis of the reduced level of flooding that would occur if the respective measures were implemented over the full range of design floods; that is, for all standard floods between the 20% AEP event and the Probable Maximum Flood.

The benefit-cost ratios for each of the Flood Modification Measures that were identified are summarised in Table 4.
Table 4  BENEFIT COST RATIOS FOR STRUCTURAL OPTIONS (2014 $)

<table>
<thead>
<tr>
<th>OPTION</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4*</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$1,706,000</td>
<td>$2,201,000</td>
<td>$2,053,000</td>
<td>$3,473,000</td>
<td>$4,253,000</td>
<td>$6,993,000</td>
<td>$4,940,000</td>
<td>$3,026,000</td>
</tr>
<tr>
<td>Benefit</td>
<td>$5,073,000</td>
<td>$5,447,000</td>
<td>$4,439,000</td>
<td>$1,167,000</td>
<td>$9,858,000</td>
<td>$11,222,000</td>
<td>$6,683,000</td>
<td>$267,000</td>
</tr>
<tr>
<td>B / C</td>
<td>3.0</td>
<td>2.5</td>
<td>2.2</td>
<td>0.3</td>
<td>2.3</td>
<td>1.6</td>
<td>1.4</td>
<td>0.1</td>
</tr>
</tbody>
</table>

* Benefit-cost ratio for S4 would be increased to 1.6 if construction of main levee at Hibbard was not undertaken as part of this option (i.e., gradual infill undertaken instead, at cost to individual developers).

2.4.3 Triple Bottom Line Assessment

In addition to calculation of the economic benefit for each measure (i.e., benefit-cost ratio), further assessment was undertaken to allow a comparison of the social and environmental benefits and dis-benefits associated with each measure. The inclusion of this assessment effectively ensured that a Triple Bottom Line (TBL) approach was incorporated into the analysis, thereby ensuring that the three "pillars of sustainability"; economic, social and environmental factors, were considered.

A summary of the TBL assessment results for all of the Flood Modification Measures is provided in Table 5. Further details of the assessment are available in the Hastings Floodplain Risk Management Study (2012).

Table 5  SUMMARY OF TRIPLE BOTTOM LINE ASSESSMENT

<table>
<thead>
<tr>
<th>OPTION</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 - North Shore Levee (Scenario A) – West of Ferry Terminal</td>
<td>46</td>
</tr>
<tr>
<td>S2 - North Shore Levee (Scenario B) – West of Donnelly’s Creek</td>
<td>44</td>
</tr>
<tr>
<td>S3 - Settlement Point Ring Levee</td>
<td>40</td>
</tr>
<tr>
<td>S4 - Hibbard Levee</td>
<td>24</td>
</tr>
<tr>
<td>S5 - Combination of North Shore Levee (S2) and Settlement Point Ring Levee (S3)</td>
<td>37</td>
</tr>
<tr>
<td>S6 - North Shore Levee (S2), Settlement Point Ring Levee (S3) and Hibbard Levee (S4)</td>
<td>27</td>
</tr>
<tr>
<td>S7 - Combination of North Shore Levee (S2) and Hibbard Levee (S4)</td>
<td>27</td>
</tr>
<tr>
<td>S8 - North Shore High Flow Bypass</td>
<td>28</td>
</tr>
</tbody>
</table>
2.5 RECOMMENDED FLOOD MODIFICATION MEASURES

The following Flood Modification Measures were recommended for inclusion in the Plan. Reference is made to Chapter 7 of the Hastings Floodplain Risk Management Study for a comprehensive description of the measures and the detailed analysis that was carried out.

**Option S1 – North Shore Levee (Scenario A): West of Ferry Terminal**

North Shore is located on the northern floodplain of the Hastings River, approximately four kilometres upstream of Port Macquarie. Option S1 involves the construction of a ring levee that would commence at the Settlement Point – North Shore ferry terminal and extend in a westerly direction along the river frontage of North Shore (refer Figure 2.7). The levee would extend in a northerly direction at the upstream extent of the urban Sector and then loop back to the east to form a ring around the greater proportion of the urban precinct.

The results of the flood modelling indicate that the residential area within the proposed levee would be fully protected from inundation during all floods up to and including the design 1% AEP flood. This includes protection of 97 properties, 34 of which would be protected above floor level.

The works associated with Option S1 would cost about $1.52M to implement.

However, efficacy and cost-effectiveness are not the only considerations in the development and implementation of floodplain management measures. Community acceptance is also important for ownership of a proposed flood management solution.

A consultation program was undertaken during March 2009 to determine the views of the community on the suitability of the floodplain management measures that were proposed for consideration. This involved the distribution of a targeted questionnaire to 130 property owners. Although only 44 responses were received, analysis of these indicated that over 40% of North Shore residents did not favour the construction of a flood protection levee at North Shore. Normally this would be sufficient to preclude an option from further investigation. However, the data also shows that between 20% and 30% of the respondents indicated that they would support construction of a flood protection levee.

While only 44 responses were received (about 30% of property owners), the outcomes from the consultation suggest that the North Shore community has polarised views over the need for a ring levee. The findings from the consultation program established that there were many that were strongly in favour and many that were strongly against the Flood Modification Measure. Therefore, it is recommended that this option be included in the Plan but that any proposal to implement be determined based on changes in community attitudes. In that regard, it needs to be recognised that changes in future flood policy to accommodate the potential impacts of climate change, and indeed real life experience of floods such as the moderate flood in March 2013, may serve to influence community attitudes.
Option S2 - North Shore Levee (Scenario B) – West of Donnelly’s Creek

Option S2 involves an extension to the levee that is proposed as Option S1 (refer above). The levee would extend in a westerly direction along the river frontage of North Shore from Donnelly’s Creek, east of the Settlement Point – North Shore ferry terminal. It would loop around the majority of the urban precinct effectively providing flood protection to all dwellings located west of Donnelly’s Creek (refer Figure 2.7).

Option S2 would provide flood protection to 120 properties in floods up to and including the 1% AEP event. This is 23 more than for Option S1.

The works associated with Option S2 would cost about $1.9M to implement.

Option S3 - Settlement Point Ring Levee

Settlement Point is located on the southern floodplain of the Hastings River, opposite North Shore. Option S3 involves the construction of a ring levee around the residential area of Settlement Point (refer Figure 2.7).

A 1.5 kilometre length of Settlement Point Road would need to be raised in order to develop the levee. A further one kilometre length of earth levee would also need to be constructed on private and public land located to the east of Settlement Point Road, in order to form a ring around the residential precinct.

If it were constructed to provide 1% AEP level of flood protection, the levee would need to have a typical height of approximately 1.5 metres above existing natural surface along Settlement Point Road. This incorporates an allowance for 500 mm freeboard. Implementation of Option S3 would provide flood protection to 85 properties in events up to and including the 1% AEP flood.

The works associated with Option S3 would cost about $1.8M to implement.

Option S5 - Combination of North Shore Levee (S2) and Settlement Point Ring Levee (S3)

Option S5 is the combination of those options that were considered to provide flood protection to both North Shore and Settlement Point (refer Figure 2.7). That is, it is the combination of Option S2 (North Shore Levee – Scenario B) and Option S3 (Settlement Point Levee).

The results of simulations undertaken to assess the hydraulic impacts associated with construction of both the North Shore Levee and the Settlement Point Ring Levee, indicate that the residential areas within the proposed levees would be fully protected from inundation during all floods up to and including the 1% AEP flood.

The works associated with Option S5 would cost about $3.8M to implement.
3. FUTURE FLOOD PROBLEM

3.1 BACKGROUND

The potential future flooding problem refers to those areas of the floodplain that are likely to be proposed for future development or to be the subject of rezoning applications.

As the land available for development becomes increasingly scarce, pressures mount for development to occur in areas of the floodplain where it might otherwise have been avoided. These pressures are typically driven by population growth, but are compounded by economic pressures. For example, the costs associated with delivering infrastructure to new areas above the level of the PMF are typically much greater than the cost of augmenting existing infrastructure within the floodplain. Hence, there will undoubtedly be pressure for development of floodplain land and the future flooding problem is a real issue that needs to be considered from a planning perspective.

The future flooding problem has potential to cause additional flood damages in the Hastings River Floodplain and presents a potential risk to loss of life. Council has a duty of care to ensure that its current planning instruments recognise the potential flood risk. Council also has a responsibility to ensure that a Floodplain Risk Management Plan is in place and that this Plan, or an associated Flood Policy, can be used to support decisions to approve or reject development proposals on flood affected sections of the LGA.

In addition, unless the Probable Maximum Flood (PMF) is adopted as the basis for determining structural and planning measures aimed at reducing flood damages, there will always be a residual or continuing flooding problem.

The adoption of the PMF as the ‘planning flood’ is not realistic or practical because it would sterilise a large area of land, thereby forcing development to areas of higher ground which may not historically be serviced or which could introduce unrealistically high infrastructure costs.

Hence, a lesser flood standard is adopted. Port Macquarie-Hastings Council has adopted the 1% Annual Exceedence Probability flood plus a freeboard of 600 mm in areas west of the Pacific Highway and 900 mm in areas east of the Pacific Highway.

As a result, measures that are put in place to control flood damage will ultimately be overwhelmed by a flood that is larger than that adopted as the threshold for the planning control of land use, or as the limiting flood for the design of structural measures.

Accordingly, Council must also consider the implications of floods greater than the adopted planning flood and to work with the State Emergency Service (SES) to develop a contingency plan for such events.
3.2 FLOOD PLANNING LEVEL

In July 2009 Worley Parsons undertook a preliminary modelling investigation to analyse the potential impacts of climate change on existing flood planning levels. As a result of the preliminary investigation, it was recommended that existing freeboard requirements be increased by 100 mm to 600 mm in areas west of the Pacific Highway and 900 mm in areas east of the Pacific Highway.

Council endorsed this change, which was implemented in March 2010.

3.3 MEASURES TO ADDRESS THE FUTURE FLOOD PROBLEM

Measures to address the future flood problem typically comprise Property Modification Measures and Response Modification Measures. These include the implementation of appropriate planning measures and controls aimed at minimising the potential for additional damages during future floods.

Measures that have been assessed during the Floodplain Risk Management Study and recommended for inclusion in the Plan are as follows.

PL1. The road upgrades outlined in Section 8 of the Hastings Floodplain Risk Management Study should be undertaken to improve flood evacuation and increase evacuation times. These upgrades are to be prioritised based on opportunities that may arise as a function of Council’s capital works program for road infrastructure. The recommended roads for upgrade and the estimated cost are listed in Table 6.

Table 6  SUMMARY OF POTENTIAL WORKS TO IMPROVE FLOOD EVACUATION

<table>
<thead>
<tr>
<th>FLOOD MANAGEMENT COMMUNITY</th>
<th>POTENTIAL WORKS</th>
<th>EXISTING ROAD LEVEL (mAHD)</th>
<th>PROPOSED LEVEL (mAHD) AND ARI</th>
<th>LENGTH (m)</th>
<th>WIDTH (m)</th>
<th>COST ESTIMATE * (APPROX.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settlement Point Road</td>
<td>Raise section of Settlement Point Road</td>
<td>1.0</td>
<td>2.1 (5 Year)</td>
<td>1,200</td>
<td>6</td>
<td>$1.77M</td>
</tr>
<tr>
<td>Boundary Road</td>
<td>Raise section of Hastings River Drive</td>
<td>2.2</td>
<td>2.5 (20 Year)</td>
<td>750</td>
<td>10</td>
<td>$0.95M</td>
</tr>
<tr>
<td>Fernbank Creek</td>
<td>Raise section of Hastings River Drive</td>
<td>1.8</td>
<td>2.1 (5 Year)</td>
<td>2,500</td>
<td>12</td>
<td>$4.62M</td>
</tr>
<tr>
<td>Fernbank Creek</td>
<td>Raise section of Fernbank Creek Road</td>
<td>2.2</td>
<td>2.85 (20 Year)</td>
<td>800</td>
<td>6</td>
<td>$0.92M</td>
</tr>
<tr>
<td>North Shore</td>
<td>Raise sections of North Shore Drive / Shoreline Drive</td>
<td>1.2</td>
<td>2.1 (5 Year)</td>
<td>1,200</td>
<td>6</td>
<td>$1.9M</td>
</tr>
<tr>
<td>Riverside</td>
<td>Raise section of Shoreline Drive</td>
<td>1.4</td>
<td>2.4 (20 Year)</td>
<td>200</td>
<td>8</td>
<td>$0.35M</td>
</tr>
</tbody>
</table>

*Cost estimates are based on Rawlinsons Australian Construction Handbook, Edition 24, 2006, updated to 2014 costs via application of CPI.
PL2. It is recommended that SES purchase flood interpretation software and that flood warning data be incorporated into a specific package for the Hastings River Valley that will provide a flood forecasting tool for SES regional officers.

PL3. Additional BOM managed rainfall and stream flow gauges are to be incorporated into the existing network to improve flood predictions. In particular, new streamflow gauges need to be installed and monitored on the Hastings River upstream of Wauchope and on the Wilson River at Telegraph Point.

Additional streamflow gauges are to be installed at the following locations:
(i) Wilson / Maria Rivers - Below the junction of the Wilson and Maria Rivers
(ii) Hastings River - Below the junction of the Hastings River and the Forbes River
(iii) Hastings River - Below the junction of the Hastings River and the Pappinbarra River
(iv) Hastings River - Below the junction of the Hastings River and Ellenborough River

PL4. The floodways and flood storage areas identified as an outcome from the Hastings River Floodplain Risk Management Study (refer hydraulic category mapping in Figures 3.1 to 3.10) are to be adopted by Council and referenced in an amendment to Port Macquarie-Hastings Council Local Environment Plan 2011 (LEP 2011).

PL5. The relevant clauses in Council’s LEP are to be updated to reflect the latest standard clauses for flood prone land, which has been agreed to by the relevant state government agencies.

PL6. Council’s Interim Flood Policy is to be updated to address the issues raised in Section 10 of the Hastings Floodplain Risk Management Study. The revised policy is to be prepared as a specific LGA wide Flood Policy / Flood Guideline.

**Proposed Actions to Implement Options PL4, PL5 and PL6**

Council’s existing policy is now considered to be out-dated by virtue of the new flood data that has been generated for the lower Hastings Valley and amended/new government policies that have been adopted since 2007.

Accordingly, it is recommended that Council’s Interim Flood Policy be updated to address the issues raised above and that it be prepared as a specific LGA wide Flood Policy / Flood Guideline that is linked to LEP 2011 and hydraulic category mapping that has been generated as part of the Hastings Floodplain Risk Management Study.

It is recommended that the Draft Flood Policy / Guideline be developed so that it meets the requirements of the Port Macquarie-Hastings Council's consolidated standard DCP.

Flood related constraints also need to be considered as part of the strategic planning for future development and land release areas.
For example, flood related constraints need to be addressed fully by the Regional Strategy, Local Strategy (e.g., PMH Urban Growth Strategy 2010) or the planning proposal for a site specific rezoning.

The flood constraints of greatest importance to this process can be accommodated by addressing the following questions:

- Has the Flood Planning Area been considered in terms of defining development precincts?
- Has the full range of floods been considered? If the land release precinct looks like it will be suitable for development in floods up to the planning flood (i.e., the 100 year ARI flood), will there be the risk of a disaster if a flood that is a little larger occurs?
- Have emergency response management issues been considered? Can people who would live in future development precincts be safely evacuated should a flood rarer than the planning flood occur? What happens in a PMF?

In conjunction with this, it is important for Council’s planners to consider the potential cumulative impact of future development on flooding and the potential for evacuation before actually promoting development as part of separate land release precincts.

There can be no doubt that as population grows there will be increased pressure to allow further development within the floodplain. The Hastings Floodplain Risk Management Study identifies those areas of the floodplain that will need to be preserved into the future for the purposes of flood conveyance. Hence, the pressures for future development are likely to extend into flood storage areas.

The loss of some of these flood storage areas can be justified both hydraulically and from the perspective of not sterilizing all of the floodplain. However, it will be necessary to establish the cumulative impact of potential future development scenarios on flooding. Therefore, the following should be considered:

- Identification of the future development precincts that are earmarked for the next 20 years and a hydraulic analysis of the cumulative impact of all of those areas being developed (i.e., filled).
- Identification of those areas currently zoned 1(a) Rural that are likely to be the subject of rezoning applications at some stage over the next 10 years. These should be assessed now to determine a Council position on whether development of these areas would be consistent with Council’s overall strategy for development or whether their development would be at odds with flooding constraints under a cumulative impact scenario.
- Assessment of individual development precincts in total rather than ad hoc site specific Flood Impact and Flood Risk Assessments.
PL7. Future development approvals for the Hibbard South Development Precinct will need to consider both mainstream flooding of the Hastings River as well as local catchment runoff. For the Hibbard South Precinct, the flood planning level is to be based on either of the following, but whichever is the highest:

- the peak 100 year Average Recurrence Interval (ARI) flood level due to backwater flooding from the Hastings River, or
- the peak flood level due to local catchment runoff that enters and is retained within the wetland area between Boundary and Kemp Streets during an embedded 100 year ARI local catchment storm.

The 100 year ARI Hastings River flood level within the Hibbard South Development Precinct is estimated to be 3.1 mAHD.

However, there is potential for future infill development at Hibbard to effectively prevent flood flows from the Hastings River from “backing-up” into the Hibbard South Precinct. Therefore, the flood planning level for future development in the Hibbard South Development Precinct should be determined by the peak flood level in the wetland area that results from a 100 year ARI local catchment rainfall event.

Hydrologic modelling indicates that the peak flood level in a local catchment 100 year ARI storm event for existing and proposed conditions is about 1.5 mAHD. Therefore, if provision is made for freeboard, the governing Flood Planning Level for the Hibbard South Precinct would be 2.4 mAHD. The area that this Flood Planning Level will apply to is identified in Figure 3.11.

Details of the investigations undertaken are presented in Section 11 of the Hastings River Floodplain Risk Management Study.

PL8. That the updated Flood DCP incorporate the recommended climate change related planning considerations outlined in Section 12.2.2 of the Hastings River Floodplain Risk Management Study.

A preliminary investigation of the potential impacts of climate change has been undertaken by WorleyParsons. As a result, Council endorsed a number of changes to its Interim Flood Policy, these changes relate to freeboard requirements for development information required to support future rezoning or development applications.

PL9. That Council commission a separate study to investigate the full range of implications for flooding associated with climate change and to assess the accordance with the related statutory requirements.

PL10. Existing Section 149 certification for flood prone properties in the study area be reviewed. Where necessary, Section 149 certificates be modified to include up-to date flood data and information.
PL11. A detailed investigation should be undertaken to assess management options for the floodway between Fernbank Creek and Hibbard. The floodway alignment shown on Figure 3.6 identifies the hydraulic characteristics of the flooding patterns in this area. However, the floodway is shown as following an alignment that extends through the Aquatic Caravan Park and a number of existing dwellings that are sited on the opposite side of Hastings River Drive.

As this is an area of existing development and includes land that is zoned for tourism, it is appropriate to investigate the potential to modify the floodway as currently shown so that it avoids the current development while at the same time maintains the necessary flow conveyance.

It is also recommended that the following measure be implemented to increase community awareness and preparedness for flooding:

PL12. Develop and implement a community flood awareness and preparedness program, working with SES to use FloodSafe Program materials.
4. FLOODPLAIN RISK MANAGEMENT PLAN

4.1 RECOMMENDED FLOOD MODIFICATION WORKS

The following Flood Modification Measures are recommended for implementation as part of the Floodplain Risk Management Plan.


   **Option S1** – North Shore Levee (Scenario A) – West of Ferry Terminal. This option is expected to reduce the Average Annual Damage by $409,000.
   The capital cost of the works is estimated to be $1.52M. The present value of the benefits associated with implementing Option S1 would be about $5.0M.
   OR

   **Option S2** – North Shore Levee (Scenario B) – West of Donnelly's Creek. This option is expected to reduce the Average Annual Damage by $438,000.
   It is estimated that this option would cost about $1.9M to implement with the estimated present value of the benefits associated the option being approximately $5.5M.

   It should be noted that due to the inconclusive response from residents, implementation of Options S1, S2 or both, which involve the construction of a ring levee at North Shore, may depend on community acceptance or a future change in flood policy.

2. Construct Settlement Point Flood Protection Levee.

   This option is expected to reduce the Average Annual Damage by $358,000. Option S3 would cost about $1.8M to implement, including road construction costs.
   The present value of the benefits associated with implementing Option S3 would be approximately $4.4M.

4.2 PROPERTY MODIFICATION MEASURES – PLANNING CONTROLS AND POLICIES

The following Property Modification Measures are recommended for implementation as part of the Floodplain Risk Management Plan. Reference is made to Chapters 10, 11 and 12 of the Floodplain Risk Management Study for a comprehensive description of the measures.

3. The Hastings River floodplain floodway extents and flood storage areas be adopted by Council and referred to by the Local Environment Plan (LEP) and proposed Flood Policy / DCP.

4. The relevant clauses in Council’s LEP should be updated to reflect the latest standard clauses for flood prone land, which has been agreed to by the relevant state government agencies (if not already).
5. That council’s interim flood policy be updated to address the issues raised in Chapter 10 of the Hastings Floodplain Risk Management Study and that it be prepared as a specific LGA wide Flood DCP/ Flood Policy.

6. That the existing Section 149 certification for flood prone properties in the study area be reviewed. Where necessary, Section 149 certificates be modified to include up-to-date flood data and information.

7. That Council commission a separate study to investigate the full range of implications for flooding associated with climate change and to assess the accordance with the related statutory requirements.

8. That Council commission a Hibbard Precinct Floodway Refinement Study to investigate potential options for the management of the designated floodway between Fernbank Creek and Hibbard, including potential options to modify the current floodway to accommodate existing development, while at the same time maintaining flow conveyance.

Future development approvals of the Hibbard South Development Precinct will need to consider both mainstream flooding of the Hastings River as well as the local catchment run-off, which is documented in Chapter 11 of the Hastings River Floodplain Risk Management Study.

9. That Council use the latest flood modelling for the Hastings River Floodplain Risk Management Study to prepare a strategy to protect (or otherwise) existing infrastructure that will be exposed to more frequent fluvial and tidal flooding as climate change impacts manifest.

10. Investigate options for properties / dwellings that fall within the floodway corridors for house raising.

4.3 RESPONSE MODIFICATION MEASURES

The following response modification measures are recommended for implementation as part of the Floodplain Risk Management Plan:

11. It is recommended that SES purchase flood interpretation software and that flood warning data be incorporated into a specific package for the Hastings River Valley that will provide a flood forecasting tool for SES regional officers.

12. Additional BOM managed stream flow gauges Additional streamflow gauges are to be installed at the following locations:

(i) Wilson / Maria Rivers - Below the junction of the Wilson and Maria Rivers
(ii) Hastings River - Below the junction of the Hastings River and the Forbes River
(iii) Hastings River - Below the junction of the Hastings River and the Pappinbarra River
(iv) Hastings River - Below the junction of the Hastings River and Ellenborough River
13. to 18. The road upgrades outlined in Section 3 should be undertaken to improve flood evacuation capacity and increase evacuation times. These upgrades should be prioritised based on opportunities that may arise as a function of Council’s capital works program for road infrastructure upgrades.

19. Develop and implement a community flood awareness and preparedness program, working with SES to use FloodSafe Program materials.

4.4 IMPLEMENTATION STRATEGY

The recommended options and measures for adoption as part of the Plan are summarised in the Implementation Schedule that is enclosed within Appendix A. An indication of the priority and cost associated with implementing the option is provided therein.

The priority classification has been developed in consideration of the implications associated with each option. The adopted prioritisation is as follows:

(1) Represents tasks with a high priority, where a delay in implementing the recommendation has the potential to prejudice flood related planning matters or expose residents to significant flood risks.

(2) Represents tasks with a medium priority, where a delay in implementing the recommendations has some potential to expose residents to moderate flood risks.

(3) Represents tasks with a lower priority that are less urgent, which should proceed at some time over the next 3 to 6 years, but may be dependent on the outcomes of other strategies.

The total cost of Priority 1 measures is estimated to be $4.42M. The cost of Priority 2 measures would be $3.28M, and Priority 3 measures are estimated to amount to $7.66M.
5. REFERENCES

- Department of Natural Resources (in draft, 2004), ‘Floodplain Management Guideline No 4 – Residential Flood Damage Calculation’.
- Smith DI (1992), ‘The Evaluation of Intangibles’; prepared for Patterson Britton & Partners Pty Ltd on behalf of the Warragamba IDC.
APPENDIX A – IMPLEMENTATION SCHEDULE
### HASTINGS RIVER FLOODPLAIN MANAGEMENT PLAN - IMPLEMENTATION SCHEDULE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>RECOMMENDED STRATEGY</th>
<th>PRIORITY RANKING</th>
<th>SUB-TASKS</th>
<th>ESTIMATED COST</th>
<th>SUGGESTED RESPONSIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Construct North Shore Flood Protection Levee (Option S1 or S2)</td>
<td>3</td>
<td>1. Review results of supplementary study into climate change impacts on Design Flood Characteristics and determine short, medium and long term implications for North Shore. Establish projected timescale for levee that acknowledges community-based safety requirements.&lt;br&gt;2. Undertake local scale stakeholder consultation to educate local community on implications of climate change on design flood characteristics and associated risk to life.&lt;br&gt;3. Prepare REF/FEA for North Shore Levee. Develop preliminary concept design that recognizes staggered impacts of climate change.&lt;br&gt;4. Apply for funding under the floodplain management grants program.&lt;br&gt;5. Develop formal concept design incorporating additional stakeholder/community consultation.&lt;br&gt;6. Undertake Detail Design.</td>
<td>$250,000</td>
<td>PMHC / OEH</td>
</tr>
<tr>
<td>2.</td>
<td>Construct Settlement Point Flood Protection Levee (Option S3)</td>
<td>2</td>
<td>1. Review results of supplementary study into climate change impacts on Design Flood Characteristics and determine short, medium and long term implications for Settlement Point. Establish projected timescale for levee that acknowledges community-based safety requirements.&lt;br&gt;2. Undertake local scale stakeholder consultation to educate local community on implications of climate change on design flood characteristics and associated risk to life.&lt;br&gt;3. Prepare REF/FEA for Settlement Point Levee. Develop preliminary concept design that recognizes staggered impacts of climate change.&lt;br&gt;4. Apply for funding under the floodplain management grants program.&lt;br&gt;5. Develop formal concept design incorporating additional stakeholder/community consultation.&lt;br&gt;6. Undertake Detail Design.</td>
<td>$250,000</td>
<td>PMHC / OEH</td>
</tr>
</tbody>
</table>

*Cost-estimates should be viewed as indicative only and should not be relied upon for budget or grant estimates unless updated to present day terms (2014 dollar)。

**TOTAL = $1,770,000**

### PROPERTY MODIFICATION MEASURES - PLANNING CONTROLS AND POLICIES

<table>
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<tr>
<th>ITEM</th>
<th>RECOMMENDED STRATEGY</th>
<th>PRIORITY RANKING</th>
<th>SUB-TASKS</th>
<th>ESTIMATED COST</th>
<th>SUGGESTED RESPONSIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Adopt Floodway Extents and Flood Storage Areas, recommended in the Hastings Floodplain Risk Management Study</td>
<td>1</td>
<td>1. Council staff to utilise mapping in conjunction with the Interim Flood Policy.</td>
<td>-</td>
<td>PMHC</td>
</tr>
<tr>
<td>4.</td>
<td>Update Port Macquarie-Hastings LEP 2011 to reflect latest standard clauses for the management of flood prone land</td>
<td>1</td>
<td>1. Develop recommended changes in wording for flood-related clauses within Port Macquarie - Hastings LEP 2011.&lt;br&gt;2. Submit recommended clause changes to Council’s Planning Department for consideration.&lt;br&gt;3. Workshop with Council’s Dept of Planning (as required).&lt;br&gt;4. Submit final recommended clause changes to Council for acceptance.&lt;br&gt;5. Following Council acceptance, forward to NSW Dept of Planning &amp; Infrastructure for adoption and incorporation into LEP 2011.</td>
<td>$9,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>5.</td>
<td>Prepare and Adopt LGA Wide Flood DCP/Policy</td>
<td>1</td>
<td>1. Prepare LGA Wide Flood DCP in line with Draft DCP recommendations to apply across the entire LGA, incorporating:&lt;br&gt;- provision for climate change impacts on design flood levels and flood planning area&lt;br&gt;- protocols for approvals on and within the Hibbard South Precinct&lt;br&gt;- exhibit draft Flood DCP in accordance with statutory requirements.&lt;br&gt;2. Council Adoption of Flood DCP.</td>
<td>$30,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>ITEM</td>
<td>RECOMMENDED STRATEGY</td>
<td>PRIORITY RANKING</td>
<td>SUB-TASKS</td>
<td>ESTIMATED COST</td>
<td>SUGGESTED RESPONSIBILITY</td>
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</tr>
</tbody>
</table>
| 6    | Review Section 149 Certificates for flood prone properties with reference to 2011 Flood Planning Area and PMF Extent | 1              | 1. Review S149 Certificates relative to 2011 Flood Planning Area and PMF Extent Mapping  
2. Identify areas / properties formerly outside 100 year ARI extent that would now be covered by flooding  
3. Review S149 Certificates for these properties to establish whether wording suitably defines the potential flood risk and amend as required  
4. Review S149 Certificates for those properties that fall between the FPA and the PMF Extent and establish whether wording suitably defines the potential flood risk. Amend as required. | $60,000 | PMHC |
| 7    | Commission a Climate Change Assessment Study to investigate and quantify the implications of climate change on existing flood predictions to Year 2100 | 2              | 1. Prepare Brief defining climate change scenarios to be investigated  
2. Engage consultant to undertake associated modelling  
3. Undertake Investigations and compare results to Design Levels adopted in Hastings FRMS (2011)  
4. Adopt revised Design Flood Levels (as appropriate)  
5. Determine and map Updated Flood Planning Area (as required) | $90,000 | PHMC / OEH |
| 8    | Commission a Hibbard Precinct Floodway Refinement Study to investigate potential options for the management of the designated floodway between Fernbank Creek and Hibbard, including potential options to modify the current floodway to accommodate existing development, while at the same time maintaining flow conveyance | 2              | 1. Undertake “local scale” investigation to identify potential alternative floodway alignments through Hibbard Precinct  
2. Consult with stakeholders including landowners to identify feasible floodway alternatives  
3. Identify potential properties for buy back over time  
4. Determine recommended alternative / refined floodway corridor  
5. Identify potential properties for voluntary purchase  
6. Develop Implementation Plan | $45,000 | PMHC |
| 9    | Commission a Climate Change Adaptation Study for the lower Hastings River Estuary that sets a strategy for protecting (or otherwise) existing infrastructure that will be exposed to more frequent fluvial and tidal flooding as climate change impacts manifest | 3              | 1. Review results of Supplementary Climate Change Modelling Investigation (Item 7) and prepare Brief defining climate change adaptation investigation requirements  
2. Engage consultant  
3. Undertake Investigations and Develop Adaptation Strategy | $50,000 | PMHC / OEH |
| 10   | Investigate options for properties / dwellings that fall within the floodway corridors for house raising | 2              | 1. Identify relevant floodway areas:  
- Ovals Crescent  
- Blackman’s Point  
- Fernbank Creek  
- Sections along Hastings River Drive in Hibbard  
2. Engage consultant to investigate feasibility and cost for house raising works  
3. Consult with residents and landowners to gauge their support for house raising | $60,000 | PMHC / OEH |
<table>
<thead>
<tr>
<th>ITEM</th>
<th>RECOMMENDED STRATEGY</th>
<th>PRIORITY RANKING</th>
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<th>ESTIMATED COST</th>
<th>SUGGESTED RESPONSIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td><strong>Flood Modification Works</strong>&lt;br&gt;Develop flood interpretation software package which incorporates flood warning data for use as a flood management tool for SES Regional Office.</td>
<td>11</td>
<td>1. Identify flood interpretation software e.g. waterRIDE or other software&lt;br&gt;2. Engage consultant to develop flood forecasting tool&lt;br&gt;3. Develop Flood Forecasting Tool&lt;br&gt;4. Undertake training of SES personnel in the use of the Flood Forecasting Tool</td>
<td>$25,000</td>
<td>SES (with assistance from PMHC)</td>
</tr>
<tr>
<td>12</td>
<td><strong>Install additional rainfall and streamflow gauges</strong> particularly at Dennis Bridge and Telegraph Point and identify any additional sites required</td>
<td>1</td>
<td>1. Engage with BoM/MHL to identify process for installation of streamflow gauges&lt;br&gt;2. Procure gauge and commence installation</td>
<td>$50,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>13</td>
<td><strong>Raise Settlement Point Road</strong> between the ferry wharf and Park Street</td>
<td>1</td>
<td>1. Prepare REF/EA for road raising&lt;br&gt;2. Apply for funding under the floodplain management grants program&lt;br&gt;3. Prepare concept &amp; detail design&lt;br&gt;4. Undertake construction works</td>
<td>$95,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>14</td>
<td><strong>Raise Hastings River Drive</strong> from west of Boundary Road to Tufts Lane</td>
<td>2</td>
<td>1. Prepare REF/EA for road raising&lt;br&gt;2. Apply for funding under the floodplain management grants program&lt;br&gt;3. Prepare concept &amp; detail design&lt;br&gt;4. Undertake construction works</td>
<td>$60,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>15</td>
<td><strong>Raise Hastings River Drive</strong> between Fernbank Creek bridge and the existing Pacific Highway</td>
<td>3</td>
<td>1. Prepare REF/EA for road raising&lt;br&gt;2. Apply for funding under the floodplain management grants program&lt;br&gt;3. Prepare concept &amp; detail design&lt;br&gt;4. Undertake construction works</td>
<td>$240,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>16</td>
<td><strong>Raise Fernbank Creek Road</strong></td>
<td>3</td>
<td>1. Prepare REF/EA for road raising&lt;br&gt;2. Apply for funding under the floodplain management grants program&lt;br&gt;3. Prepare concept &amp; detail design&lt;br&gt;4. Undertake construction works</td>
<td>$90,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>17</td>
<td><strong>Raise Shoreline Drive and North Shore Drive (subject to construction of North Shore and Settlement Point Levees)</strong></td>
<td>1</td>
<td>1. Prepare REF/EA for road raising&lt;br&gt;2. Apply for funding under the floodplain management grants program&lt;br&gt;3. Prepare concept &amp; detail design with consideration of existing stormwater drainage issues&lt;br&gt;4. Undertake construction works</td>
<td>$85,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>18</td>
<td><strong>Raise short section of Shoreline Drive</strong> near Riverside Drive intersection (interim emergency response measure)</td>
<td>1</td>
<td>1. Prepare REF/EA for road raising&lt;br&gt;2. Apply for funding under the floodplain management grants program&lt;br&gt;3. Prepare concept &amp; detail design&lt;br&gt;4. Undertake construction works</td>
<td>$35,000</td>
<td>PMHC</td>
</tr>
<tr>
<td>19</td>
<td><strong>Develop and initiate flood education and awareness program</strong> for vulnerable groups and flood affected communities</td>
<td>1</td>
<td>1. Vulnerable groups to include:&lt;br&gt;- Heritage Christian School at Hibbard&lt;br&gt;- Wauchope High School&lt;br&gt;- St Josephs Primary School and Regional High School&lt;br&gt;2. Priority flood affected communities to target:&lt;br&gt;- Settlement Point&lt;br&gt;- Hibbard&lt;br&gt;- Fernbank&lt;br&gt;- Backmans Point</td>
<td>$35,000</td>
<td>PMHC</td>
</tr>
</tbody>
</table>

* Preliminary cost estimates are based on WorleyParsons’ experience and judgement as a firm of practising professional engineers familiar with the construction industry. Construction cost estimates may exclude items which should be considered in a cost plan. Examples of such items are design fees, project management fees, authority approval fees, contractors risk and project contingencies (e.g. to account for construction and site conditions, weather conditions, ground conditions and unforeseen services). The Preliminary Cost Estimates are not to be relied upon for the purposes of construction. If a reliable cost estimate is required, then an appropriately qualified Quantity Surveyor should be engaged.