South Western CFRAM Study

Preliminary Options Report UoM 21

July 2016

The Office of Public Works

Oifig na nOibreacha Poiblí
The Office of Public Works

SOUTH WESTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

Mott MacDonald

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Preliminary Options Report UoM 21

July 2016

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Executive Summary

The Office of Public Works (OPW) is undertaking six catchment-based flood risk assessment and management (CFRAM) studies to identify and map areas across Ireland which are at existing and potential future risk of flooding. Mott MacDonald Ireland Ltd. has been appointed by the OPW to assess flood risk and develop flood risk management options in the South Western River Basin District. This Preliminary Options Report is one of a series of reports being produced as part of the South Western Catchment Flood Risk Assessment and Management Study (SW CFRAM Study). This report details the analysis undertaken to identify the preferred measures and options to manage flood risk in Unit of Management 21 (The Dunmanus / Bantry / Kenmare Bay Catchment) which will form the basis for the Flood Risk Management Plan for this Unit of Management.

The preferred Flood Risk Management Options selected for inclusion in the Flood Risk Management Plan for UoM 21 are set out below:

- Planning Control
- Building Regulations
- SUDS
- Public Awareness
- Individual Property Flood Resilience
- Land Use Management

In addition to the options selected for the UoM, the preferred Flood Risk Management Options selected for inclusion in the Flood Risk Management Plan for each of the AFAs in UoM 21 are set out below:

The preferred option for Bantry as identified in the MCA is Flood Defences. There was no feedback provided at the Bantry PCD.

The preferred option for Castletownbere as identified in the MCA is Flood Defences. The limited feedback provided at the Castletownbere PCD indicated that the public agreed with the preferred option indicated in the MCA.

The preferred option for Kenmare as identified in the MCA is Conveyance and Flood Defences. The feedback provided at the Kenmare PCD indicated that the public agreed with the preferred option indicated in the MCA. Based on the feedback provided at the PCD alternative options including a flow diversion of the Kealnagower Stream were considered. However, the preferred option remains Conveyance and Flood Defences.

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1 Introduction

1.1 Background

Flooding is a natural process that occurs throughout Ireland as a result of extreme rainfall, river flows, storm surges, waves, and high groundwater. Flooding can become an issue where the flood waters interact with people, property, farmland and protected habitats.

Flood risk in Ireland has historically been addressed through the use of structural or engineered solutions (arterial drainage schemes and / or flood relief schemes). In line with internationally changing perspectives, the Government adopted a new policy in 2004 that shifted the emphasis in addressing flood risk towards:

- A catchment-based context for managing risk;
- More pro-active flood hazard and risk assessment and management, with a view to avoiding or minimising future increases in risk, such as that which might arise from development in floodplains;
- Increased use of non-structural and flood impact mitigation measures.

A further influence on the management of flood risk in Ireland is the 'Floods' Directive [2007/60/EC]. The aim of this Directive is to reduce the adverse consequences of flooding on human health, the environment, cultural heritage and economic activity.

The Office of Public Works (OPW) is the lead agency in implementing flood management policy in Ireland. The OPW have commissioned a number of Catchment Flood Risk Assessment and Management Studies in order to assess and develop Flood Risk Management Plans (FRMPs) to manage the existing flood risk and also the potential for significant increases in this risk due to climate change, ongoing development and other pressures that may arise in the future.

Mott MacDonald Ireland Ltd. has been appointed by the OPW to undertake the Catchment-Based Flood Risk Assessment and Management Study (CFRAM Study) for the South Western River Basin District, henceforth referred to as the SW CFRAM Study. Under the project, Mott MacDonald Ireland Ltd. will produce FRMPs which will set out recommendations for the management of existing flood risk in the Study Area, and also assess the potential for significant increases in this risk due to climate change, ongoing development and other pressures that may arise in the future.

1.1 SW CFRAM Study Process

The overarching aims of the SW CFRAM Study are as follows:

- Identify and map the existing and potential future flood hazard;
- Assess and map the existing and potential future flood risk; and,
- Identify viable structural and non-structural options and measures for the effective and sustainable management of flood risk in the South Western River Basin District.

In order to achieve the overarching aims, the study is being undertaken in the following stages:

- Data collection;
- Hydrological analysis;
- Hydraulic analysis;
- Development of flood maps;
- Strategic Environmental Assessment and a Habitats Directive Appropriate Assessment;
- Flood risk assessment of people, economy and environment;
- Development and assessment of flood risk mitigation options; and,
- Development of the Flood Risk Management Plan (FRMP).

The resultant FRMP will set out recommendations for the management of existing flood risk and the potential for significant increases in this risk due to climate change, ongoing development and other pressures that may arise in the future.

The South Western River Basin District is split into five Units of Management (UoM). These Units follow watershed catchment boundaries and do not relate to political boundaries. The Units are as follows;

- The Blackwater Catchment (UoM 18)
- The Lee / Cork Harbour Catchment (UoM 19)
- The Bandon / Skibbereen Catchment (UoM 20)
- The Dunmanus / Bantry / Kenmare Bay Catchment (UoM 21)
- The Laune / Maine / Dingle Bay Catchment (UoM 22)

1.2 Report Structure

Table 1.1: Report Structure

Chapter	Key Contents of Chapter
1. Introduction	▪ Context of the Study ▪ The SW CFRAM process and aims ▪ Scope of Work
2. Description of the Unit of Management	▪ Description of study area ▪ Description of spatial scales of assessment
3. Screening of Possible Flood Risk Management Measures	▪ Description of the screening process ▪ Outcome of the screening process
4. Possible Flood Risk Management Measures	▪ Description of non-structural FRM measures ▪ Description of Structural measures
5. Development of Potential Flood Risk Management Options for AFAs	▪ Description of potential FRM options
6. Environmental Assessment	▪ Assessment of environmental impacts of potential FRM options
7. Stakeholder Input	▪ Summary of public consultations undertaken ▪ Summary of feedback received at public consultations
8. Flood Risk Assessment	▪ Description of the flood risk assessment process ▪ Description of receptors ▪ Description of flood risk maps
9. Estimate of Costs	▪ Estimate of costs of potential options
10. Appraisal of Options	▪ Description of the derivation of local weightings ▪ Description of the multi criteria analysis process
11. Selection of Preferred Options	▪ Description of preferred options

2 Description of the Unit of Management

2.1 Spatial Scales of Assessment

The South Western River Basin District covers an area of approximately 11,160 km^2. The Study Area includes most of County Cork, large parts of Counties Kerry and Waterford, along with small parts of the counties of Tipperary and Limerick. The Study Area contains over 1,800 km of coastline along the Atlantic Ocean and the Celtic Sea. There are five Units of Management within the South Western River Basin District, which are listed below:

- The Blackwater Catchment (UoM 18)
- The Lee / Cork Harbour Catchment (UoM 19)
- The Bandon / Skibbereen Catchment (UoM 20)
- The Dunmanus / Bantry / Kenmare Bay Catchment (UoM 21)
- The Laune / Maine / Dingle Bay Catchment (UoM 22)

Within the CFRAM Study, the screening, assessing and developing of Flood Risk Management (FRM) methods and options is to be considered on a range of Spatial Scales of Assessment (SSAs) that shall include:

- The Units of Management (UoM)
- Each Sub-Catchment within the Unit of Management
- Areas for Further Assessment (AFAs)
- Individual Risk Receptors (IRRs)

2.2 Spatial Scales of Assessment for Unit of Management 21

Within UoM 21 the AFAs do not form any sub-catchments as they are on separate watercourses and located in the lower reaches of the watercourse with no other downstream receptors.

No IRRs have been identified within the South Western RBD and as such are not considered.

Based on the above, UoM 21 is split into 2 Spatial Scales of Assessment (SSAs). These are:

- The Unit of Management (UoM)
- Areas for Further Assessment (AFAs)
  - Bantry
  - Castletownbere
  - Durrus
  - Kenmare

3 Screening of Possible Flood Risk Management Methods

3.1 General

A flood risk management option consists of one or, more commonly, a combination of flood risk management (FRM) methods or measures. The OPW have identified a range of possible FRM methods that could apply to areas at risk from flooding. The screening of possible FRM methods to determine their applicability and viability is carried out in this section.

3.2 Screening of Possible Flood Risk Management Methods

A preliminary assessment was carried out to identify which Flood Risk Management (FRM) methods were applicable to each of the SSAs within UoM 21.

The applicability and viability of each of the FRM methods was considered in terms of the following criteria:

- Applicability to the SSA
- Economic (potential benefits, impacts, likely costs etc.)
- Environmental (potential impacts and benefits)
- Social (impacts on people, society and the likely acceptability of the method) and
- Cultural (potential benefits and impacts upon heritage sites and resources)

The viability of each of the methods was assessed to a preliminary degree only. The purpose of the screening process was to identify the FRM methods that are clearly not applicable or viable within UoM 21. The FRM methods considered and the outcome of the screening process are shown in Table 3.1 below.

Table 3.1: Screening of Possible Flood Risk Management Methods

Measures / Methods	UoM	Sub-Catchment	AFA			
	21	N/A	Bantry	Castletownbere	Durrus	Kenmare
Do Nothing	Not Viable	N/A	Not Viable	Not Viable	Viable	Not Viable
Existing Regime	Not Viable	N/A	Not Viable	Not Viable	Viable	Not Viable
Do Minimum	Not Viable	N/A	Not Viable	Not Viable	Not Viable	Not Viable
Non-structural Measures						
• Planning Control	Viable	N/A	Viable	Viable	Viable	Viable
• Building Regulations	Viable	N/A	Viable	Viable	Viable	Viable
• SUDS	Viable	N/A	Viable	Viable	Viable	Viable
• Flood Forecasting	Viable	N/A	Viable	Viable	Viable	Not Viable
• Public Awareness	Viable	N/A	Viable	Viable	Viable	Viable
• Individual Property Flood Resilience	Viable	N/A	Viable	Viable	Viable	Viable
• Land Use Management	Viable	N/A	Viable	Viable	Viable	Viable
Structural Measures (Future Risk)						
• Strategic Development Management	Viable	N/A	Viable	Viable	Viable	Viable
Structural Measures (Current Risk)						
• Fluvial Storage	Viable	N/A	Viable	Not Viable	Not Viable	Viable
• Flow Diversion	Not Viable	N/A	Not Viable	Not Viable	Not Viable	Viable
• Increase Conveyance	Not Viable	N/A	Viable	Not Viable	Not Viable	Viable
• Flood Defences	Not Viable	N/A	Viable	Viable	Not Viable	Viable
• Improve existing defences	Not Viable	N/A	Not Viable	Not Viable	Not Viable	Not Viable
• Relocate Properties	Viable	N/A	Not Viable	Not Viable	Not Viable	Not Viable
• Localised protection works	Not Viable	N/A	Viable	Viable	Not Viable	Viable
Channel or Flood Defence Maintenance Works	Not Viable	N/A	Not Viable	Not Viable	Not Viable	Not Viable
Other Works	-	N/A	Tidal Barrage	-	-	-

3.3 Screening of UoM scale FRM Methods

3.3.1 Do Nothing / Existing Regime / Do Minimum

These measures are not viable due to the significant flood risk within UoM 21 to the economy and society for extreme events in the current and future scenarios. These measures are not economically viable.

3.3.2 Structural Measures (Current Risk)

Structural measures are typically not applicable to UoM scale SSAs due to cost and the likely significant social and environmental impacts of such works. Also, within UoM scale SSAs there are areas and receptors which are less vulnerable to flooding. Structural measures are more appropriate and applicable to AFA scale SSAs.

However, structural measures such as upstream storage and relocation of properties can be viable structural measures on a UoM scale.

3.4 Screening of Sub-Catchment scale FRM Methods

As outlined in Section 2.2 there are no sub-catchments within UoM 21.

3.5 Screening of AFA scale FRM Methods

This section details each of the non-viable measures which have been screened out from further assessment. The remaining viable Flood Risk Management measures are assessed further in Chapter 4 and Chapter 5.

3.5.1 Do Nothing / Existing Regime

For the majority of the AFAs these measures are not viable due to the significant flood risk to the economy and society for extreme events in the current scenario and for future scenarios.

However, as part of the Flood Risk Assessment and Mapping, Durrus was identified as having a low existing risk as there are no properties within the 1% AEP fluvial event flood extent. As a result, Durrus has been excluded from the development of FRM Options on the basis that there is a low likelihood of achieving a cost-beneficial solution and/or the low priority that would be given to the AFA for any such works. Therefore, for Durrus, the Do Nothing / Existing Regime are viable measures while all other structural measures are deemed to be not economically viable.

3.5.2 Do Minimum (e.g. Infilling of gaps etc.)

Within the AFAs considered there are no identifiable points or locations where minimum works such as infilling of gaps etc. would lead to a reduction in flood risk. Therefore, the do minimum approach is not applicable.

3.5.3 Bantry – Flow Diversion

There are a number of watercourses within the Bantry AFA that give rise to flooding. The topography and existing development within the surrounding areas restricts the possible diversion routes. This measure is not applicable.

3.5.4 Bantry – Improve Existing Defences

There are no existing flood defences in Bantry. This measure is not applicable.

3.5.5 Bantry – Relocate Properties

There are no isolated properties at risk within Bantry. There are 148 properties at risk of flooding. The available capped benefit in Bantry is €42,962,484. The available budget to relocate each property is €290,287. It is not likely that a property could be relocated in Bantry for this sum. This measure is therefore not economically or socially viable.

3.5.6 Bantry – Channel or Flood Defence Maintenance Works

Bantry does not have an existing channel scheme or flood defence scheme to maintain. This measure is not applicable.

3.5.7 Castletownbere – Fluvial Storage

Castletownbere is at risk of tidal flooding. Fluvial storage is not applicable.

3.5.8 Castletownbere – Flow Diversion

Castletownbere is at risk of tidal flooding. Flow diversion is not applicable.

3.5.9 Castletownbere – Increase Conveyance

Castletownbere is at risk of tidal flooding. Increase conveyance is not applicable.

3.5.10 Castletownbere – Improve Existing Defences

There are no existing flood defences in Castletownbere. This measure is not applicable.

3.5.11 Castletownbere – Relocate Properties

There are 29 properties at risk of flooding. The available capped benefit in Castletownbere is €3,056,759. The available budget to relocate each property is €105,405. It is not likely that a property could be relocated in Castletownbere for this sum. This measure therefore is not economically or socially viable.

3.5.12 Castletownbere – Channel or Flood Defence Maintenance Works

Castletownbere does not have an existing channel scheme or flood defence scheme to maintain. This measure is not applicable.

3.5.13 Kenmare – Flood Forecasting

The time to peak is less than 5 hours, which limits the time available for flood warning. This measure is not applicable.

3.5.14 Kenmare – Improve Existing Defences

There are no existing flood defences in Kenmare. This measure is not applicable.

3.5.15 Kenmare – Relocate Properties

There are 161 properties at risk of flooding. The available capped benefit in Kenmare is €10,671,146. The available budget to relocate each property is €66,280. It is not likely that a property could be relocated in Kenmare for this sum. This measure therefore is not economically or socially viable.

3.5.16 Kenmare – Channel or Flood Defence Maintenance Works

Kenmare does not have an existing channel scheme or flood defence scheme to maintain. This measure is not applicable.

4 Possible Flood Risk Management Measures

4.1 General

A flood risk management option consists of one or, more commonly, a combination of flood risk management methods / measures. This section assesses the possible flood risk management measures as screened in Table 3.1.

4.2 Non-Structural Measures

Non-structural measures such as Land Use Management, Natural Flood Management, Green Infrastructure etc. are terms used to cover a suite of measures that are intended to reduce flood risk by working with natural systems and, where possible, provide environmental benefits. While in small catchments they can effectively manage flood risk to a certain degree in their own right, in larger catchments they can work in a complimentary way with other measures to achieve flood risk management targets.

Due to the time required to initiate, establish and prove the flood risk management targets of such measures, they are not deemed viable to mitigate the current flood risk and any potential reductions in flood risk should not be considered when developing other options based on structural measures.

Where there is existing flood risk, the implementation of non-structural measures such as Planning Control, SUDS etc. at any spatial scale of assessment will not mitigate flood risk, unless those measures are retrospectively applied. As this is unrealistic and not economically viable, such non-structural measures can only be applied to new development to maintain the status quo of the current flood risk scenario or mitigate future flood risk. The application of non-structural measures such as individual property resilience, public awareness and flood forecasting, to redevelopment or new development may reduce potential damage costs.

The non-structural measures described in this section are complimentary to structural measures and should be implemented as national policy to the SSAs where appropriate. However, at this stage they should not be considered in the development of options based on structural measures.

4.2.1 Planning Control

In November 2009, the Guidelines on the Planning System and Flood Risk Management, jointly developed by DECLG and the OPW, were published under Section 28 of the Planning Acts. These Guidelines provide a systematic and transparent framework for the consideration of flood risk in the planning and development management processes, whereby:

A sequential approach should be adopted to planning and development based on avoidance, reduction and mitigation of flood risk.

A flood risk assessment should be undertaken that should inform the process of decision-making within the planning and development management processes at an early stage.

Development should be avoided in floodplains unless there are demonstrable, wider sustainability and proper planning objectives that justify appropriate development and where the flood risk to such development can be reduced and managed to an acceptable level without increasing flood risk elsewhere (as set out through the Justification test).

The proper application of the Guidelines by the planning authorities is essential to avoid inappropriate development in flood prone areas, and hence avoid unnecessary increases in flood risk into the future. The flood mapping provided as part of the FRMP will facilitate the application of the Guidelines.

In flood-prone areas where development can be justified (i.e., re-development, infill development or new development that has passed the Justification Test), the planning authorities can manage the risk by setting suitable objectives or conditions, such as minimum floor levels or flood resistant or resilient building methods.

4.2.2 Building Regulations / Planning Conditions

The risk of damage to properties from flooding can be mitigated by the use of appropriate construction techniques and materials. For example the damage caused to an internal wall of a property by flooding can depend on the materials and methods of its construction. A timber stud partition covered with plasterboard with low level electrical wiring would have to be completely replaced following immersion in flood water. However, a solid concrete block wall covered with tiles and high level electrical wiring on the other hand would only have to be washed down following a flood.

If for a particular town or high flood probability areas, certain building regulations or planning conditions were adopted that ensured structures were flood resilient through specified construction methods, building fabrics and uses, a decrease in the risk of damage could be achieved. The question of whether such regulations or planning conditions could be imposed upon developers, business owners or householders in flood prone areas would need to be addressed if this were to be brought forward as a flood risk management measure.

A link to a UK guidance document “Improving the Flood Performance of New Buildings” prepared by the Department for Communities and Local Government is provided below.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

4.2.3 Sustainable Urban Drainage Systems (SUDS)

Sustainable Urban Drainage (SUDS) involves the management of surface water run-off from developments in a manner which attempts to replicate the natural behaviour within catchments and watercourses, which is typically achieved through attenuation.

Within existing urban or developed areas there is typically little space available for the attenuation of storm water flows to a degree which would mitigate or reduce current flood risk. Therefore, it is not considered practical to implement SUDS for the mitigation of current risk at any SSA. However, within all SSAs every new developments (and where possible redevelopment), should apply the principles of SUDS.

A separate Strategic SUDS report has been prepared for UoM 20 outlining potential SUDS measures in the AFAs. These measures focus on areas that are zoned for future development.

4.2.4 Flood Forecasting and Warning

Flood forecasting is a means of providing advanced warning of an impending flood event. A reliable advance warning system allows protective measures to be put in place and protective actions to be carried out in advance of a flood event. These actions and measures can reduce the damage caused in a flood event.

Flood forecasting is not a possible FRM measure at all SSAs. This is because the time between transmitting a flood forecast in which the authorities have reasonable confidence and the arrival of flood waters may not be long enough for people to take effective action to reduce flood damage. The minimum time to take effective action is deemed to be 6 hours. This time limit is set on the basis that once rainfall has been recorded it can take up to 2 hours to run a complex model and get meaningful forecasts. Following this forecast it is assumed that it can take people up to 3 hours to travel to their home and take the necessary measures to protect their property from flooding.

Flood forecasting and warning has been identified as a possible FRM measure for the SSAs highlighted in Table 4.1. Table 4.1 highlights the time to peak for the critical event (Fluvial = 1% AEP event / Tidal = 0.5% AEP event) and summarises the infrastructure required to implement a flood forecasting and warning system. The infrastructure required is based upon the layout of the catchment and the arrangement of watercourses that could contribute to flood flows. Gauges are located at critical locations in the catchment so that data on precipitation and rising river levels can be collected and analysed to feed into the forecasting system.

The accuracy of the forecasting system will depend on the number of river level and rain gauges collecting data. The more gauges there are the greater the accuracy of the system. The cost and complexity of the system will also increase with more gauges. This will give more accurate forecasts but it will take longer for the system to generate them.

Table 4.1: SSAs Suitable for Flood Forecasting

Spatial Scale of Assessment	Time to Peak of Event	Infrastructure
AFA		
Bantry		
Bantry River	< 5 Hours	Unlikely to be effective due to small steep catchment with short time to peak
Dromacoosane River	< 5 Hours	Unlikely to be effective due to small steep catchment with short time to peak
Mealagh River	> 6 Hours	Rain gauges River level gauges
Tidal	> 6 Hours	Use the existing OPW storm surge forecasting system to predict high tide levels
Castletownbere (Tidal)	> 6 Hours	Use the existing OPW storm surge forecasting system to predict high tide levels
Durrus	> 6 Hours	Rain gauges

Spatial Scale of Assessment	Time to Peak of Event	Infrastructure
		River level gauges
Kenmare		
Finnnihy River	< 5 Hours	Unlikely to be effective due to the short time to peak
Tidal	> 6 Hours	Use the existing OPW storm surge forecasting system to predict high tide levels

Source: UoM 21 Hydraulics Report

An equation to estimate the impacts of flood warnings on flood damages has been developed by Green & Penning-Rowsell. This equation determines that the estimated actual flood damage avoided owing to flood warnings is approximately 13% of potential damages.

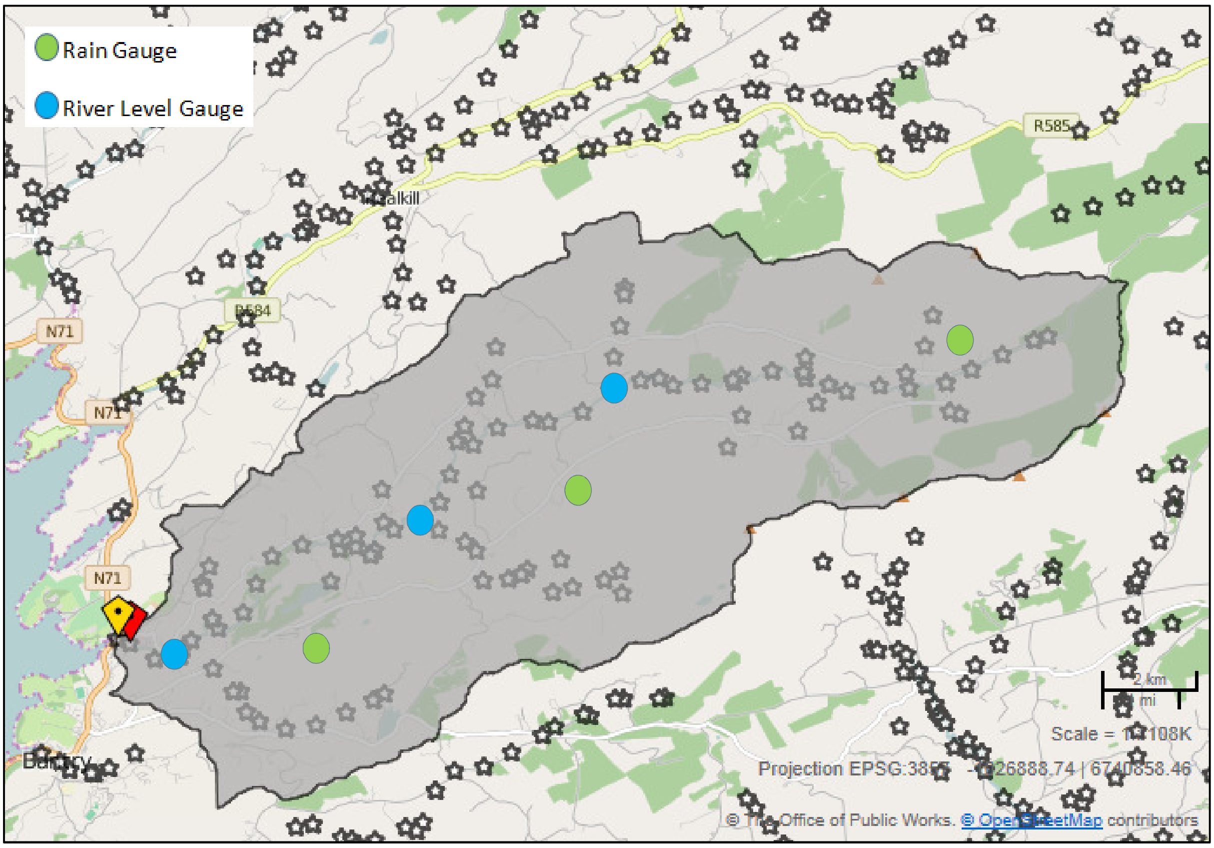
4.2.4.1 Bantry – Mealagh River

The infrastructure required for a flood forecasting and warning system on the Mealagh River in Bantry (AFA) is listed in Table 4.2 and the proposed locations are shown in Figure 4.1.

Table 4.2: Ballingeary – Flood Forecasting Infrastructure

Equipment	Quantity
Rain Gauges	3
River Level Gauge (Hydrometric Gauging Station)	3

Figure 4.1: Bantry – Mealagh River – Proposed Gauges



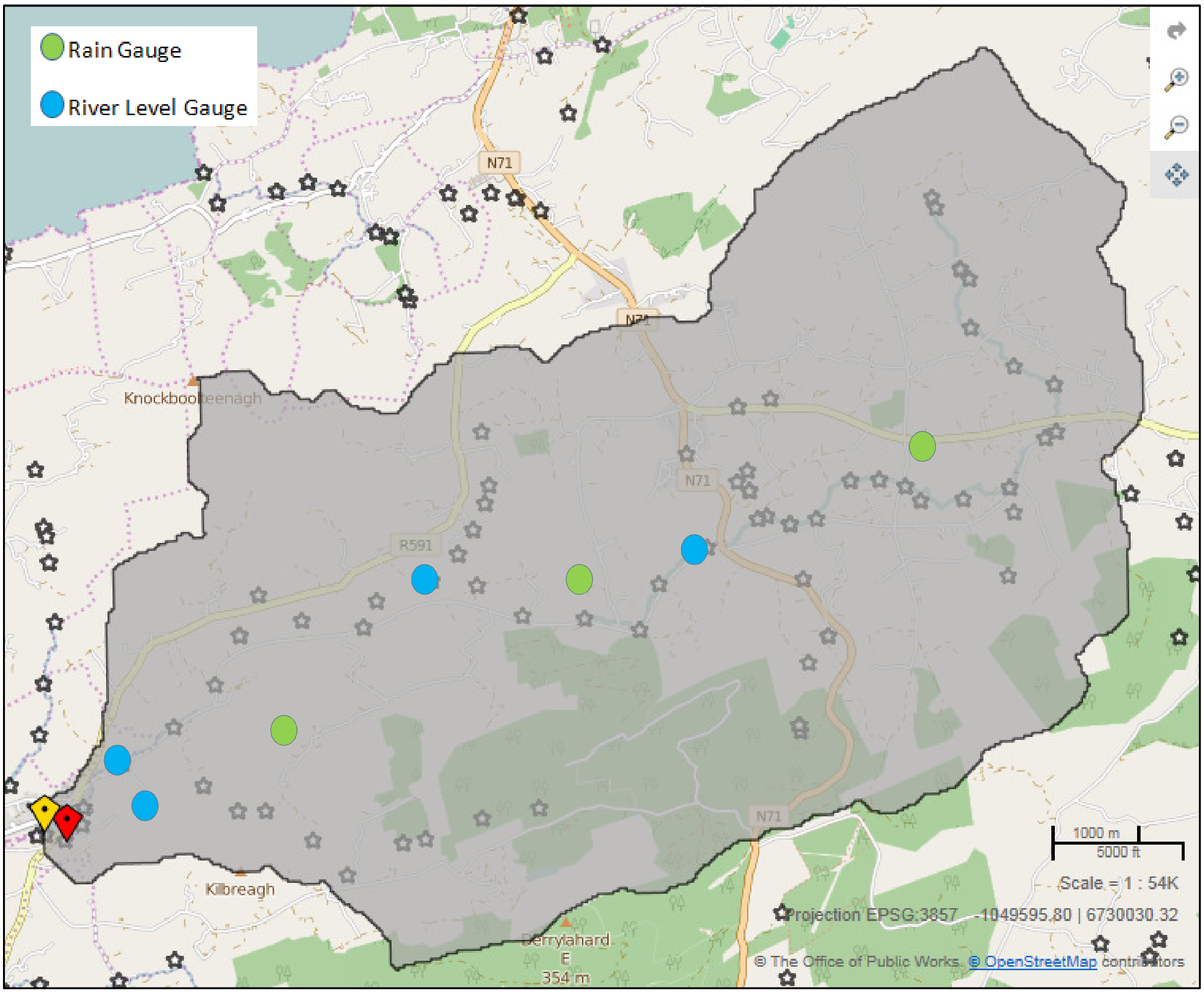
4.2.4.2 Durrus

The infrastructure required for a flood forecasting and warning system in Durrus (AFA) is listed in Table 4.3 and the proposed locations are shown in Figures 4.2.

Table 4.3: Durrus – Flood Forecasting Infrastructure

Equipment	Quantity
Rain Gauges	3
River Level Gauge (Hydrometric Gauging Station)	4

Figure 4.2: Durrus – Proposed Gauges



Cost estimates for the proposed flood forecasting and warning systems are included in Section 9.0.

4.2.5 Public Awareness

Many of the measures to mitigate and manage flood risk and the potential consequences for flooding will involve the public at large. It is therefore important that the public is made aware of where to find information, what the information means and what actions the public and business owners can take to reduce the damage that would occur to their properties, possessions and interests in the event of a flood.

Public awareness measures will engender the public's recognition of the potential of the risk of flooding and the potential consequences thereof. Knowing in advance means that actions can be taken in a timely manner.

Measures to increase and promote public awareness include:

- Identifying the areas prone to flooding
- Information on measures to be implemented to reduce and / or manage the risk of flooding
- Measures in place to provide advance warning of flooding
- Establishment of methods to interface with the public and in particular the owners of vulnerable properties, i.e. workshops and meetings, Facebook, Twitter, text messaging, newsprint, websites, etc.

Flood risk maps and flood hazard maps have been produced for the UoM 21 AFAs. The dissemination of this information to the public will increase awareness.

4.2.6 Land Use Management

Land Use Management can be utilised as a non-structural measure to prevent or reduce the impact of flooding on properties, roads and other critical infrastructure. Land Use Management includes strategies to control overland flow, such as improving agricultural and forestry practices in key catchment areas. Local natural flood management measures such as the creation of wetlands or forestry to retain overland flow could also be adopted.

4.2.7 Emergency Response Planning

Well prepared and executed emergency response plans can significantly reduce the impact of flood events, particularly for human health and welfare.

The Framework for Major Emergency Management was developed in 2005 and was adopted by Government decision in 2006. Its purpose is to set out common arrangements and structures for front line public sector emergency management in Ireland. The Framework is based on the internationally recognized systems approach that, in essence, proposes an iterative cycle of continuous activity through five stages of emergency management:

- Hazard Identification
- Mitigation
- Preparedness
- Response
- Recovery

Under the Framework, Local Authorities are designated as the lead agency for co-ordinating the response to severe weather events, and each Local Authority should have, as a specific sub-plan of its Major Emergency Plan, a plan for responding to severe weather emergencies, whether a major emergency is declared or not. The other principal response agencies should include sub-plans for responding to notifications from the Local Authorities of severe weather warnings.

A Guide to Flood Emergencies (MEM Guidance Document 11, July 2013) has been published to assist the Principal Response Agencies in meeting their responsibilities, under the Framework for Major Emergency Management, and to deliver on the responsibilities of the OPW and the Local Authorities with respect to emergency planning as set out in the Report of the Flood Policy Review Group. The Guide provides advice on the development and implementation of consistently effective flood emergency response and short-term recovery planning by the Principal Response Agencies and others, and includes a template plan.

4.3 Structural Measures

4.3.1 General

As highlighted above, a flood risk management option consists of one or, more commonly, a combination of flood risk management methods / measures. Therefore, please note that some of the following structural measures may be required in combination to provide a potential flood risk management option that will mitigate both fluvial and tidal flood risk.

The possible flood risk management measures for each of the AFAs being considered are detailed in Table 4.4 below.

Table 4.4: Possible Structural Measures

AFA	Bantry	Castletownbere	Durrus	Kenmare
Fluvial Storage	Y	N	N	Y
Flow Diversion	N	N	N	Y
Increase Conveyance	Y	N	N	Y
Flood Defences	Y	Y	N	Y
Improve Existing Defences	N	N	N	N
Relocate Properties	N	N	N	N
Localised Protection Works	Y	Y	N	Y
Channel or Flood Defence Maintenance Works	N	N	N	N
Other works	Tidal Barrage	-	-	-

Details of the possible flood risk management measures and how they can be combined into potential options are included in Section 5.

5 Development of Potential Flood Risk Management Options for AFAs

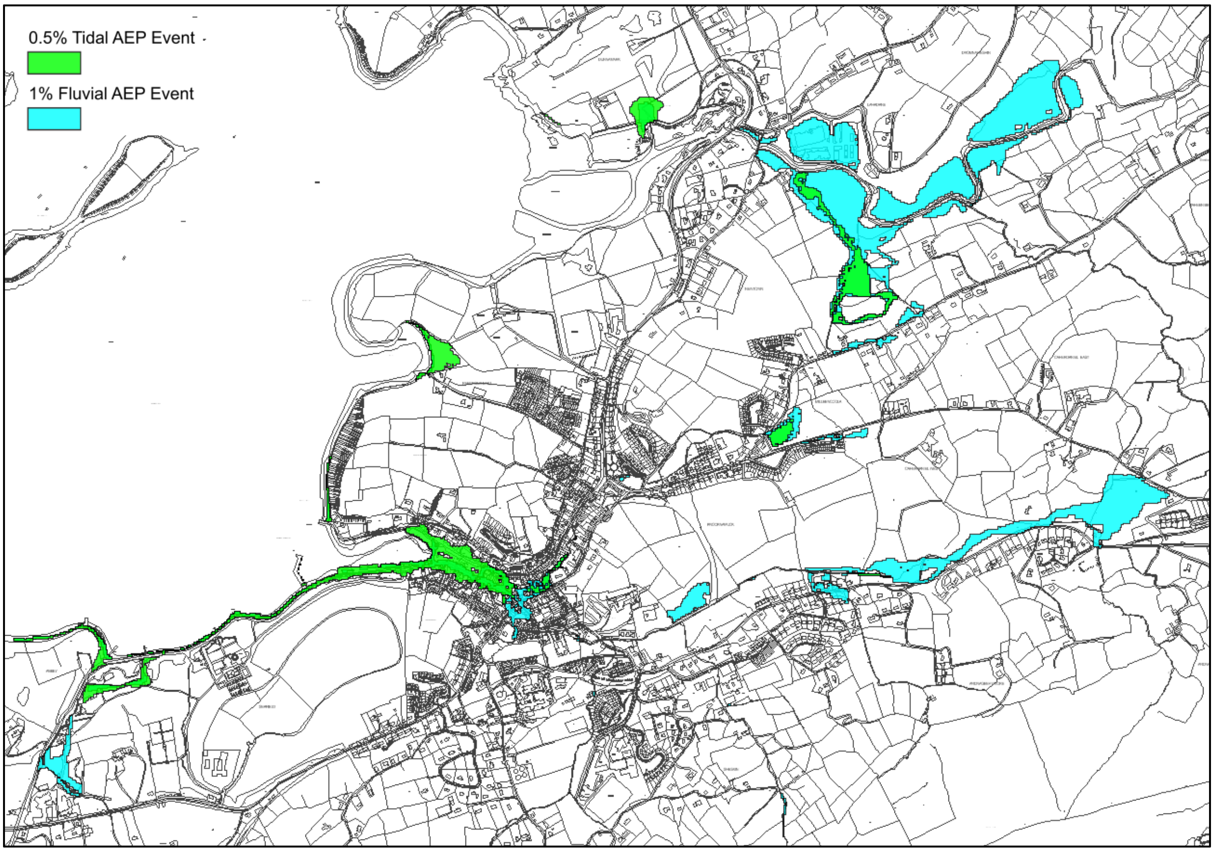
5.1 General

A Flood Risk Management (FRM) option consists of one, or more commonly a combination of FRM measures. This section outlines the development of the potential Flood Risk Management (FRM) options for each of the AFA's within UoM 21.

5.2 Bantry, Co. Cork

Bantry is located at the mouth of the River Bantry in County Cork and is at risk of both fluvial and tidal flooding. The AFA and the existing flood risk are highlighted in Figure 5.1.

Figure 5.1: Bantry – Current Scenario Fluvial / Tidal Flood Extents



5.2.1 Possible FRM Measures

As outlined in Section 3.0, the screening process identified the following possible flood risk mitigation measures:

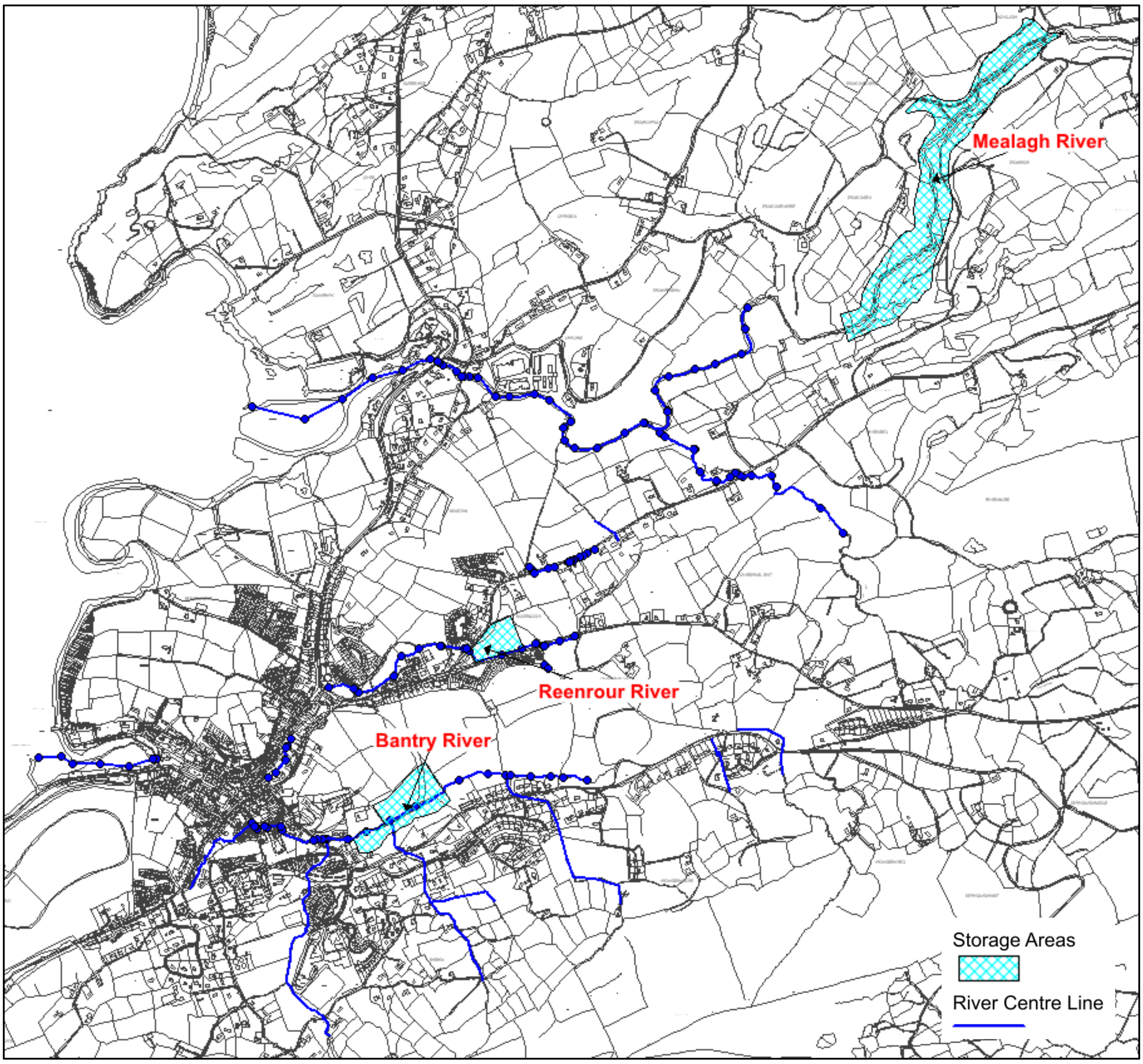
- Storage
- Increase Conveyance
- Flood Defences (Fluvial / Tidal)
- Tidal Barrage

The possible measures were reviewed and assessed further to determine if they were applicable and viable. The measures were modelled individually to determine their effectiveness and impact.

5.2.1.1 Storage

The Bantry AFA contains a number of watercourses which can give rise to fluvial flooding. A number of potential locations for the storage of fluvial flows were identified on the River Bantry, the Reenrour River and the Mealagh River. The location of the potential storage areas is shown in Figure 5.2.

Figure 5.2: Bantry – Location of Storage Areas



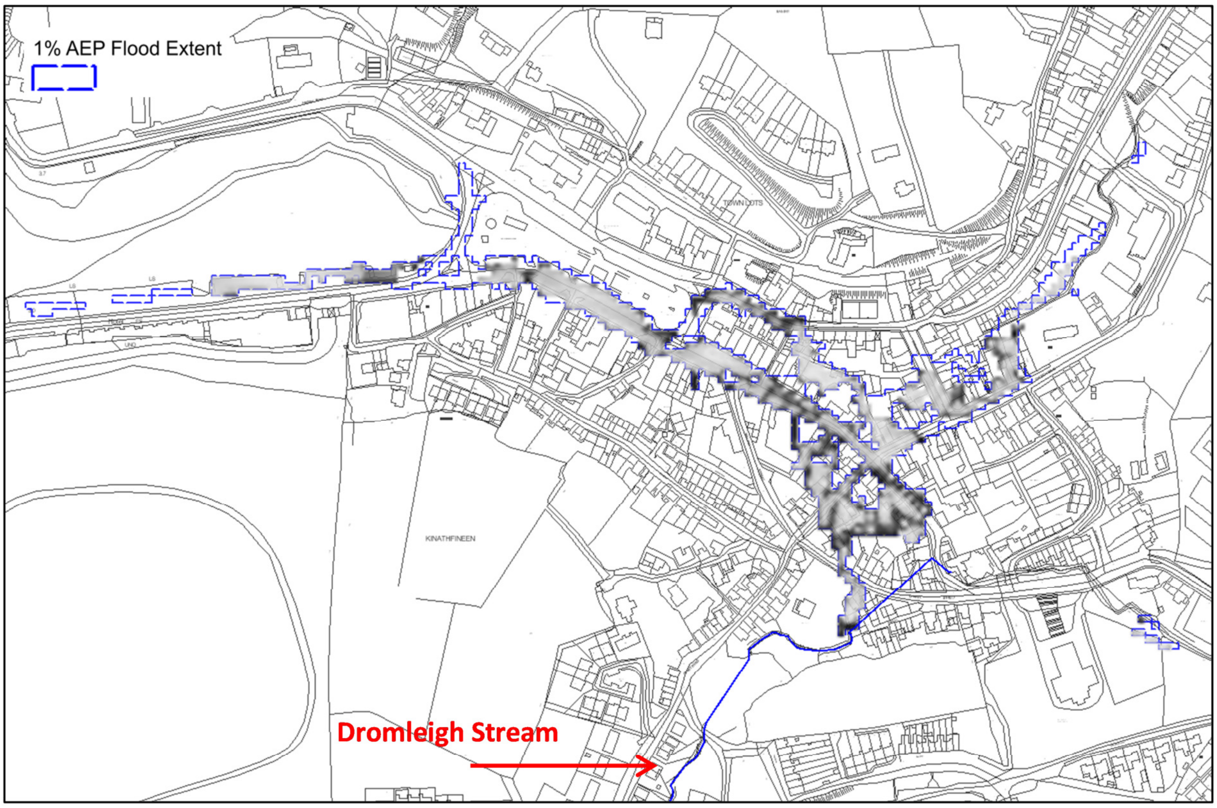
The required capacities of the storage areas are derived using the catchment hydrology as applied in the hydraulic modelling. No allowances for uncertainties in the estimate of the index flood flow or flood growth curve have been made.

The aim of the proposed storage areas on the Bantry and Reenrour Rivers is to mitigate the fluvial flooding through the town. The peak flows in the Bantry and Reenrour Rivers at the locations of the proposed storage areas for the 1% AEP event are 6.72m3/s and 1.57m3/s respectively.

The storage area on the Bantry River is 47,960m2 with a capacity of 47,960m3 which can limit the outflow to the peak of the 50% AEP event. The storage area on the Reenrour River is 19,760m2 with a capacity of 9,835m3/s which can store all flows up to and including the 1% AEP event.

Hydraulic modelling of the storage areas on the Bantry and Reenrour did not result in a significant reduction in flood extent or depth through the town as shown in Figure 5.3. Also, these measures do not mitigate the flood risk upstream. Therefore, storage on the Bantry and Reenrour Rivers are not deemed to be viable measures.

Figure 5.3: Bantry – Storage Measure (Bantry & Reenrour Rivers) Flood Extent

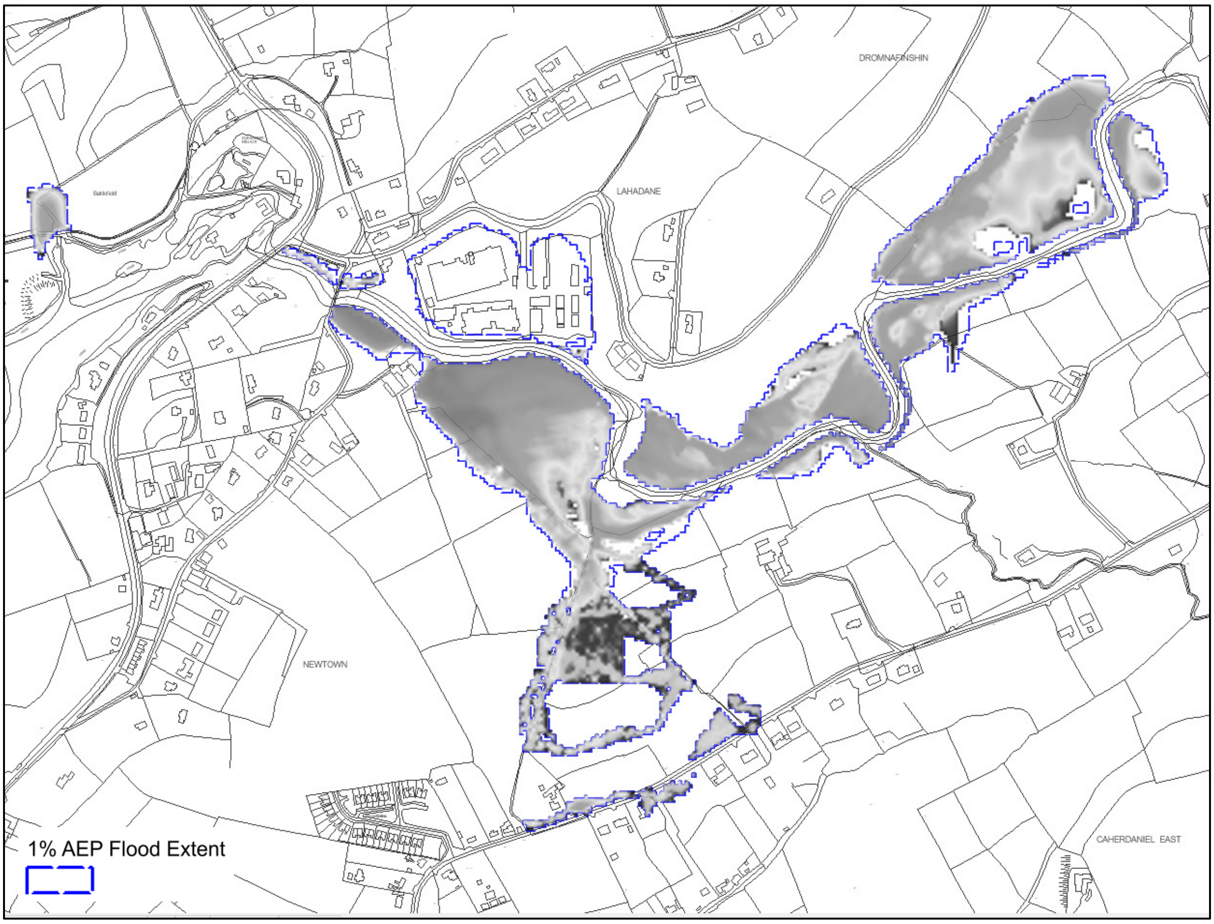


However, the hydraulic modelling of the storage measure confirmed that the main source of flooding to the town is from the Dromleigh Stream which is identified in Figure 5.3.

The aim of the proposed storage areas on the Mealagh River is to mitigate the fluvial flooding of an existing industrial site and two residential properties downstream. The peak flow in the Mealagh Rivers at the location of the proposed storage area for the 1% AEP event is 181m3/s.

The storage area on the Mealagh River is 198,600m2 with a capacity of 496,500m3 which can limit the outflow to the peak of the 5% AEP event (139.4m3/s). Hydraulic modelling of the storage area shows a reduction in flood extent with a maximum reduction in depth of 0.54m. While this measure mitigates the flood risk at the industrial site, the two residential properties are still at risk from the 1% AEP event.

Figure 5.4: Bantry – Storage Measure (Meelagh River) Flood Extent



Due to the size of the storage areas required and the remaining fluvial risk to the residential properties, storage on the Mealagh River is not deemed to be a viable measure.

5.2.1.2 Increased Conveyance

This measure aims to mitigate the fluvial flood risk along the Mealagh River by improving the conveyance of the channel through regrading of the river.

In the hydraulic model the Mealagh River was regraded over a length of 1.3km with a maximum downstream reduction in bed level of approx. 5m. The regrading is highlighted in Figures 5.5 and 5.6.

Figure 5.5: Bantry – Conveyance Measure – Mealagh River – Existing Bed Level

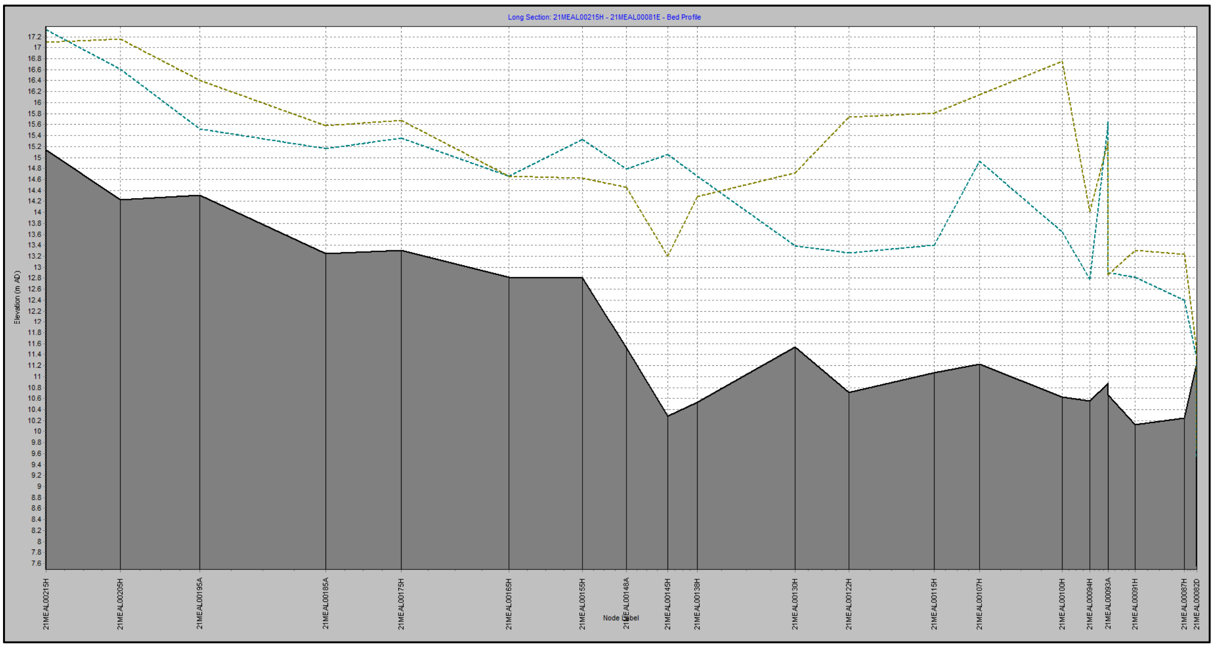
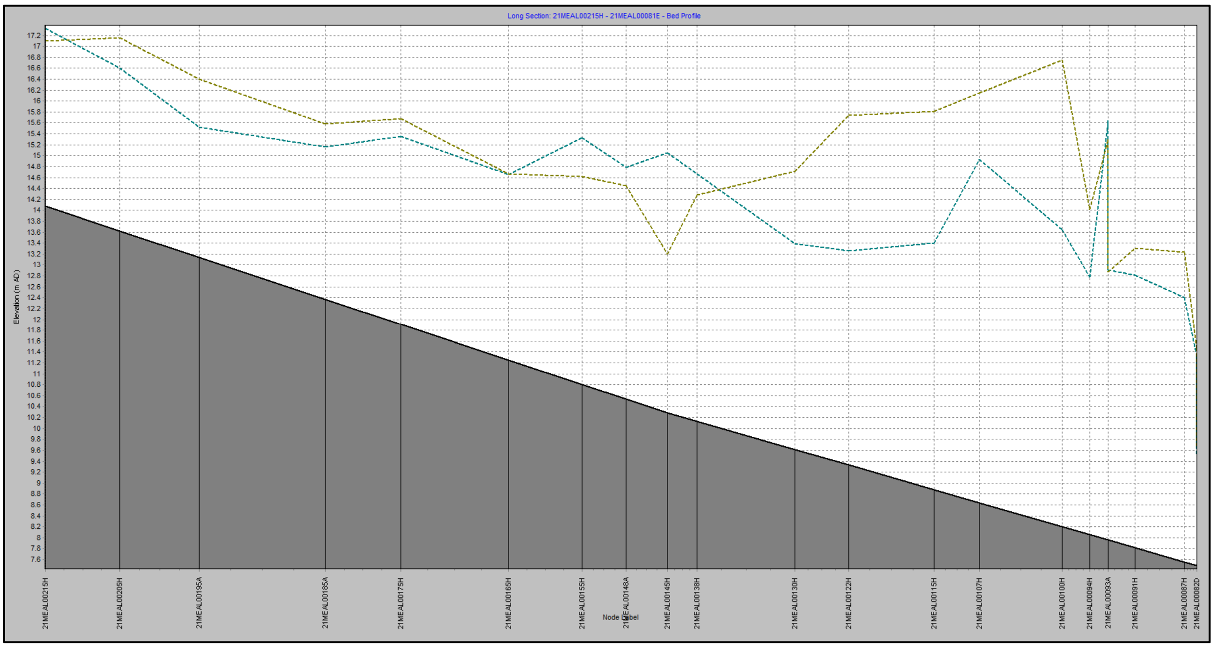
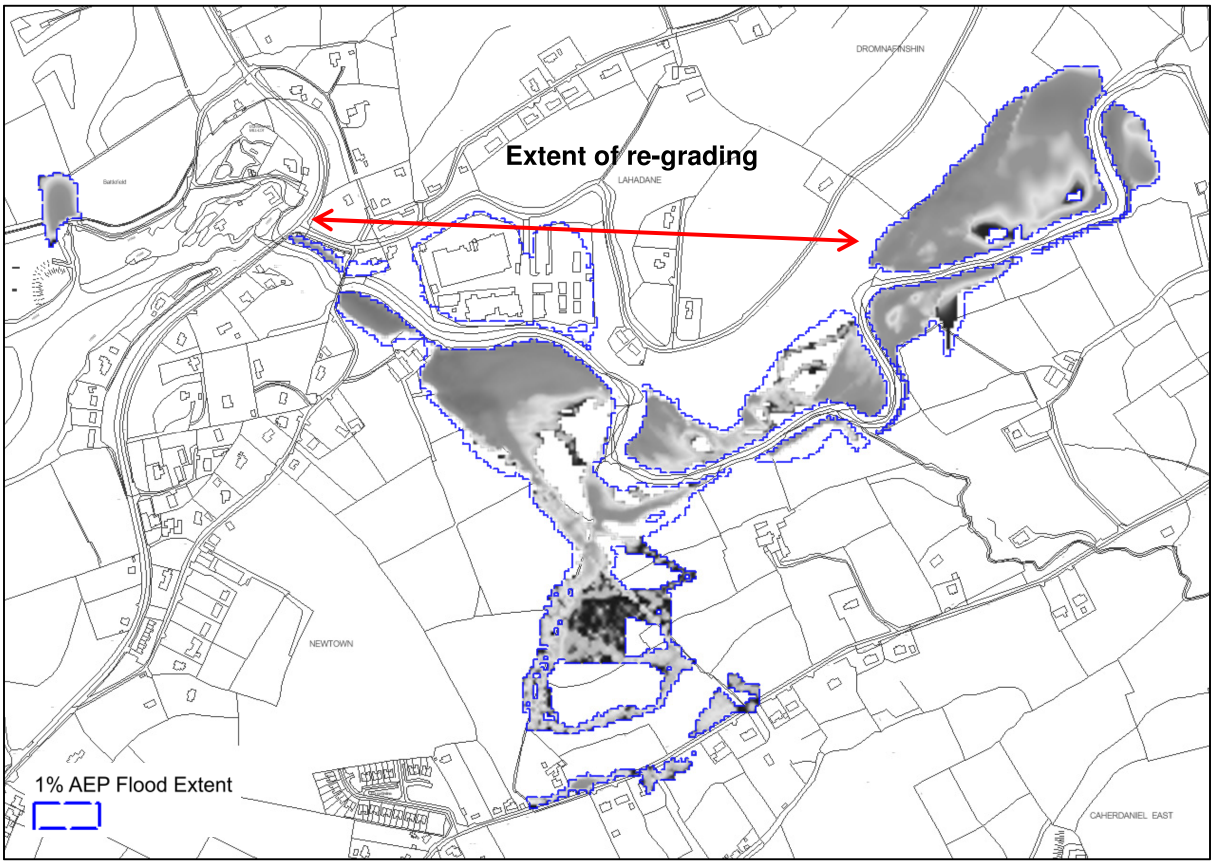


Figure 5.6: Bantry – Conveyance Measure – Mealagh River – Regraded Bed Level



This measure represents the extremes of any potential regrading of the river. While this measure mitigates the flood risk at the industrial site, the downstream residential property is still at risk from the 1% AEP event. While this measure could be combined with flood defences at this isolated property to form a viable option on this watercourse, this combination would not be preferred as flood defences are a viable measure along the length of the Mealagh and the conveyance measure involves the removal of a scenic waterfall. Therefore, regrading of the Mealagh River is not deemed to be a viable measure.

Figure 5.7: Bantry – Conveyance Measure (Mealagh River) Flood Extent



5.2.1.3 Flood Defences

This measure aims to mitigate the fluvial and tidal flood risk through the construction of flood defences. These defences include walls and embankments. The locations and heights of the defences are shown in the following figures.

Figure 5.8: Bantry – Flood Defence Measure – Bantry Town

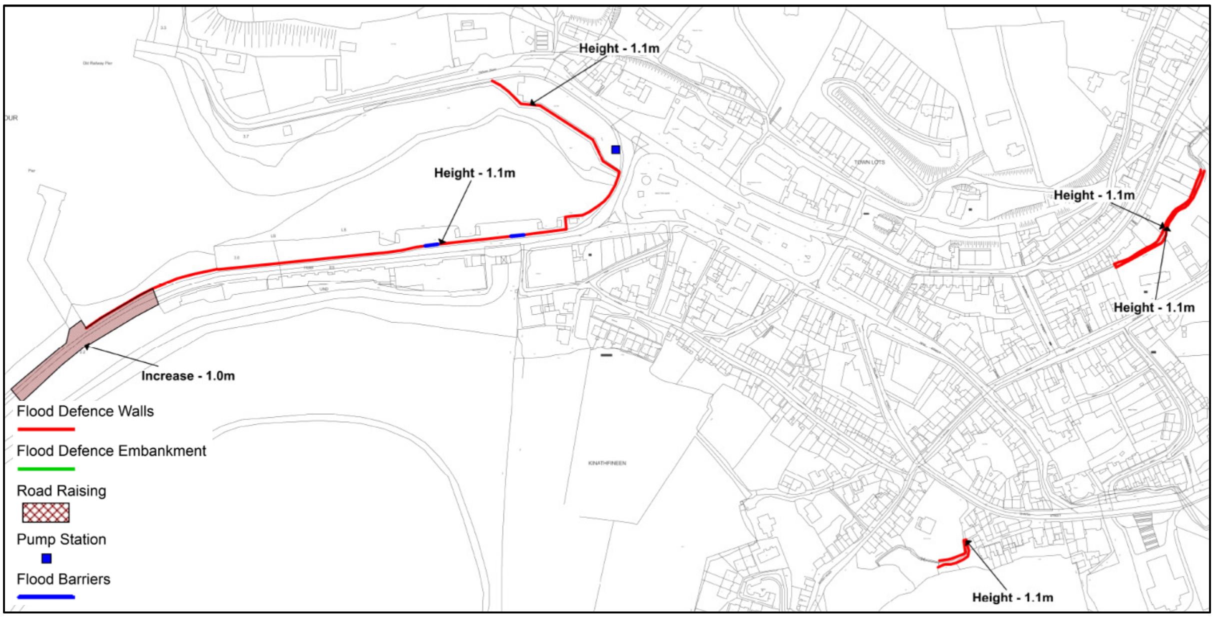


Figure 5.9: Bantry – Flood Defence Measure – Caherdaniel West

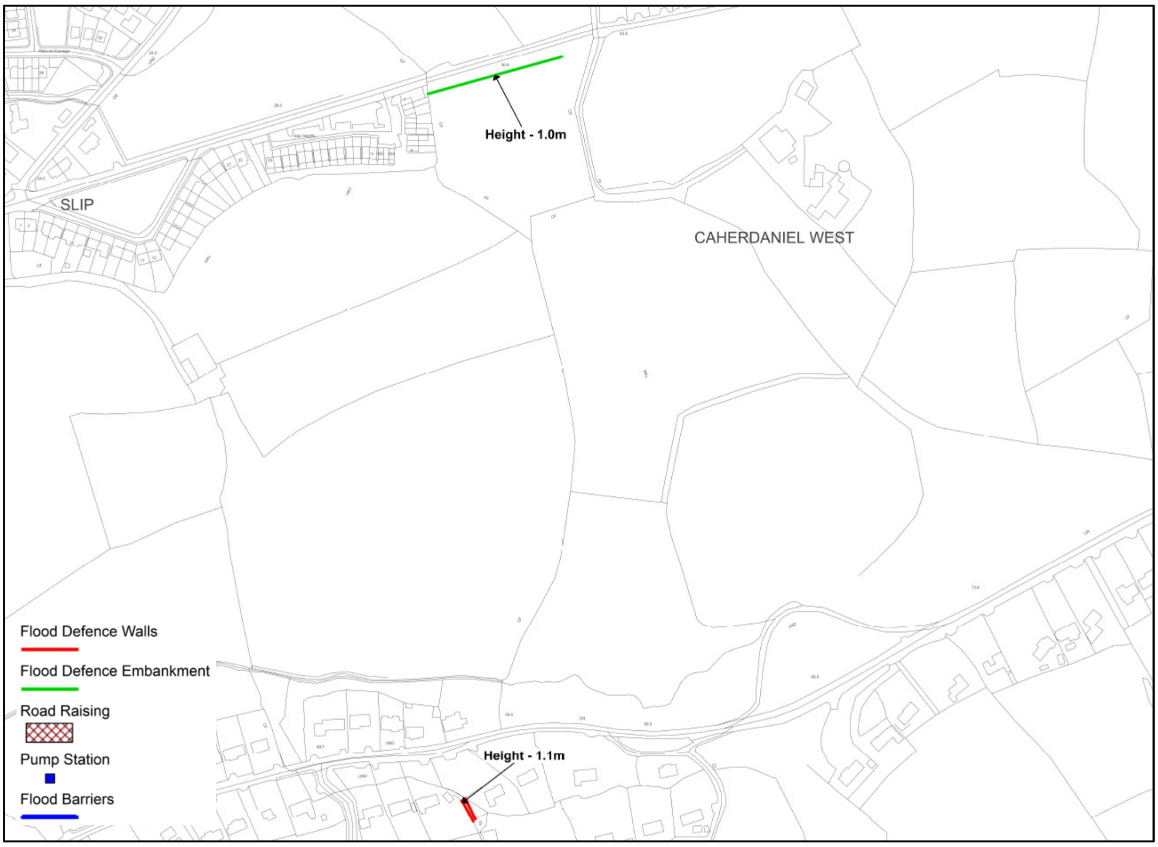
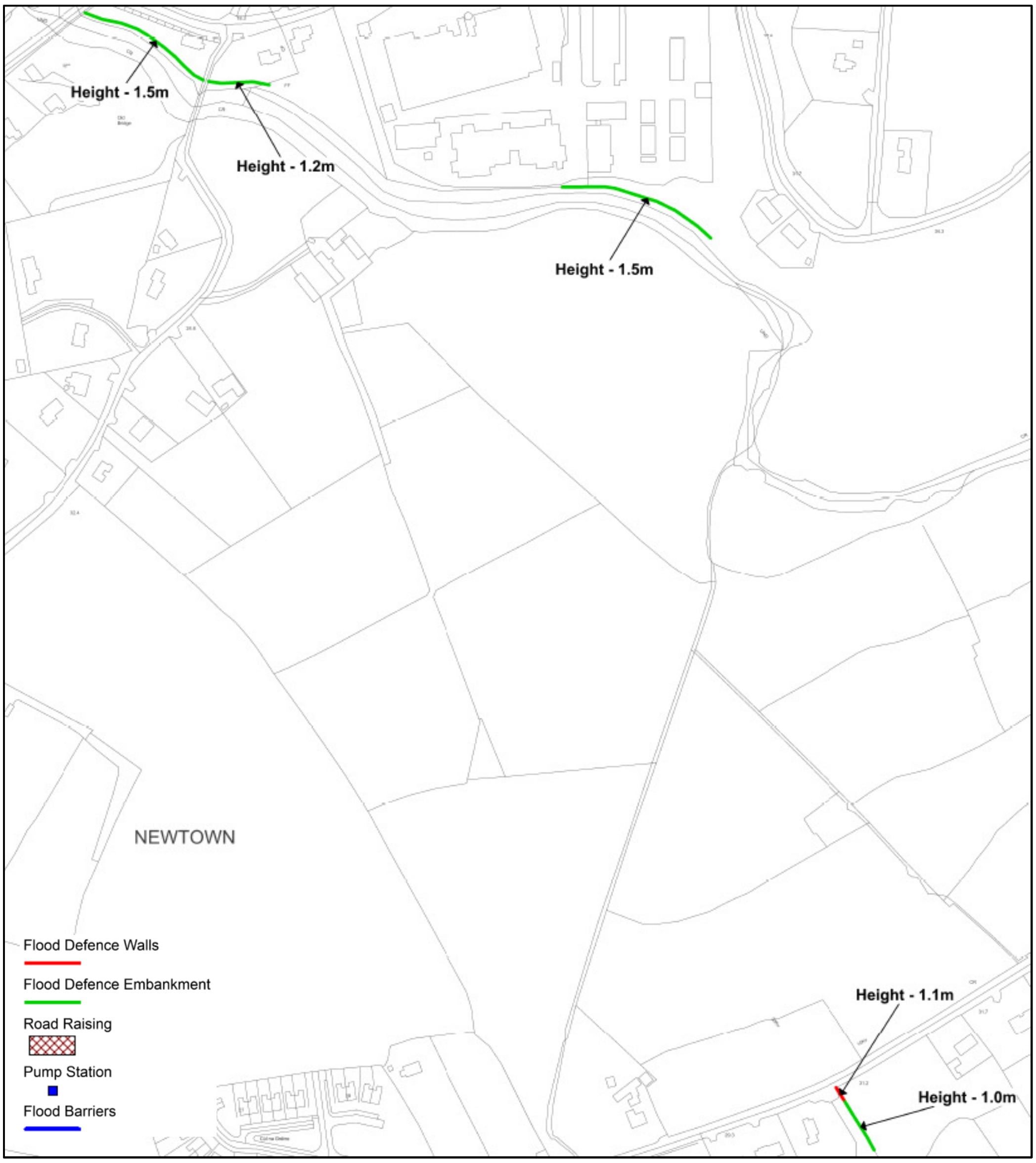


Figure 5.10: Bantry – Flood Defence Measure – Mealagh River / Newtown

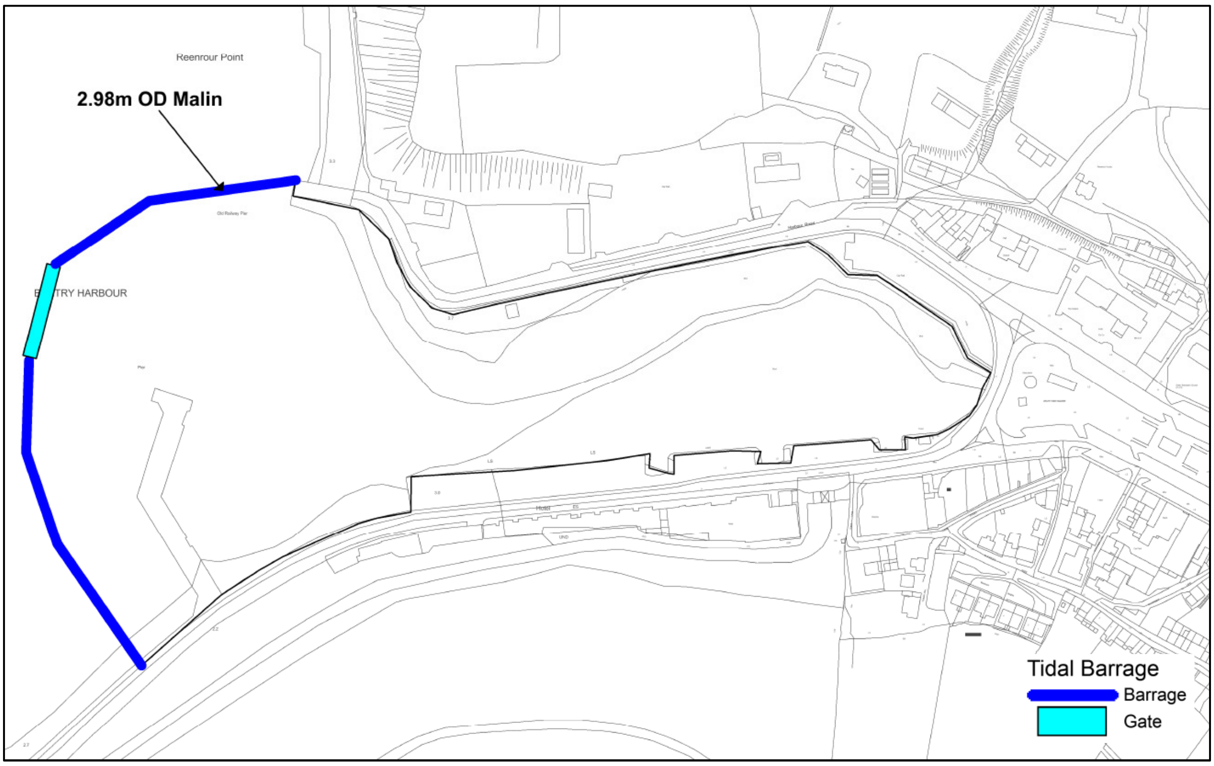


The hydraulic modelling of the proposed flood defences as outlined in the above figures indicates that the measure fully achieves the required standard of protection for the 1% AEP fluvial event and the 0.5% AEP tidal event. The proposed defences result in an average increase in water levels of 0.02m with a maximum increase of 0.20. This is deemed to be a viable measure / option.

5.2.1.4 Tidal Barrage

This measure aims to mitigate the tidal flood risk through the construction of a tidal barrage. The location and level of the tidal barrage is shown in Figure 5.11.

Figure 5.11: Bantry – Tidal Barrage



In order for the tidal barrage to be an effective measure it must have sufficient storage within the barrage to accommodate the fluvial flows during the 0.5% AEP tidal event. To maximise the potential storage area for fluvial flows the barrage should be closed at the low tide preceding a tidal event.

The lowest tide level within the harbour preceding a 0.5% AEP tidal event is -1.08m OD Malin. The lowest existing bank level within the harbour is 1.45m OD Malin. If the barrage is closed at low tide, this gives an average depth of available storage for fluvial flows within the barrage of 2.22m.

The barrage should remain closed until the tide level outside is lower than the maximum water level within the barrage (1.45m OD Malin). Therefore, the barrage should remain closed for approx. 9 hours. Allowing for the 50% AEP fluvial event to coincide with the 0.5% AEP tidal event, the tidal barrage must be able to store approx. 114,793m3 of fluvial flow. Based on the average depth of available storage of 2.22m, the tidal barrage should have an inside area of approx. 51,615m2.

In order to take account of the existing piers and structures within the harbour and proposed future development, the proposed tidal barrage has an inner area of approximately 78,880m2. The maximum water level for the 0.5% AEP tidal event is 2.68m OD Malin. Allowing for freeboard of 0.3m, the minimum level of the proposed tidal barrage is 2.98m OD Malin.

The proposed tidal barrage is deemed to be a viable measure for mitigating tidal flooding for the 0.5% AEP tidal event.

5.2.2 Potential FRM Measures

Based on the review and hydraulic modelling the following are deemed to be potential FRM measures:

- Flood Defences
- Tidal Barrage

5.2.3 Potential FRM Options

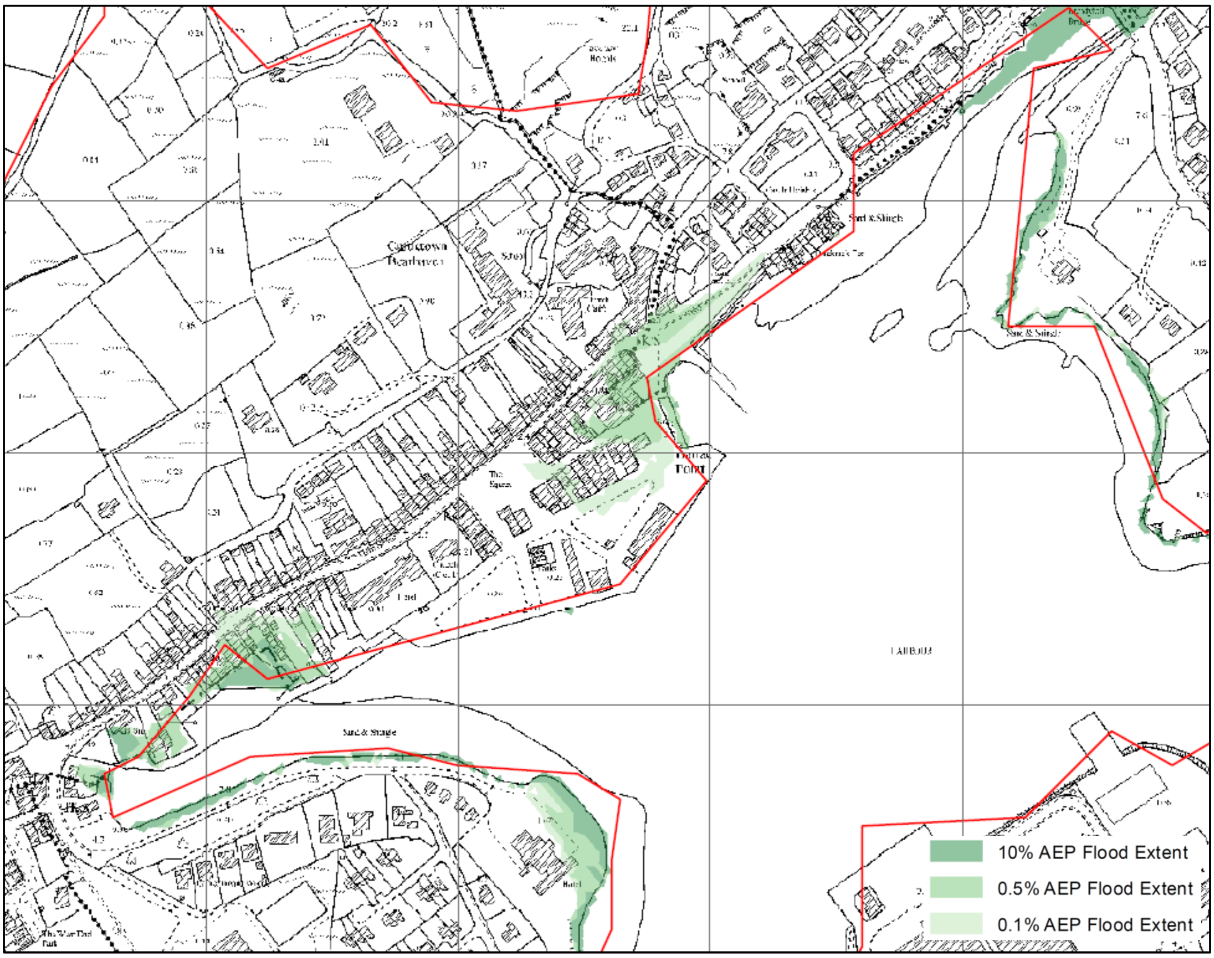
Based on the assessment of the potential (viable) FRM measures and detailed hydraulic modelling of the combined measures, the following are potential FRM options. Full outline drawings are included in Appendix B for each of the potential options.

- Option 1 – Fluvial & Tidal Flood Defences
- Option 2 – Fluvial Flood Defences & Tidal Barrage

5.3 Castletownbere, Co. Cork

Castletownbere is located in County Cork on the Beara Peninsula and is at risk of tidal flooding. The AFA and the existing flood risk are highlighted in Figure 5.12.

Figure 5.12: Castletownbere – Current Scenario Tidal Flood Extents



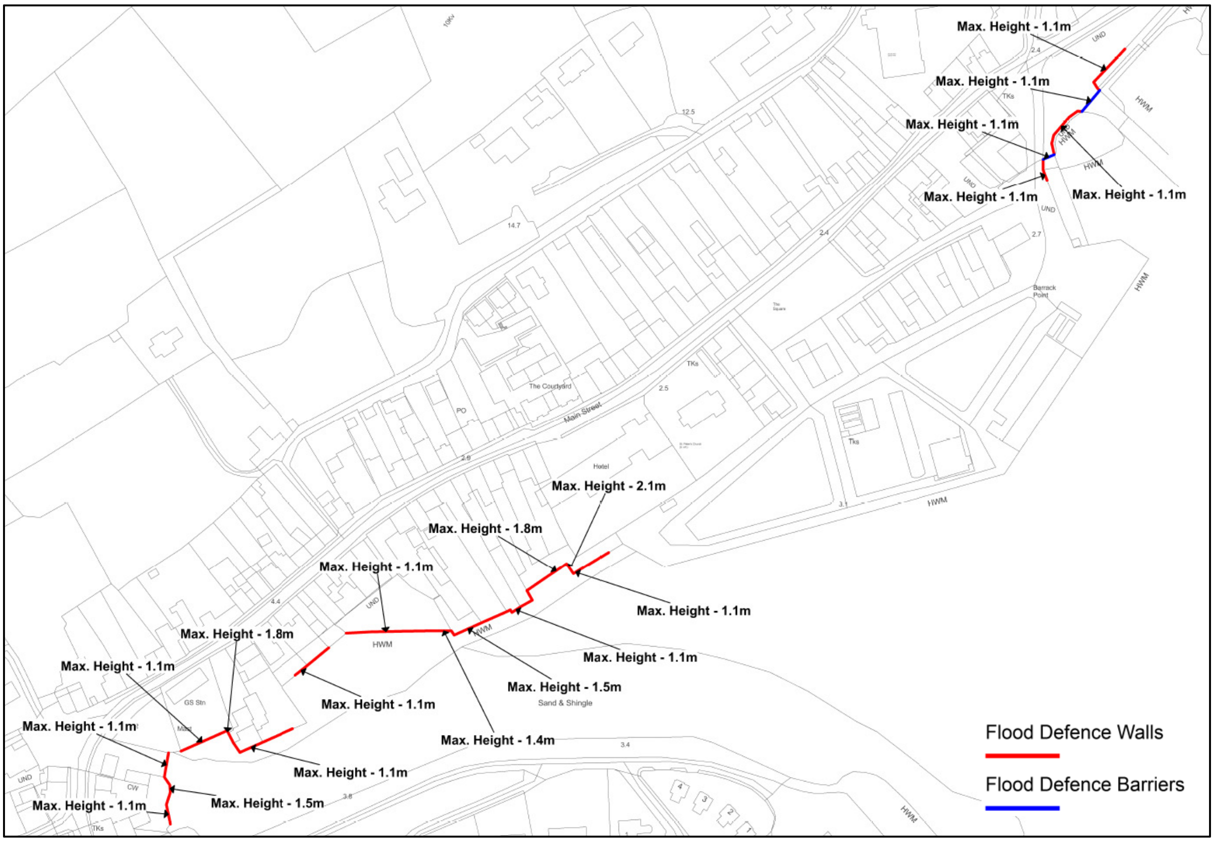
5.3.1 Possible FRM Measures

As outlined in Section 3.0, the screening process identified that the possible flood risk mitigation measures for Castletownbere are limited to tidal flood defences.

5.3.1.1 Flood Defences

This measure aims to mitigate the tidal flood risk through the construction of flood defences. These defences include walls and some flood barriers. The locations and heights of the defences are shown in the following figures.

Figure 5.13: Castletownbere – Tidal Flood Defence Measure



The hydraulic modelling of the proposed flood defences as outlined in the above figures indicates that the measure fully achieves the required standard of protection for the 0.5% AEP tidal event. This is deemed to be a viable measure / option.

5.3.2 Potential FRM Measures

Based on the review and hydraulic modelling the following are deemed to be potential FRM measures:

- Flood Defences

5.3.3 Potential FRM Options

Based on the assessment of the potential (viable) FRM measures and detailed hydraulic modelling of the combined measures, the following are potential FRM options. Full outline drawings are included in Appendix B for each of the potential options.

- Option 1 – Tidal Flood Defences

Drawings of the viable FRM Options are included in Appendix B.

5.4 Kenmare, Co. Kerry

Kenmare is located along the Finnihy River, approximately 1km from the where it enters the bay. Kenmare is at risk of both fluvial and tidal flooding. The AFA and the existing flood risk are highlighted in Figures 5.14 and 5.15.

Figure 5.14: Kenmare – Current Scenario Fluvial Flood Extents

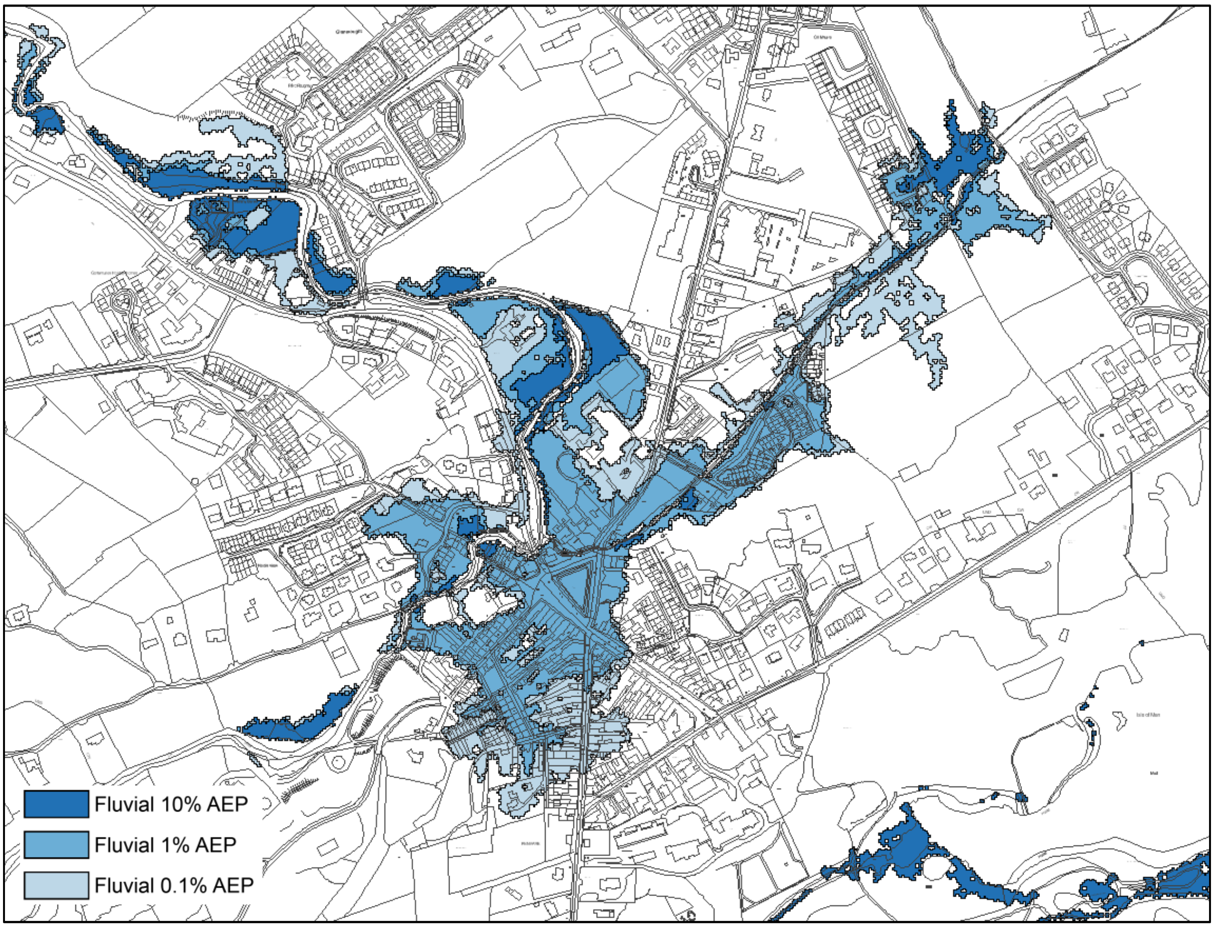
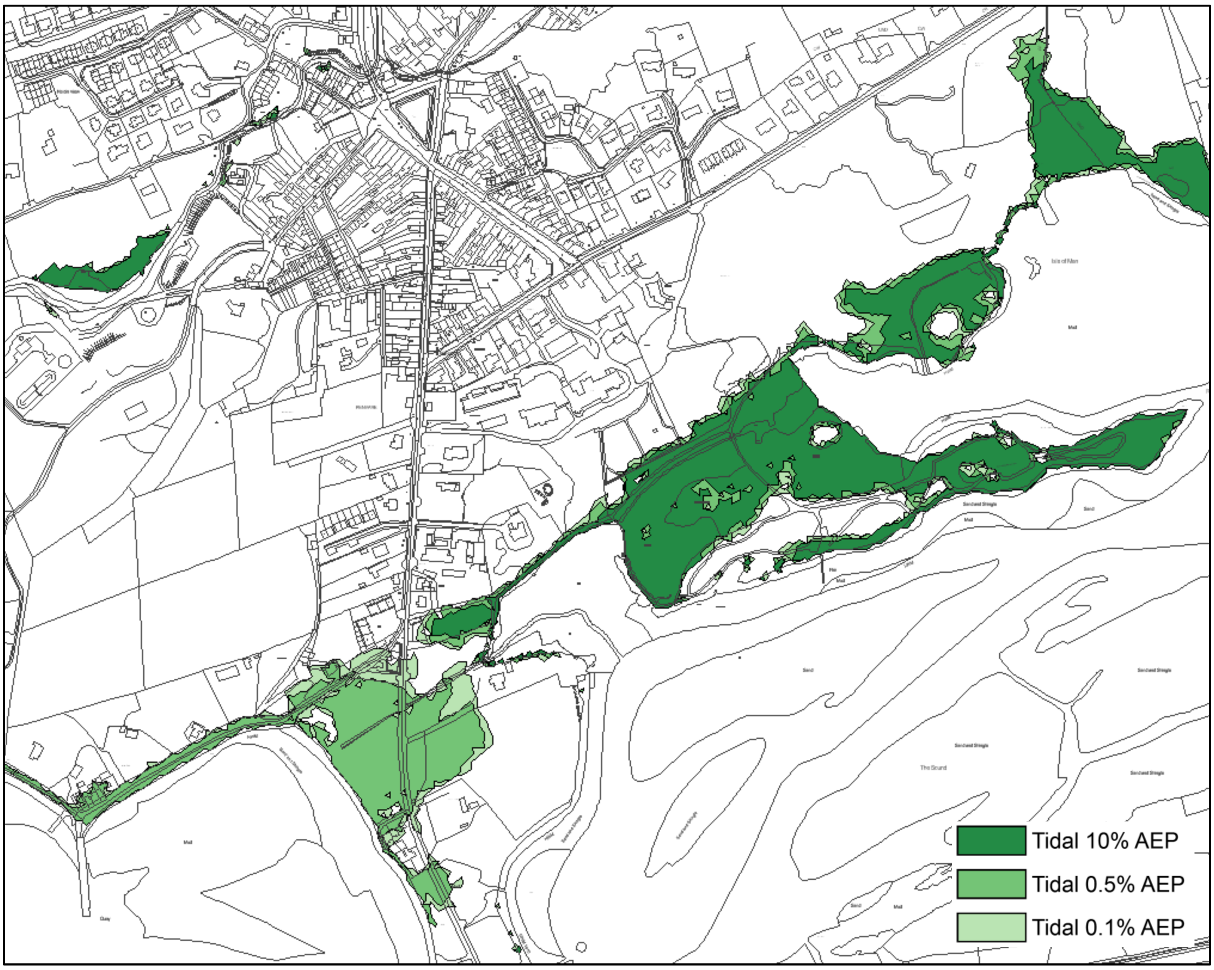


Figure 5.15: Kenmare – Current Scenario Tidal Flood Extents



5.4.1 Possible FRM Measures

As outlined in Section 3.0, the screening process identified the following possible flood risk mitigation measures:

- Increase Conveyance
- Flood Defences (Fluvial / Tidal)
- Storage
- Flow Diversion

The possible measures were reviewed and assessed further to determine if they were applicable and viable. The measures were modelled individually to determine their effectiveness and impact.

5.4.1.1 Increased Conveyance – Removal of Pipe in Finnihy Bridge

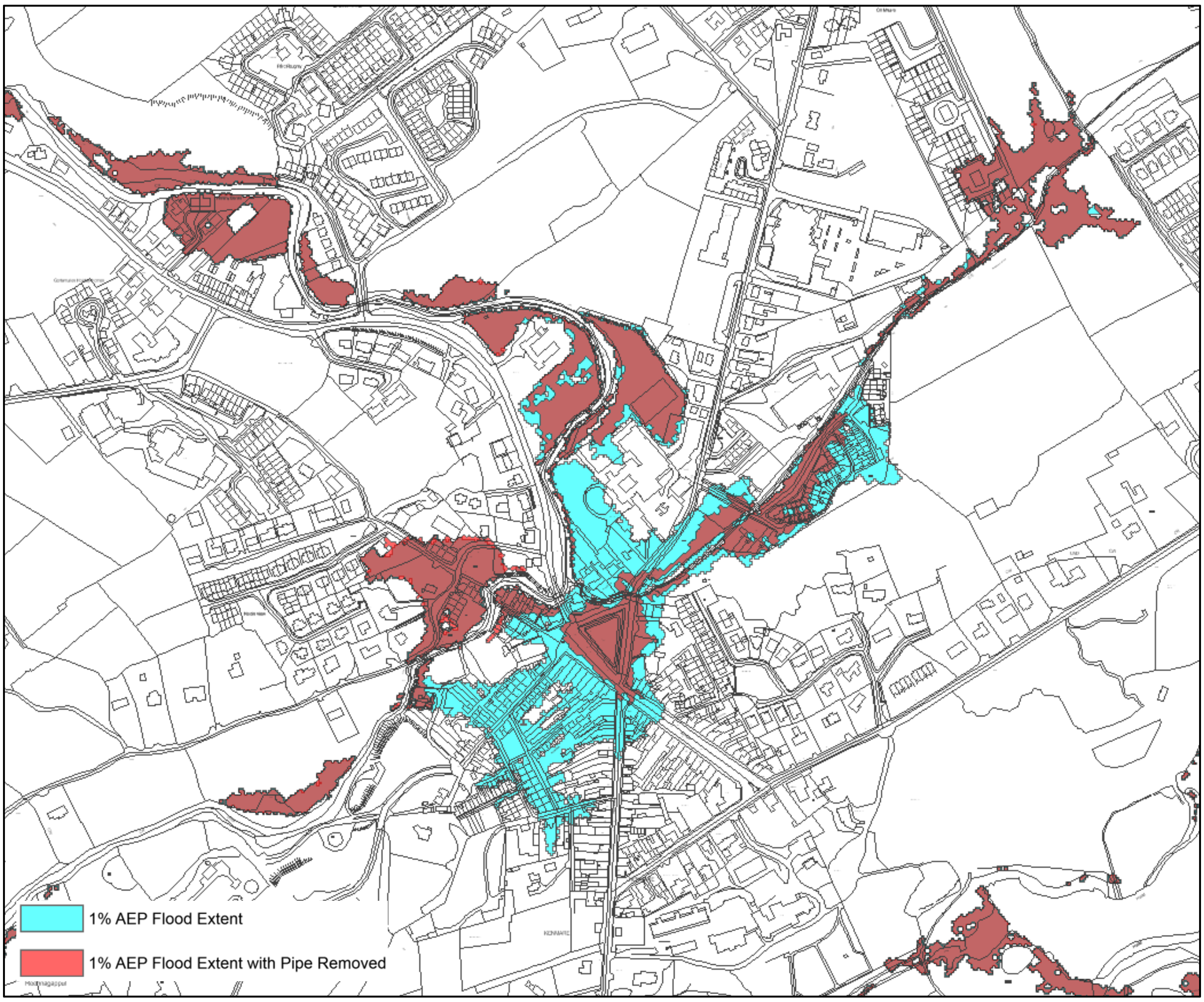
The Finnihy Bridge is located in the centre of the town and has been identified as a critical control structure along the watercourse. The capacity of the bridge is restricted by a pipe crossing through the eyes of the bridge. The pipe is encased in concrete forming a beam 0.7m by 0.5m and contains a live sewer.

This measure aims to mitigate the fluvial flood risk by improving the conveyance of the bridge by removing the existing pipe crossing. The pipe crossing is shown in Figure 5.16.

Figure 5.16: Kenmare – Finnihy Bridge – Pipe Crossing

The pipe crossing was removed from the hydraulic model which resulted in a significant reduction in flood extent and depth. Flooding was reduced through the centre of the town and in the reaches immediately upstream of the confluence as shown in Figure 5.17.

Figure 5.17: Kenmare – Reduction in Fluvial Flood Extent due to Removal of Pipe in Finnihy Bridge



While the reduction in fluvial flood extent / risk associated with this measure is significant it does not achieve the required standard of protection and is therefore not deemed to be a viable measure individually. However, it is likely to be very effective in combination with other measures such as fluvial flood defences or storage. This measure does not mitigate against tidal flood risk.

5.4.1.2 Increased Conveyance – Replacement / Removal of Bridges, Removal of Pipe at Finnihy Bridge and Downstream Sedimentation and Channel Debris

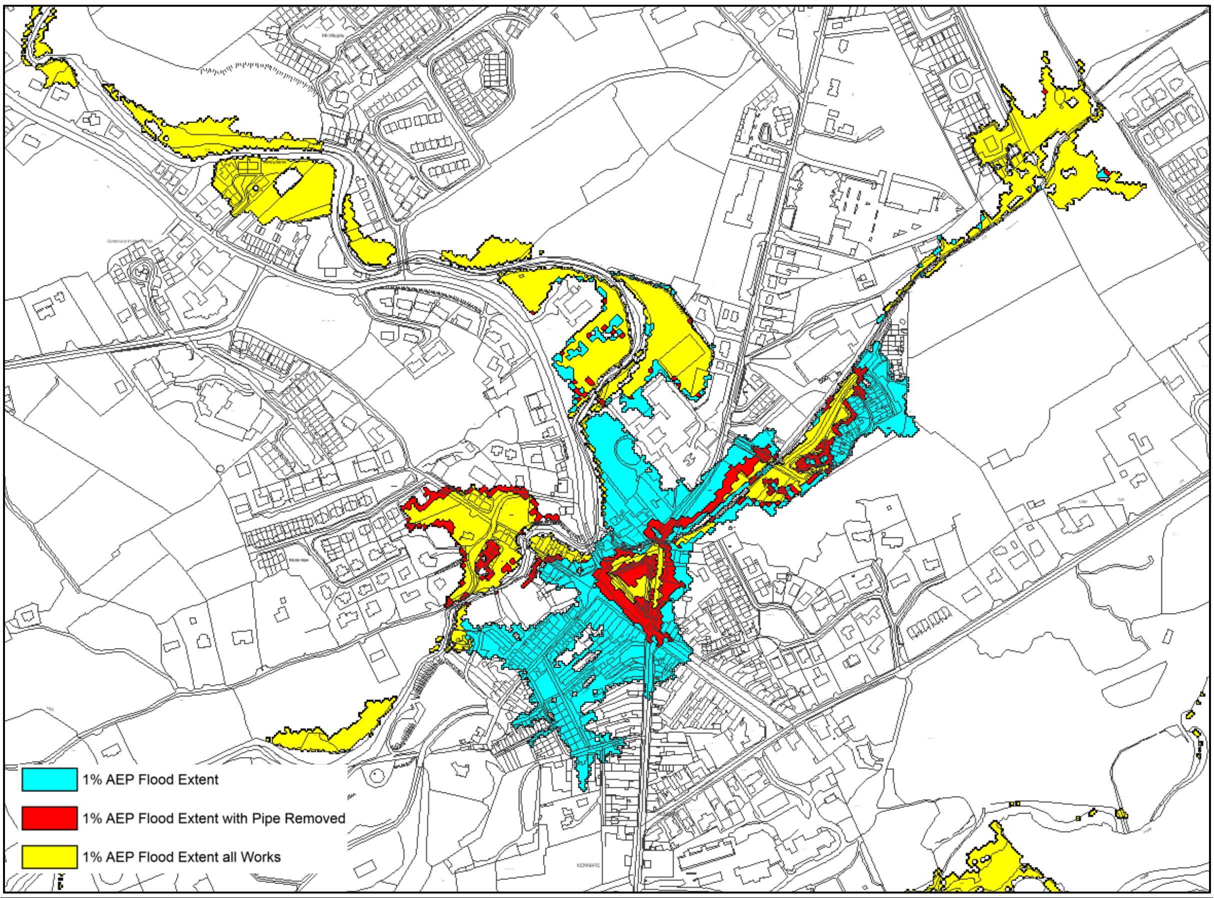
As part of the hydraulic modelling for the flood risk mapping a number of bridges were identified which restrict the channel capacity and have an impact on flooding. These bridges (and the proposed conveyance measures) are:

- Finnihy Bridge (remove pipe crossing)
- Creamery Bridge (replace with single span bridge)
- Heritage Trail Footbridge (remove)
- Scarteen Park Bridge (replace bridge with longer span)
- East Park Lane Bridge (replace bridge with single span bridge)

Immediately downstream of the Finnihy Bridge there is a bend in the river leading to significant build-up of sedimentation and debris.

This measure aims to mitigate the fluvial flood risk by maximising improvements in conveyance through a series of works. These works include removing the pipe crossing at Finnihy Bridge as described in the previous measure, replacing and removing bridges along with general channel improvements such as removing the significant build-up of sedimentation and debris which has developed downstream of Finnihy Bridge.

Figure 5.18: Kenmare – Reduction in Fluvial Flood Extent due to Conveyance Works



The proposed works to improve conveyance were represented in the hydraulic model which indicated that there was a reduction in flood extent / risk. However, it is clear that the reduction is primarily due to the removal of the pipe in Finnihy Bridge. The further reduction in flood extent associated with channel improvements, the removal of a footbridge and the replacement of three bridges is minimal when you consider the extent of works required. Based on this assessment, this measure is not deemed to be a viable measure individually or in combination.

Consideration was also given to the removal of the stepping stones downstream of Finnihy Banks. The hydraulic model results indicates that the backwater at the stepping stones only contributes to flooding above the 2% AEP event and results in an increase in water level of 0.28m upstream of this location during the 1% AEP event. Removal of the stepping stones may increase flow downstream during more frequent events and there would not be a significant cost saving in reducing the height of 3m high walls in Finnihy Banks by 280mm. For these reasons the removal of the stepping stones was not considered to be a viable measure.

5.4.1.3 Flood Defences

This measure aims to mitigate the fluvial and tidal flood risk through the construction of flood defences. These defences include walls, embankments and flood barriers. The locations of the fluvial defences are shown in Figure 5.19 with the heights shown on subsequent figures. The locations and heights of the tidal defences are shown in Figure 5.25.

Figure 5.19: Kenmare – Fluvial Flood Defences

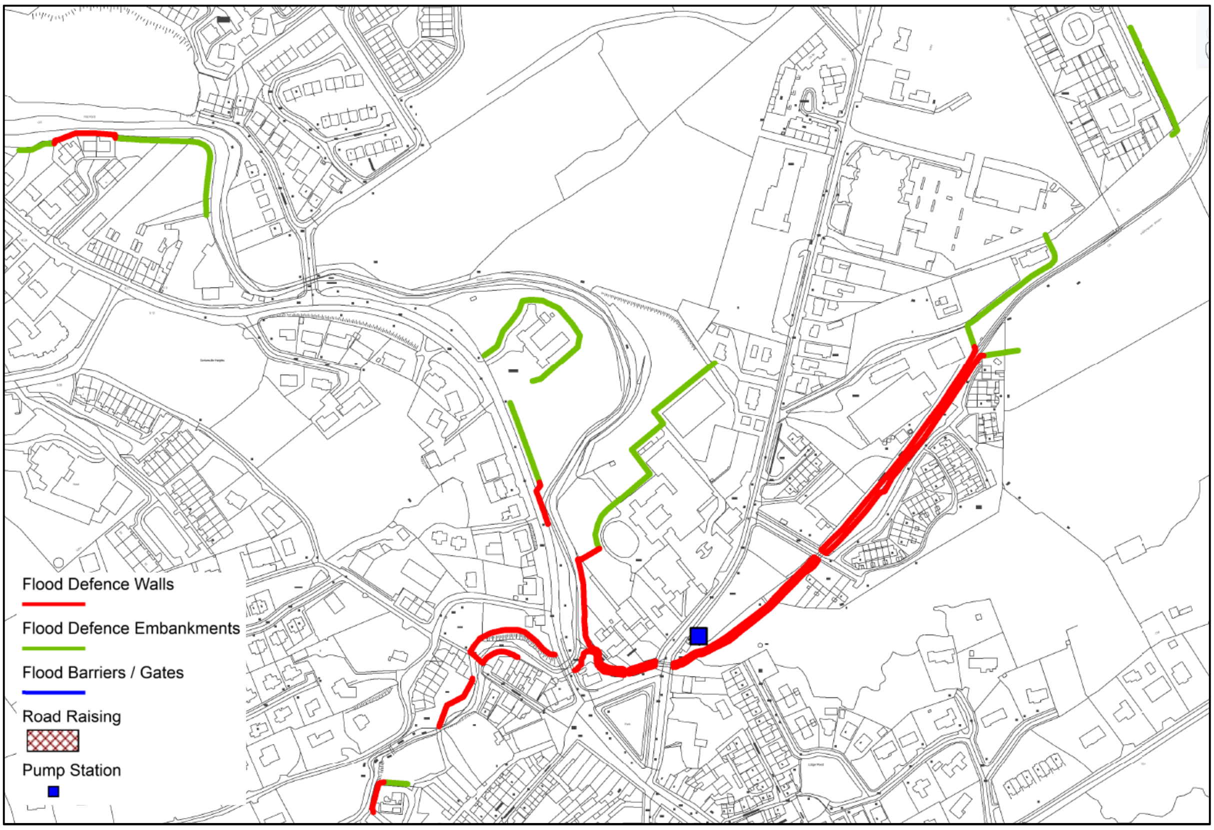


Figure 5.20: Kenmare – Fluvial Flood Defences – Finnihy Banks

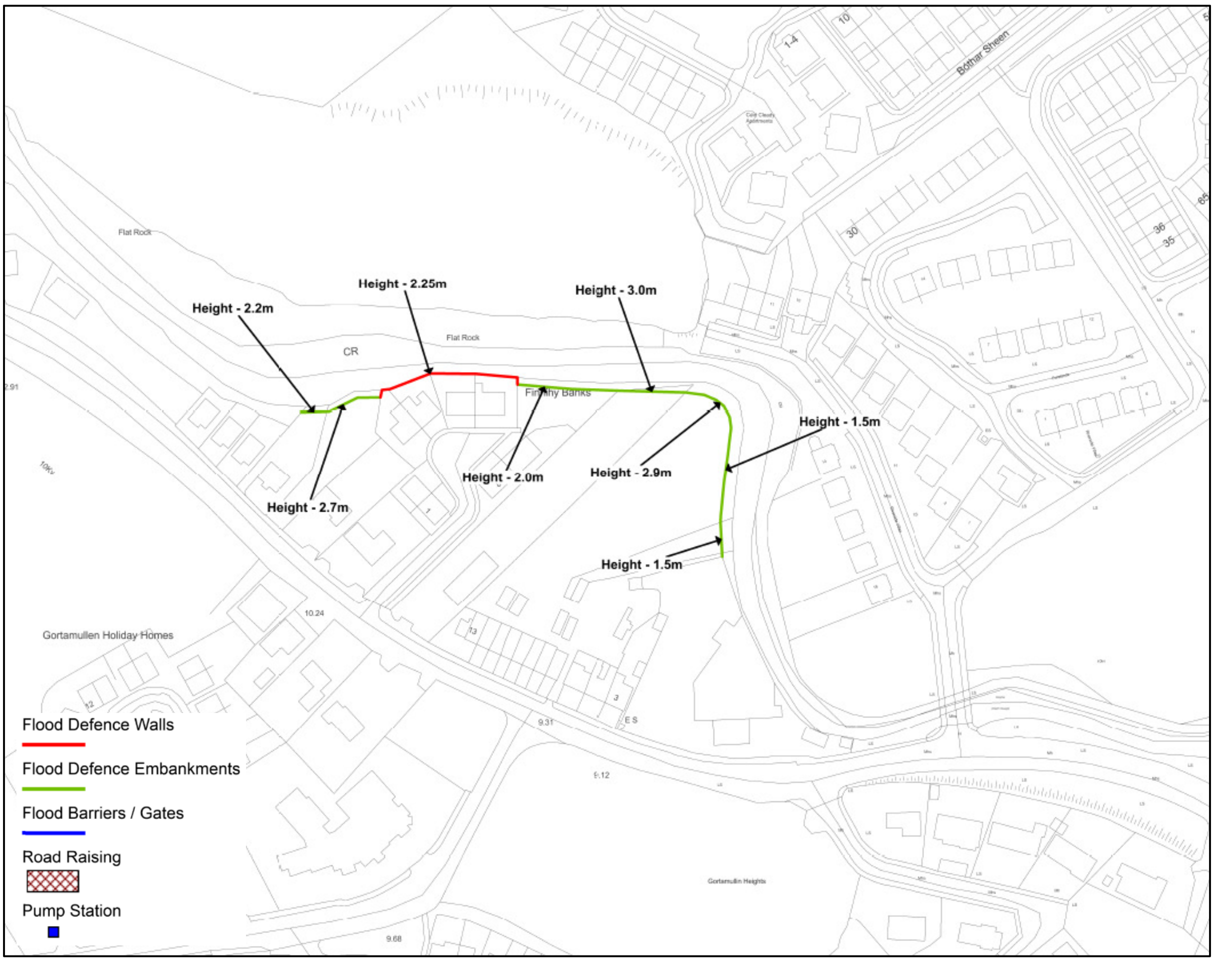


Figure 5.21: Kenmare – Fluvial Flood Defences – School / Convent

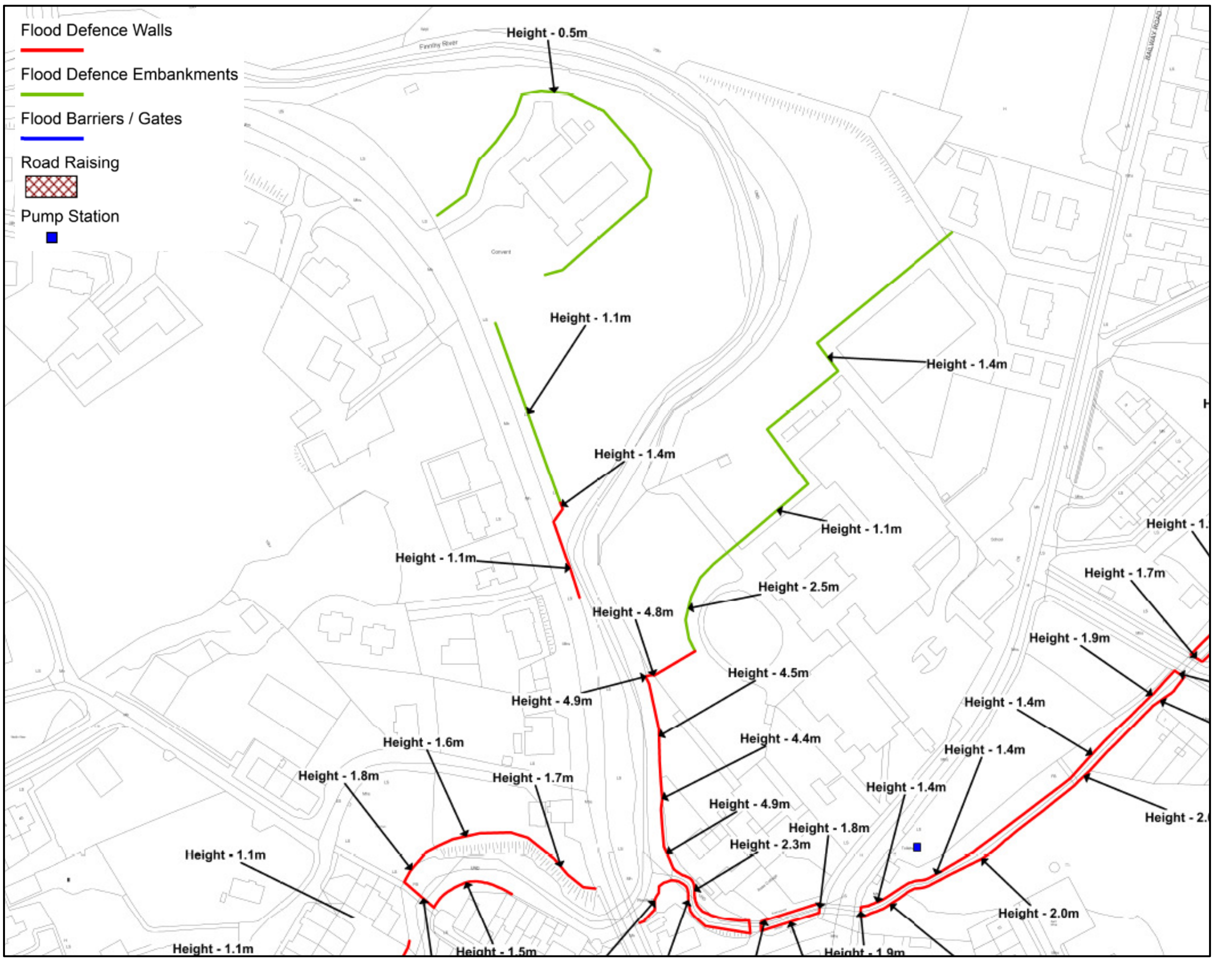


Figure 5.22: Kenmare – Fluvial Flood Defences – Town Centre

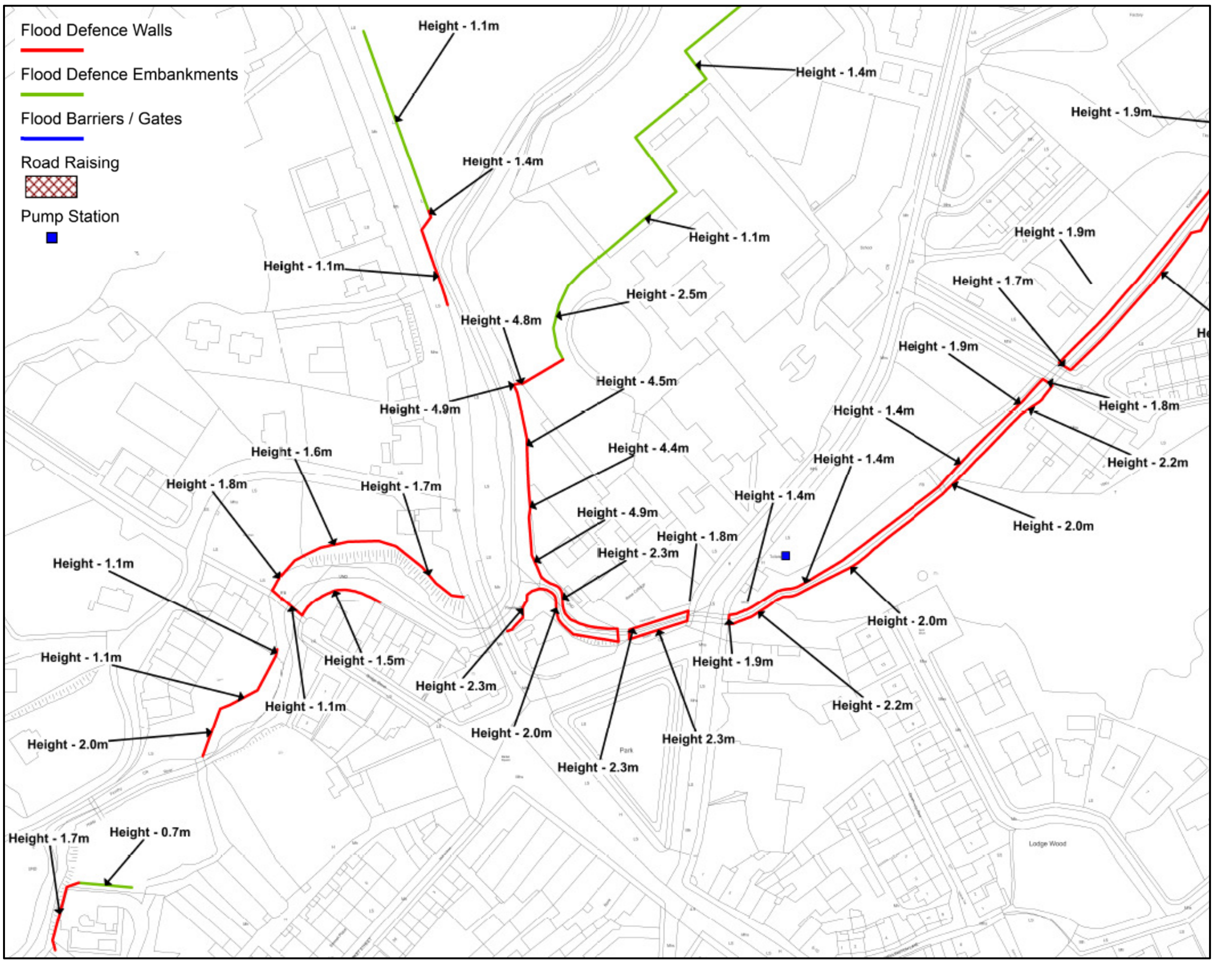


Figure 5.23: Kenmare – Fluvial Flood Defences – Kealnagour Lower

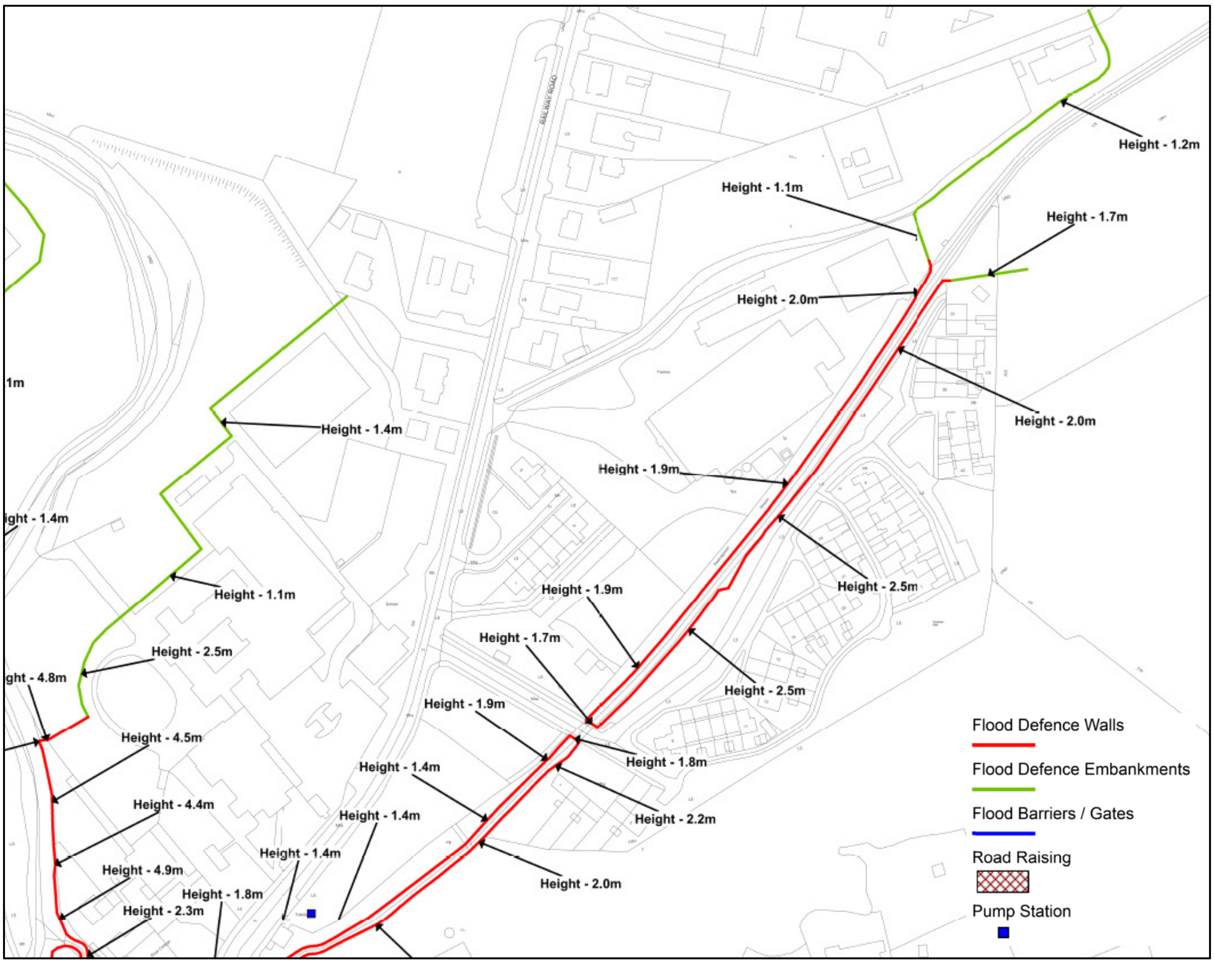


Figure 5.24: Kenmare – Fluvial Flood Defences – Kealnagour Upper

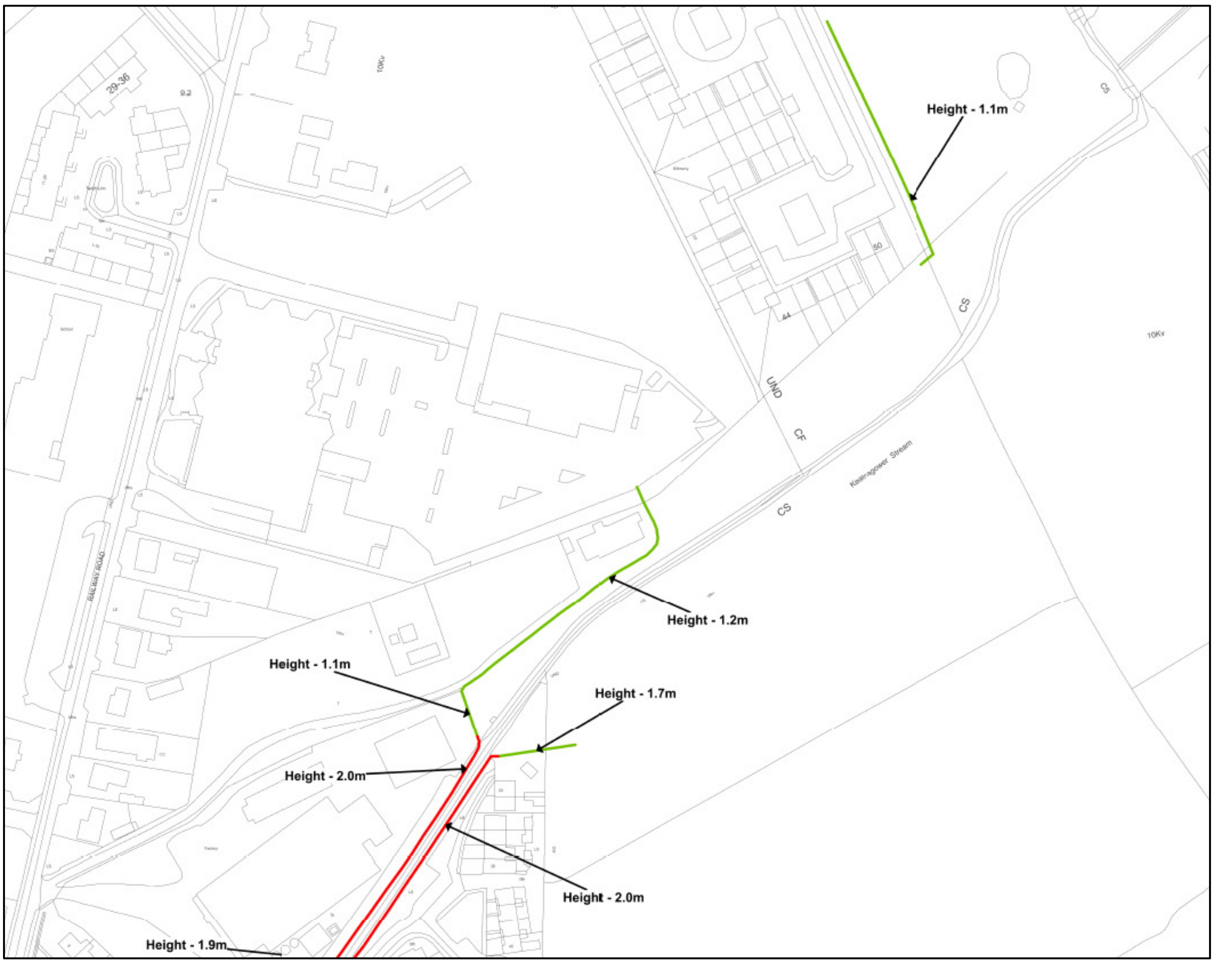
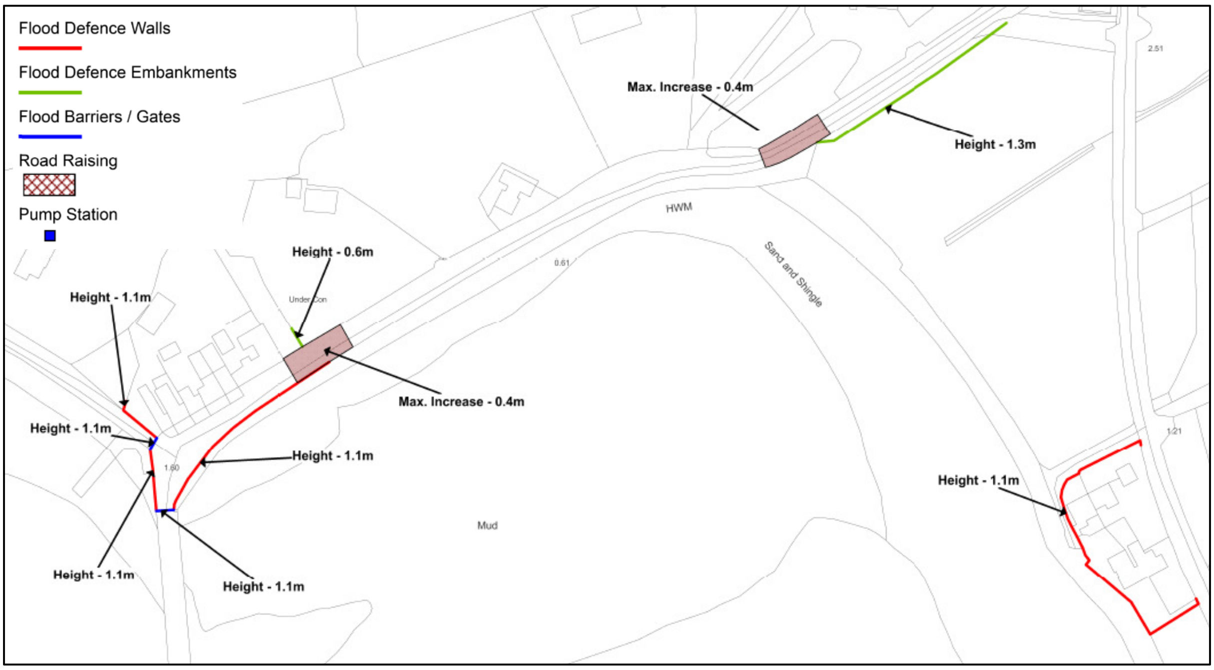


Figure 5.25: Kenmare – Tidal Flood Defences



The hydraulic modelling of the proposed flood defences as outlined in the above figures indicates that the measure fully achieves the required standard of protection for the 1% fluvial event. This is deemed to be a viable measure / option.

If fluvial flood defences are selected in combination with another measure (i.e. storage or conveyance) to form a flood mitigation option for Kenmare, the heights and extents of the flood defences described above will reduce.

5.4.1.4 Storage

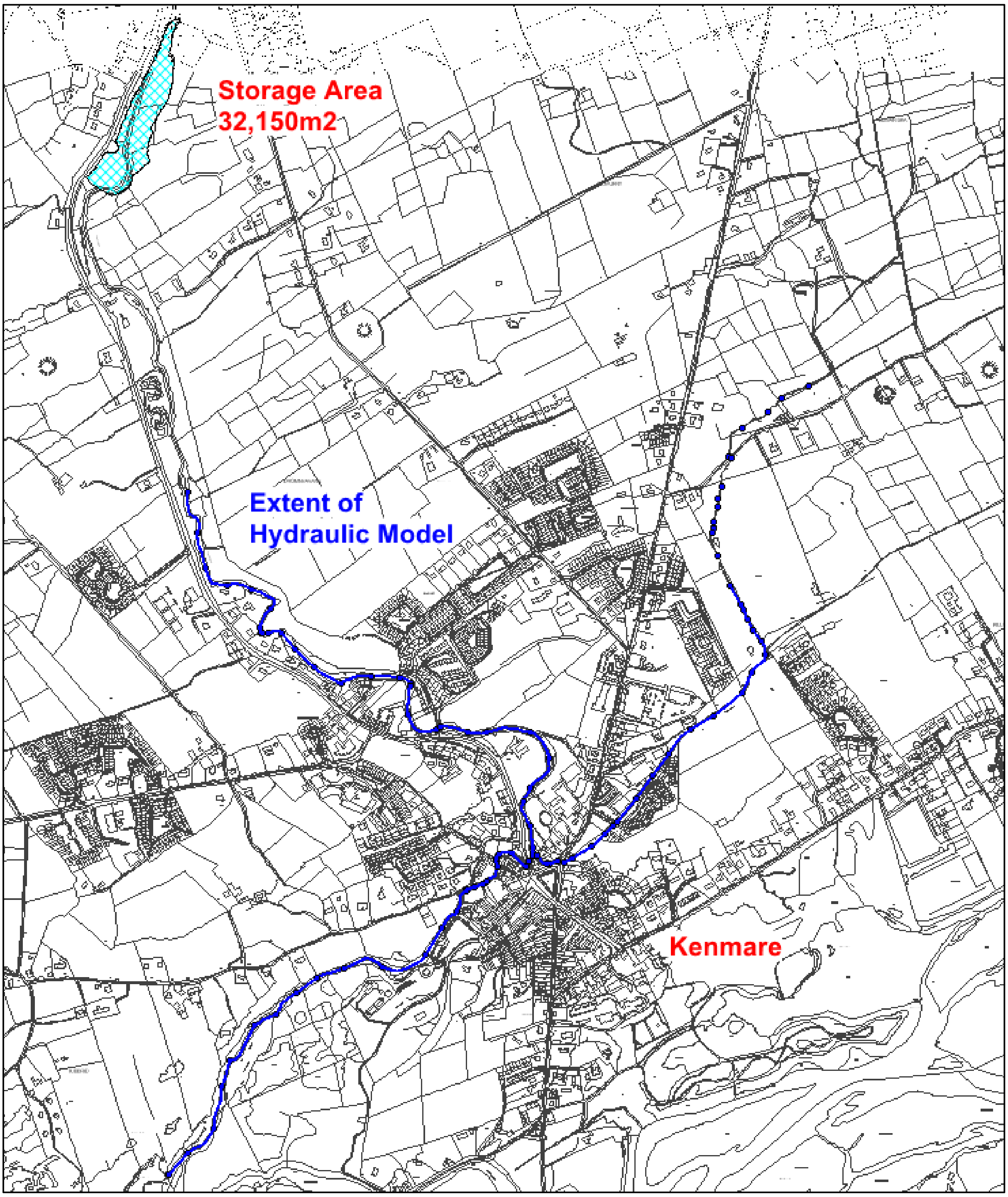
Kenmare is located at the confluence of the Finnihy River and Kealnagour River. A potential location for the storage of fluvial flows was identified on the Finnihy River approximately 2.5km upstream of the town centre and an assessment of the available storage capacity was carried out. The location of the potential storage area is shown in Figure 5.26.

The required capacities of the storage areas are derived using the catchment hydrology as applied in the hydraulic modelling. No allowances for uncertainties in the estimate of the index flood flow or flood growth curve have been made.

The peak flow in the Finnihy River at the extent of the hydraulic model for the 1% AEP event is 63.1m3/s which results in significant flooding along the watercourse and through the town. The storage area on the Finnihy River is 32,150m2 and has a capacity of approx. 96,450m3 (assuming a depth of 3m) which can limit the outflow to approx. 47.8m3/s. This equates to the peak of the 5% AEP event.

Hydraulic modelling of the storage area was carried out which resulted in a reduction in flood extent along the Finnihy. As significant flooding remains it not deemed to be a viable measure individually. However, it may be effective in combination with other measures such as fluvial flood defences or conveyance. This measure does not mitigate against tidal flood risk.

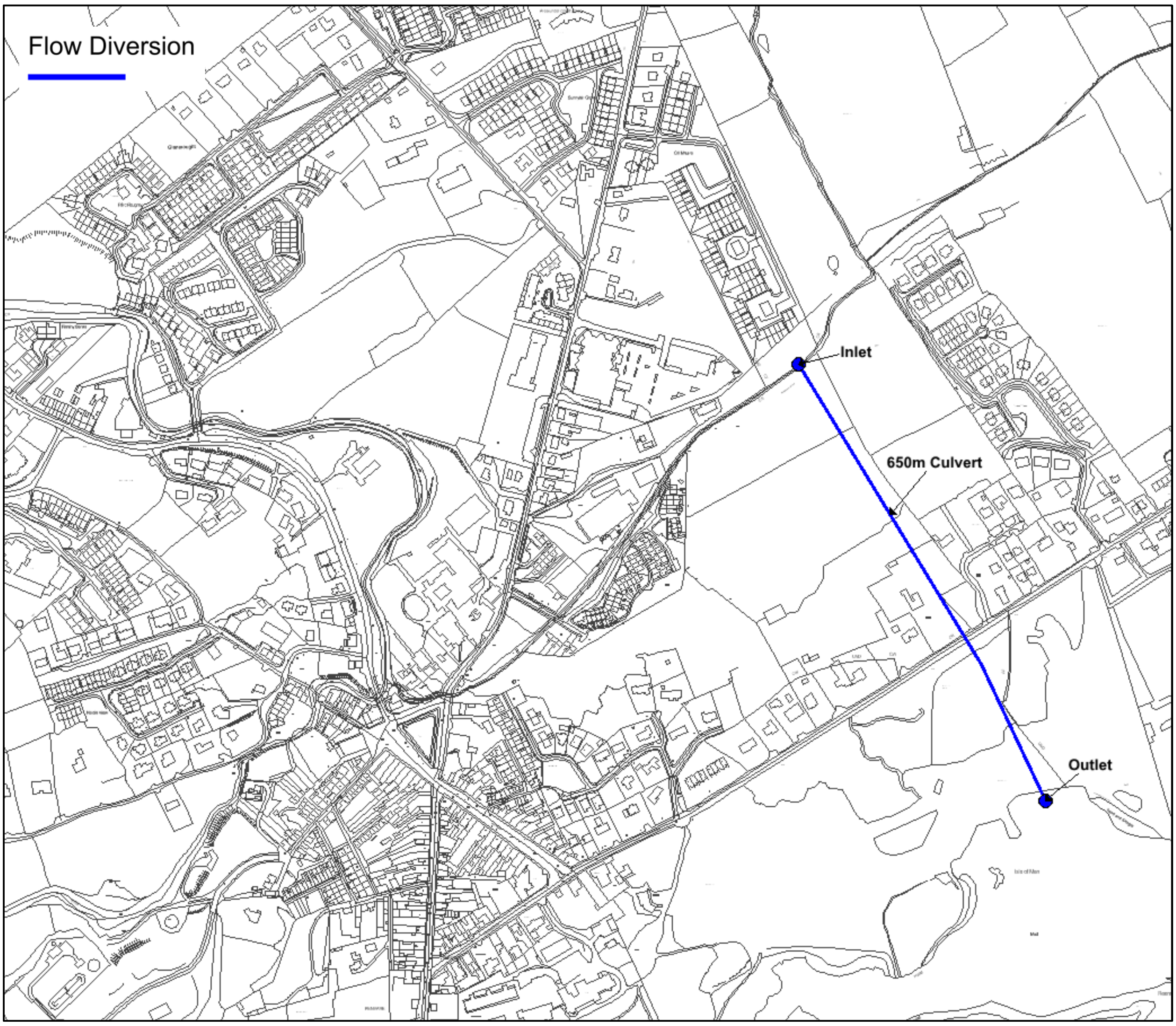
Figure 5.26: Kenmare – Location of Storage Area



5.4.1.5 Flow Diversion (Kealnagower)

This measure aims to mitigate fluvial flood risk along the Kealnagower Stream and through the town by diverting flows to Kenmare Bay. Figure 5.27 shows the location of the flow diversion culvert.

Figure 5.27: Kenmare – Flow Diversion



The Kealnagower Stream is a tributary of the Finnihy River. For the 1% AEP fluvial event the Finnihy River has a peak flow of 69m3/s just upstream of the confluence with the Kealnagower Stream. The peak flow in the Kealnagower Stream is 6.4m3/s.

The proposed flow diversion will limit the flow in the Kealnagower Stream to 2m3/s with all excess flow being discharged directly to Kenmare Bay. This is less than the peak flow in the Kealnagower Stream for the 50% AEP fluvial event or Qmed.

The proposed route is 650m long and based on existing bed levels at the inlet and outlet a minimum culvert size of 2.4m x 2.1m is required. Based on the Lidar data, the proposed route would involve a dig of greater than 5m over the majority of its length.

The hydraulic modelling of the proposed flow diversion indicates that there is a minor reduction in flood extent with an average reduction in water level of 0.12m. The maximum reduction in water level of 0.72m occurs immediately upstream of the culvert inlet where there is no existing flood risk. Therefore, flow diversion is not deemed to be a viable measure individually as it does not achieve the required standard of protection.

Due to the minor reductions in water levels along the Kealnagower and the significant flows of the Finnihy River, flow diversion is unlikely to be viable in combination with measures such as storage or conveyance. However, if combined with a flood defence measure it may reduce flood defence heights.

5.4.2 Potential FRM Measures

Based on the review and hydraulic modelling the following are deemed to be potential FRM measures:

- Increase Conveyance – Removal of Pipe Crossing
- Flood Defences – Fluvial & Tidal
- Storage – Finnihy
- Flow Diversion (Kealnagower)

5.4.3 Potential FRM Options

Based on the assessment of the potential (viable) FRM measures and detailed hydraulic modelling of the combined measures, the following are potential FRM options. Full outline drawings are in included in Appendix B for each of the potential options.

- Option 1 – Flood Defences
- Option 2 – Storage & Flood Defences
- Option 3 – Conveyance & Flood Defences
- Option 4 – Flow Diversion & Flood Defences
- Option 5 – Conveyance, Flow Diversion & Flood Defences

6 Environmental Assessment

6.1 General

Refer to Appendix C for Draft SEA Options Appraisal Report and Appendix D for Draft Habitats Directive Screening (for Appropriate) Assessment.

7 Stakeholder Input

7.1 Draft Flood Mapping Public Consultation Days

Public Consultation Days (PCDs) were held in Unit of Management (UoM) 21 between October 2014 and February 2015. The purpose of the PCDs were to present the public with the Draft Flood Maps that have been prepared as part of the South Western CFRAM Study, to seek their feedback on those maps and on the Flood Risk management Objectives that apply to this area.

Details of the Public Consultation days held in the UoM 21 AFAs are shown in Table 7.1 below.

Table 7.1: Draft Flood Mapping PCDs

AFA	Date	Venue	Nr of Attendees
Bantry	3rd October 2014	Aras Beanntrai	18
Durrus	17th February 2015	Phillip's Green Building	6
Castletownbere	8th October 2014	The Library	3
Kenmare	15th October 2014	The Brook Lodge Hotel	18

7.2 Flood Risk Management Measures

At the Draft Flood Mapping PCDs, attendees were asked to indicate what they thought should be done to manage flood risk in their AFAs. The responses are shown in Table 7.2 below.

Table 7.2: Flood Risk Management – Public Opinion

AFA	What needs to be done to manage flood risk?
Bantry	Building of retention reservoir to contain floodwater at times of high tides
	Water has been pumped by Fire Brigade to ease the pressure on businesses getting flooded by diverting water away to non-risk flood areas.
Durrus	Maybe reinforce river banks by housing estate (see address attached, i.e., Sruth Mhuilleann)
Kenmare	Care of all issues in C.8, especially drainage

7.3 Preliminary Options PCDs

On the 3rd of November 2015 a stakeholder workshop was held with local Authority Engineers to discuss the emerging preferred options. Feedback received at this workshop was used to revise the proposed options in advance of the Public Consultation Days.

In December 2015 PCDs were held to display various Flood Risk Management Options in each of the UoM 21 AFAs under consideration. Details of the PCDS are shown in Table 7.3 below.

Table 7.3: Details of Public Consultation Days

AFA	Date	Venue	Nr of Attendees
Bantry	3rd of December 2015	Cork Community Centre Offices / Court House	5
Castletownbere	2nd of December 2015	Castletownbere Library	5
Kenmare	10th of December 2015	Brook Lane Hotel, Kenmare	45

At the Preliminary Options PCDs Attendees were asked to indicate their preference for the Flood Risk Management Options under consideration in each of the UoM 21 AFAs. Their responses are summarised in Table 7.4 below.

Table 7.4: Public Preference for Potential Options

AFA	Option	Nr of Rank 1 Received	Rank
Bantry	Fluvial & Tidal Flood Defences	-	-
	Fluvial Flood Defences & Tidal Barrage	-	-
	Do Nothing	-	-
Castletownbere	Tidal Flood Defences	2	1
	Do Nothing	0	2
Kenmare	Flood Defences	5	2
	Storage & Flood Defences	0	3
	Conveyance & Flood Defences	6	1
	Flow Diversion & Flood Defences	Flow Diversion suggested at PCD	-
	Conveyance, Flow Diversion & Flood Defences	Flow Diversion suggested at PCD	-
	Do Nothing	0	4

No feedback was received from the Bantry PCD.

At the Kenmare PCD members of the public proposed a flow diversion measure with a specific route. Following the PCD this route was incorporated into a number of options for consideration.

8 Flood Risk Assessment

8.1 General

Flood risk mapping for the UoM 21 AFAs and Medium Priority Watercourses (MPWs) has been undertaken as part of this Study. The mapping includes the receptors that are at risk from flooding in the following categories:

- Society
- The Environment
- Cultural Heritage
- The Economy

The Flood Risk Maps for UoM 21 are included in an Annexe to the Preliminary Options Report: Annex I, Flood Risk Maps.

8.2 Receptors

Examples of the receptors in each of these categories are included in Table 8.1 below:

Table 8.1: Flood Risk Receptors

Category	Receptor
Society	People Homes Fire Stations Garda Stations Hospitals Care centres
The Environment	Protected Areas Pollution Sources
Cultural Heritage	Protected Archaeological Sites Protected Buildings
The Economy	Business Premises Roads Railway Ports Utilities

The numbers of receptors at risk from flooding in each AFA and each MPW are listed in tables 8.3 to 8.12 below. These numbers were calculated by counting the number of receptors that existed in a location that had a positive depth of flooding. These tables indicate the receptors at risk from the current scenario, the Mid-Range Future Scenario (MRFS) and the High End Future Scenario (HEFS) and are split into the Annual Exceedance Probability of the flooding concerned.

Annual Exceedance Probability, henceforth referred to as AEP, is a term used throughout this report and the wider CFRAM studies to refer to the rarity of a flood event. The probability of a flood relates to the likelihood of an event of that size or larger occurring within any one year period. For example, a one in hundred year flood has a one chance in a hundred of occurring in any given year; 1:100 odds of occurring in any given year; or a 1% likelihood of occurring. This is described as a 1% annual exceedance probability (AEP) flood event.

Table 8.2 converts the 'return periods' to %AEP for key flood events as a reference to previous studies.

Table 8.2: Flood Probabilities

% Annual Exceedance Probability (%AEP)	Odds of a Flood Event in Any Given Year	Chance of a Flood Event in Any Given Year or Previous 'Return Period'
50%	1:2	1 in 2
20%	1:5	1 in 5
10%	1:10	1 in 10
5%	1:20	1 in 20
2%	1:50	1 in 50
1%	1:100	1 in 100
0.5%	1:200	1 in 200
0.1%	1:1000	1 in 1000

Table 8.3 below lists the number of Inhabitants at risk from fluvial flooding in each AFA.

Table 8.3: Risk to Society: Nr. of Inhabitants

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	0	3	3	8	44	75	94	127	62	83	114	125	151	185	302	307	161	302	413
Castletownbere	3	3	6	6	11	17	28	36	34	48	67	78	95	101	101	106	112	118	123
Durrus	0	0	0	0	0	0	0	39	0	0	0	0	0	0	3	42	0	0	45
Kenmare	10	23	26	60	237	372	411	437	23	39	101	296	338	419	424	458	309	458	515

Table 8.4 below indicates the number of Residential Properties at risk from fluvial flooding in each AFA.

Table 8.4: Risk to Society: Nr. of Residential Properties

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	0	1	1	3	17	29	36	49	24	32	44	48	58	71	116	118	62	116	159
Castletownbere	1	1	2	2	4	6	10	13	12	17	24	28	34	36	36	38	40	42	44
Durrus	0	0	0	0	0	0	0	14	0	0	0	0	0	0	1	15	0	0	16
Kenmare	4	9	10	23	91	143	158	168	9	15	39	114	130	161	163	176	119	176	198

Table 8.5 below lists the number of high vulnerability properties at risk from fluvial flooding in each AFA. High vulnerability properties include Hospitals, Nursing Homes, Schools, Prisons, Camping / Halting sites.

Table 8.5: Risk to Society: Nr. of High Vulnerability Properties

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	1	1	1	1	1	1	2	1	0	1	1	1	2	2	2	3	2	3	3
Castletownbere	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Durrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kenmare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.6 below lists the number of Social Amenity Sites at risk from fluvial flooding in each AFA

Table 8.6: Risk to Society: Nr. of Social Amenity Sites

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	0	0	0	0	1	5	5	4	4	6	5	6	6	7	8	8	7	9	10
Castletownbere	0	1	1	2	2	2	3	4	3	5	7	7	8	8	8	10	10	10	10
Durrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kenmare	0	0	0	0	0	1	1	2	0	0	0	0	0	2	2	2	0	2	2

Table 8.7 below lists the number of properties on the National Inventory of Architectural Heritage at risk from fluvial flooding in each AFA

Table 8.7: Risk to Cultural Heritage: Nr. of NIAH Buildings

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	0	0	0	0	8	23	26	26	21	25	25	29	29	31	37	49	39	48	52
Castletownbere	0	0	0	0	0	1	3	6	6	8	12	12	16	16	16	17	17	17	17
Durrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kenmare	0	1	1	1	6	8	9	12	1	1	2	5	8	9	11	12	6	14	14

Table 8.8 below lists the number of Archaeological Monuments at risk from fluvial flooding in each AFA.

Table 8.8: Risk to Cultural Heritage: Nr. of RMPs

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Castletownbere	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Durrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Kenmare	0	1	1	1	2	3	4	4	1	1	2	3	3	3	4	4	5	6	7

Table 8.9 below lists the number of Non-Residential Properties at risk from fluvial flooding in each AFA

Table 8.9: Risk to the Economy: Nr. of Non-Residential Properties

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	1	1	1	1	67	119	135	133	90	118	123	136	151	155	173	175	164	191	205
Castletownbere	1	2	4	7	8	13	19	31	22	40	56	58	70	73	76	86	88	94	96
Durrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kenmare	0	1	1	3	37	81	100	137	1	1	18	52	73	115	129	140	51	126	142

Table 8.10 below lists the number of Roads at risk from fluvial flooding in each AFA

Table 8.10: Risk to the Economy: Nr. of Roads

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	0	0	0	0	4	8	8	8	5	5	8	10	11	13	13	14	14	14	14
Castletownbere	2	2	2	2	3	4	4	4	4	6	6	6	6	6	6	6	6	6	6
Durrus	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	2	2	2	3
Kenmare	0	0	1	5	5	5	5	5	0	2	4	4	4	5	5	5	6	8	8

Table 8.11 below lists the number of Utilities at risk from fluvial flooding in each AFA

Table 8.11: Risk to the Economy: Nr. of Utilities

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Bantry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Castletownbere	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Durrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kenmare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

In addition to fluvial flood risk, Bantry and Kenmare in UoM 21 are at risk from tidal flooding. Tables 9.12 and 9.13 below list the receptors at risk from tidal flooding in these AFAs

Table 8.12: Tidal Flood Risk – Bantry

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
Receptor	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	0.5%	0.1%
Inhabitants	29	36	42	44	44	49	49	52	49	47	52	57	60	65	81	96	96	101	109
Residences	11	14	16	17	17	19	19	20	19	18	20	22	23	25	31	37	37	39	42
High Vulnerability Properties	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	3
Social Amenity sites	2	3	4	5	5	5	5	5	5	4	4	6	7	7	9	9	9	11	11
Archaeological sites	13	16	17	22	24	29	29	34	26	28	28	33	35	36	40	45	47	50	54
Architectural Sites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-residential properties	70	70	75	79	85	93	98	106	93	88	98	106	109	118	141	150	149	167	179
Roads	3	3	3	3	5	5	5	5	6	6	7	7	7	7	7	7	7	7	7
Utilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.13: Tidal Flood Risk – Kenmare

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
Receptor	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	0.5%	0.1%
Inhabitants	0	0	0	0	8	26	31	34	62	65	68	68	68	68	68	73	125	164	174
Residences	0	0	0	0	3	10	12	13	24	25	26	26	26	26	26	28	48	63	67
High Vulnerability Properties	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social Amenity sites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Archaeological sites	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2
Architectural Sites	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	3	5	5
Non-residential properties	1	1	1	1	1	1	1	1	1	1	1	2	4	4	4	4	4	9	11
Roads	0	0	1	1	2	3	3	3	3	3	3	3	3	3	3	3	5	5	5
Utilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

8.3 Flood Risk Maps

Flood Risk Maps have been prepared to represent the various receptors at risk from flooding in each of the AFAs and MPWs. These maps are described in the following sections below.

8.3.1 Inhabitants Maps

Maps have been prepared to represent the number of people at risk from flooding of various frequencies. The number of people per house was taken from CSO data. For UoM 21 the average occupancy is 2.8 people per house. For each AEP flood extent the number of residential properties at risk was counted and multiplied by that occupancy. The numbers of people at risk are represented as a density per hectare on the maps.

8.3.2 Economic Activity Maps

The types of economic activity at risk from flooding in UoM 21 are shown on the economic activity risk map. The types of activities considered are:

- Property
- Infrastructure
- Rural Land Use
- Economic

8.3.3 Economic Risk Density Maps

Maps have been prepared to represent the economic risk from flooding of various frequencies. The economic risk is represented on the maps as a density of the Annual Average Damage value per hectare.

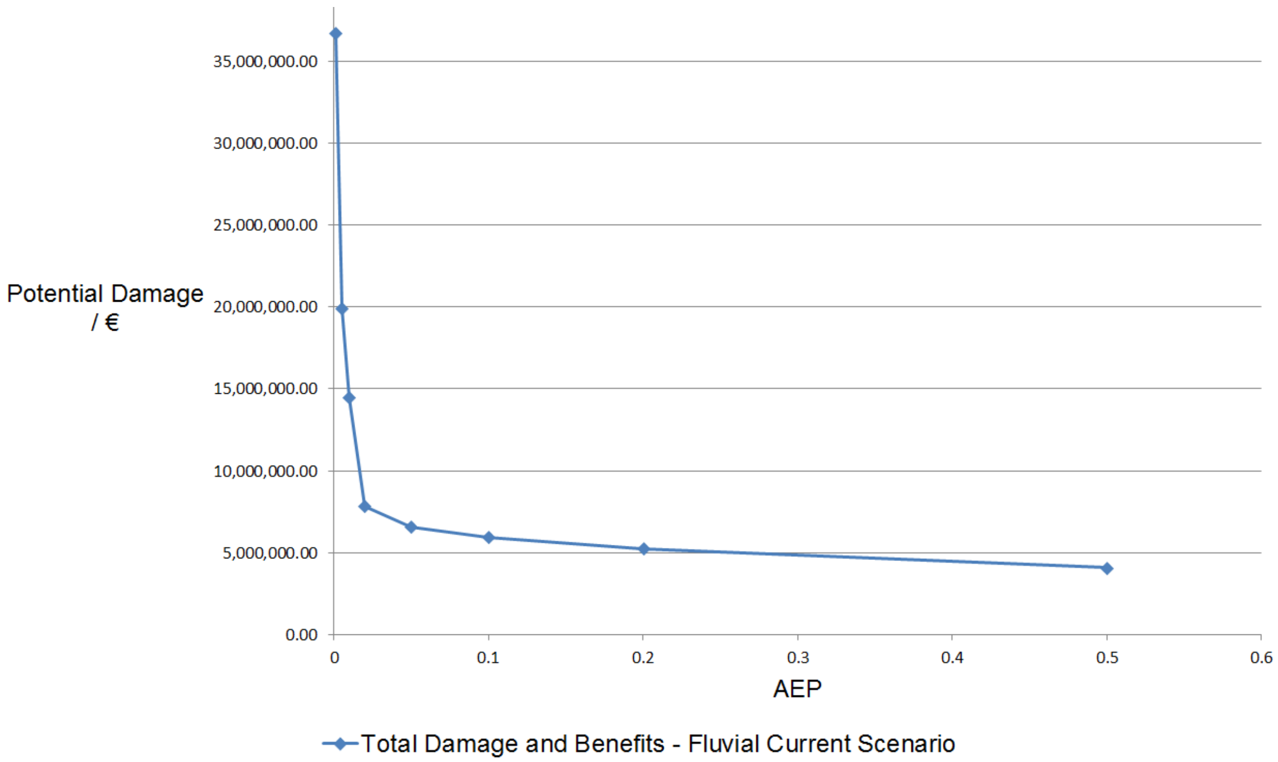
8.3.3.1 Annual Average Damage

The potential economic damage that could be caused by flooding was calculated for every property in each of the UoM 21 AFAs. The damage to a property is related to the type, use and the predicted depth of flooding within the property. It is possible to calculate the damage that could arise from a series of floods of different Annual Exceedance Probability (AEP). Using these damage values the Annual Average Damage for the AFA can be calculated by measuring the area under the Damage / Probability Curve.

For each property, the depth of flooding was extracted from the hydraulic model for the full range of design scenarios (i.e. 50% AEP to 0.01% AEP for both fluvial and tidal flooding). Using the research from the FHRC Multi-coloured Handbook, damage costs were calculated for each property for the range of scenarios.

The damage costs are based on property type and/or area. The total damages for each design scenario were summed and plotted on the annual average flood loss curve which is shown in Figure 8.1. The area under the curve is the Annual Average Damage (AAD).

Figure 8.1: Typical Damage / Probability Curve (Annual Average Flood Loss Curve)



The Annual Average Damage for each AFA is listed in Table 8.14 below.

Table 8.14: Annual Average Damage €

AFA	Current Scenario €	Mid-Range Future Scenario €	High End Future Scenario €
Bantry	3,848,582.85	13,367,832.72	24,975,420.89
Castletownbere	192,504.33	3,304,239.38	7,819,635.92
Durrus	993.36	1,241.95	1,496.82
Kenmare	883,646.85	2,947,718.43	5,086,613.29

8.3.3.2 Present Value Damage (PVd)

The Present Value Damage (PVd), based on a scheme that will have to be renewed after 50 years and a discount rate of 4%, has also been calculated. The PVd is calculated for each individual property in order to allow capping of PVd values where the PVd exceeds the current market value of the property.

Where a property's estimated potential damage for an event of 0.1% AEP is equal to or exceeds €0.5M, a threshold survey was carried out as a spot check on the ground level as determined by the DTM. Where a discrepancy was noted, the damage assessment was updated and damages recalculated. Spot checks were also carried out on properties where the PVd of a property is 1% or more of the total PVd for the AFA.

Table 8.15 lists all properties with damages for the 0.1% AEP event exceeding €0.5M or with a PVd greater than 1% of the Total AFA PVd

Table 8.15: List of properties with damages exceeding €0.5M or a PVd greater than 1% of the Total AFA PVd

AFA	Property Type	Object ID	Fluvial Damages 0.1% AEP €	Tidal Damages 0.1% AEP €	PVd - 1% of Total
Bantry	Bank	441252	192,936.16	609,266.03	3.58%
	Factory	644155	4,689,347.62	n/a	6.59%
	Factory	644231	1,870,032.23	n/a	1.64%
	Hotel	1064	0.00	1,119,695.45	1.79%
	Hotel	441195	161,700.16	620,865.60	3.29%
	Office	249880	0.00	271,798.97	1.29%
	Office	250079	0.00	585,003.50	1.65%
	Pub	1043	45,446.18	198,999.63	1.01%
	Pub	249704	72,938.96	80,232.85	1.16%
	Pub	441133	55,008.37	226,054.61	1.27%
	Restaurant	441184	41,222.74	156,273.87	1.07%
	School	249863	158,565.58	158,707.97	3.51%
	Shop	1041	38,384.41	11,662.40	1.65%
	Shop	249677	62,476.47	214,020.69	3.35%
	Shop	249700	18,369.80	99,476.95	1.35%
	Shop	249821	23,779.07	107,441.58	1.85%
	Shop	249846	28,254.05	131,288.66	2.40%
	Shop	250038	15,642.03	108,088.05	1.42%
	Shop	250140	34,450.91	12,279.47	1.68%
	Shop	250178	21,591.17	100,328.11	1.67%
	Shop	441131	25,253.59	95,059.57	1.69%
	Shop	441164	40,662.55	135,740.26	2.81%
	Shop	441239	66,465.48	263,198.81	2.56%
	Shop	441249	20,731.57	89,813.19	1.15%
	Shop	249387	365,339.50	676,393.42	3.94%
Castletownbere	Semi	979524	0.00	64,231.14	7.81%

AFA	Property Type	Object ID	Fluvial Damages 0.1% AEP €	Tidal Damages 0.1% AEP €	PVd - 1% of Total
	Terrace	979378	0.00	53,430.38	5.24%
	Factory	978245	0.00	355,716.16	49.99%
	Factory	981964	0.00	153,668.46	1.45%
	HealthCentre	979560	0.00	142,381.11	7.15%
	Hotel	979709	0.00	255,859.18	3.89%
	Office	979925	0.00	82,318.56	7.58%
	Shop	979063	0.00	86,853.55	2.26%
	Shop	981890	0.00	750,179.87	7.38%
	Warehouse	979359	0.00	19,424.72	1.04%
Kenmare	Bungalow	2312083	83,208.52	n/a	2.43%
	Bungalow	2312193	79,215.47	n/a	2.09%
	Bungalow	2312194	79,215.47	n/a	2.14%
	Bungalow	2312198	81,877.51	n/a	2.30%
	Bungalow	2312251	80,546.49	n/a	2.13%
	Bungalow	2312265	90,560.81	n/a	2.58%
	Bungalow	2312274	81,877.51	n/a	2.36%
	Bungalow	2312275	90,560.81	n/a	2.59%
	Bungalow	3094323	85,743.79	n/a	1.05%
	Terrace	3094347	60,506.94	n/a	1.18%
	Terrace	3094563	69,608.40	54,641.40	1.95%
	Church	3094642	755,575.70	n/a	1.59%
	Court	3094649	254,082.53	n/a	1.21%
	Restaurant	5486	214,069.08	n/a	1.24%
	Restaurant	3094210	347,515.13	n/a	1.29%
	RetailWH	3094396	455,035.29	n/a	1.23%
	Shop	5496	225,698.54	n/a	1.18%
	Shop	5502	246,569.17	n/a	1.18%
	Shop	3094351	196,158.70	n/a	1.03%
	Shop	3094473	1,055,829.12	n/a	10.12%
	Shop	5512	612,081.37	n/a	5.87%

Following the survey spot check, adjustments were made as required and property damages were capped. For Residential properties, the damages were capped at the market value of the property and non-residential properties were capped at ten times the rateable value of the property. The capping process was carried out in line with Guidance Note 27. Market values for residential properties were determined within each AFA. Typical capping values for residential properties are as follows:

- Detached = €250k - €300k
- Semi-detached = €150k - €250k
- Terrace = €100k - €150k

The annual average damage and present value damages for each of the AFAs is listed in Table 8.16. The benefit of a flood risk management option (Scheme) was also calculated which is the damage avoided by implementing a scheme to the required Standard of Protection (SOP).

Table 8.16: Summary of Damages & Benefit of Scheme Benefit

AFA	AAD €	PVd	Capped PVd	Benefit of Scheme (Damage Avoided) €
Bantry	3,848,582.85	82,675,967.34	47,680,602.89	42,962,484.53
Castletownbere	192,504.33	4,135,413.63	3,413,487.19	3,056,759.09
Durrus	993.36	21,339.50	21,339.50	0.00
Kenmare	883,646.85	18,982,664.67	15,537,343.65	10,671,145.95

It is clear from Table 8.16 that there is low potential damage in Durrus and that there is no benefit in implementing a scheme as damage only occurs for events greater than the standard of protection.

Table 8.17 lists the benefit or damage avoided by implementing a flood forecasting and warning system.

Table 8.17: Benefit of Implementing a Flood Forecasting & Warning System

Spatial Scale of Assessment	Infrastructure	Benefit € (13% of PVd)
AFA		
Bantry (Mealagh River)	Rain gauges River level gauges	748,519.71
Bantry (Tidal)	Use the existing OPW storm surge forecasting system to predict high tide levels	5,066,566.19
Castletownbere	Use the existing OPW storm surge forecasting system to predict high tide levels	537,603.77
Durrus	Rain gauges River level gauges	2,774.14
Kenmare	Use the existing OPW storm surge forecasting system to predict high tide levels	40,807.07

Source: UoM 21 Hydraulics Report

It is clear from Table 8.17 that a flood forecasting and warning system is not viable for Durrus due to the low potential benefits.

In Bantry fluvial flood forecasting and warning is only applicable for the Mealagh River. The other watercourses are too steep and have short times to peak making forecasting and warning ineffective. The potential benefit of a fluvial forecasting and warning system on the Mealagh River is shown in Table 8.17.

9 Estimates of Cost

9.1 Flood Forecasting and Warning Systems

The cost of the flood forecasting and warning systems were calculated using the rates and methods contained in the Unit Cost Database developed by the OPW for use in the CFRAM studies. The estimates in Table 9.1 include costs for specifications, site surveys, gauging and telemetry equipment, forecast model setup and development along with training, operation and maintenance. In addition, in order to take account of the high level nature of the estimate and include for unseen costs, optimism bias is included in these estimates. The costs are exclusive of VAT. Full details of the costs are included in Appendix A.

Table 9.1: Estimate of Costs – Flood Forecasting and Warning Systems

Spatial Scale of Assessment	Infrastructure	Benefit € (13% of PVd)	Estimated Cost / €
AFA			
Bantry (Mealagh River)	3 Nr. Rain Gauges 3 Nr. River Level Gauges (Hydrometric Station)	748,519.71	637,499.00
Bantry (Tidal)	Use the existing OPW storm surge forecasting system to predict high tide levels	5,066,566.19	< 100k
Castletownbere	Use the existing OPW storm surge forecasting system to predict high tide levels	537,603.77	< 100k
Durrus	3 Nr. Rain Gauges 4 Nr. River Level Gauges (Hydrometric Station)	2,774.14	674,710.00
Kenmare	Use the existing OPW storm surge forecasting system to predict high tide levels	40,807.07	< 40k

From Table 9.1 it can be seen that flood forecasting is not a viable measure for Durrus.

9.2 Structural Options

The cost of each option was calculated using the rates contained in the Unit Cost Database developed by the OPW for use in the CFRAM studies. This database contains rates for constructing various types of flood risk management measures depending on their height (depth), length and location.

The estimates in Table 9.2 below include costs for construction, maintenance, operation, land acquisition, and professional fees. In addition, in order to take account of the high level nature of the estimate and include for unseen costs, optimism bias is included in these estimates. The costs are exclusive of VAT. Full details of the costs are included in Appendix A.

Table 9.2: Estimate of Costs for Potential Options

SSA	Option	Estimated Cost / €	Benefit of Scheme €
AFA			
Bantry	Fluvial & Tidal Flood Defences	6,693,304.51	42,962,485
	Fluvial Flood Defences & Tidal Barrage	75,572,581.09	
Castletownbere	Tidal Flood Defences	2,564,578.74	2,954,219
Kenmare	Flood Defences	15,457,087.66	10,671,146
	Storage & Flood Defences	3,654,349.79	
	Conveyance & Flood Defences	5,432,188.34	
	Flow Diversion & Flood Defences	10,591,632.75	
	Conveyance, Flow Diversion & Flood Defences	7,840,851.90	

10 Appraisal of Options

The effectiveness and potential impacts of each of the potential options is assessed using a Multi Criteria Analysis, (MCA). This MCA process assigns a score for each option that relates to how effective that option is in terms of achieving set goals under a set of objectives. The MCA can then be used to guide the decision on which particular option is the preferred option to manage flood risk in a particular area.

10.1 Flood Risk Management Objectives

The effectiveness of each of the potential options is measured in terms of how it achieves a set of Flood Risk Management Objectives. These objectives are split into a number of categories. These are:

- Technical
- Economic
- Social
- Environmental

Some of these objectives are further split into sub-objectives, where this is not the case the sub objective is the same as the objective. The Objectives and Sub objectives are shown in Table 10.1 below.

Table 10.1: Flood Risk Management Objectives

Criteria		Objective		Sub-Objective
1 Technical	a	Ensure flood risk management options are operationally robust	i)	Ensure flood risk management options are operationally robust
	b	Minimise health and safety risks associated with the construction, operation and maintenance of flood risk management options	I)	Minimise health and safety risks associated with the construction, operation and maintenance of flood risk management options
	c	Ensure flood risk management options are adaptable to future flood risk, and the potential impacts of climate change	i)	Ensure flood risk management options are adaptable to future flood risk, and the potential impacts of climate change
2 Economic	a	Minimise economic risk	i)	Minimise economic risk
	d	Minimise risk to transport infrastructure	i)	Minimise risk to transport infrastructure
	c	Minimise risk to utility infrastructure	i)	Minimise risk to utility infrastructure
	d	Minimise risk to agriculture	i)	Minimise risk to agriculture
3 Social	a	Minimise risk to human health and life	i)	Minimise risk to human health and life of residents
			ii)	Minimise risk to high vulnerability properties
	b	Minimise risk to community	i)	Minimise risk to social infrastructure and amenity
			ii)	Minimise risk to local employment
4 Environmental	a	Support the objectives of the WFD	i)	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives.

Criteria		Objective		Sub-Objective
	B	Support the objectives of the Habitats Directive	i)	Avoid detrimental effects to, and where possible enhance, Natura 2000 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.
	c	Avoid damage to, and where possible enhance, the flora and fauna of the catchment	i)	Avoid damage to or loss of, and where possible enhance, nature conservation sites and protected species or other know species of conservation concern.
	d	Protect, and where possible enhance, fisheries resource within the catchment	i)	Maintain existing, and where possible create new, fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species.
	e	Protect, and where possible enhance, landscape character and visual amenity within the river corridor	i)	Protect, and where possible enhance, visual amenity, landscape protection zones and views into / from designated scenic areas within the river corridor.
	f	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting	i)	Avoid damage to or loss of features, institutions and collections of architectural value and their setting.
			ii)	Avoid damage to or loss of features, institutions and collections of archaeological value and their setting.

:Source ; GN28

10.2 Global and Local Weightings

In order to take account of the relative importance of some objectives in comparison other objectives, each sub-objective is given a Global Weighting. These global weightings are set at a national level and are the same across all of the CFRAM Studies.

The Global Weightings for each sub objective are shown in Table 10.2 below.

Table 10.2: Global Weighting of Flood Risk management Objectives

Objective Ref	Sub Objective	Global Weighting
1(a)(i)	Ensure flood risk management options are operationally robust	20
1(b)(i)	Minimise health and safety risks associated with the construction, operation and maintenance of flood risk management options	20
1(c)(i)	Ensure flood risk management options are adaptable to future flood risk, and the potential impacts of climate change	20

Objective Ref	Sub Objective	Global Weighting
2(a)(i)	Minimise economic risk	24
2(b)(i)	Minimise risk to transport infrastructure	10
2(c)(i)	Minimise risk to utility infrastructure	14
2(d)(i)	Minimise risk to agriculture	12
3(a)(i)	Minimise risk to human health and life of residents	27
3(a)(ii)	Minimise risk to high vulnerability properties	17
3(b)(i)	Minimise risk to social infrastructure and amenity	9
3(b)(ii)	Minimise risk to local employment	7
4(a)(i)	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives.	16
4(b)(i)	Avoid detrimental effects to, and where possible enhance, Natura 2000 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	10
4(c)(i)	Avoid damage to or loss of, and where possible enhance, nature conservation sites and protected species or other know species of conservation concern.	5
4(d)(i)	Maintain existing, and where possible create new, fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species.	13
4(e)(i)	Protect, and where possible enhance, visual amenity, landscape protection zones and views into / from designated scenic areas within the river corridor.	8
4(f)(i)	Avoid damage to or loss of features, institutions and collections of architectural value and their setting.	4
4(f)(ii)	Avoid damage to or loss of features, institutions and collections of archaeological value and their setting.	4

Source: GN28

In order to take cognisance of the local perspective on the relative importance of objectives, each sub objective is also given a local weighting. Local weightings vary from 0 for not locally important to 5 for very important locally.

During the Draft Flood Mapping Public Consultation Day (PCD) the public were invited to consider each of the sub-objectives and provide a weighting on its importance. The local weightings listed below, which have been used in the MCA, are based on an assessment of the importance of these sub-objectives which has been informed by the input of the public at the PCD.

The Local Weighting for each FRM objective is shown in Table 10.3 below. The table also outlines the manner in which the Local weighting is derived. In some instances the Local Weighting is determined through local consultation. In other instances they are calculated based upon the number of receptors affected. The data used for calculating the local weighting are included in Appendix F1.

Table 10.3: Local Weighting

Sub Objective	Bantry	Castletownbere	Kenmare	Calculation Method
1(a)(i)	5	5	5	Constant
1(b)(i)	5	5	5	Constant
1(c)(i)	5	5	5	Constant
2(a)(i)	5	2.26	5	AAD / €75,000
2(b)(i)	5	5	5	Based on calculated assessment, adjusted by professional judgement
2(c)(i)	0	0	0	Based on calculated assessment, adjusted by professional judgement
2(d)(i)	2.5	0	5	By professional judgement assisted by local advice
3(a)(i)	5	0.37	5	Based on calculated assessment, adjusted by professional judgement
3(a)(ii)	5	0	0	Based on calculated assessment, adjusted by professional judgement
3(b)(i)	5	1.4	0.28	Based on calculated assessment, adjusted by professional judgement
3(b)(ii)	5	5	5	Based on calculated assessment, adjusted by professional judgement
4(a)(i)	5	5	5	Constant
4(b)(i)	1	2	5	By professional judgement assisted by local advice
4(c)(i)	4	2	5	By professional judgement assisted by local advice
4(d)(i)	5	2	2	By professional judgement assisted by local advice
4(e)(i)	4	4	2	By professional judgement assisted by local advice
4(f)(i)	3	3	3	By professional judgement assisted by local advice
4(f)(ii)	3	1	3	By professional judgement assisted by local advice

10.3 MCA Scoring

Each sub objective has a basic requirement and an aspirational target associated with it. The basic requirement for each sub objective equates to a no change scenario. That is the status quo before the FRM option is adopted. The aspirational target in most cases is set to the highest achievement that is reasonably possible against the sub-objective in implementing the FRM option. The performance of each FRM option is measured against the basic and aspirational targets for each sub objective and assigned a score in accordance with the principals in Table 10.4 below.

Table 10.4: MCA Scoring

Option Performance	Score
Meets Aspirational Target	5
Partially Achieving Aspirational Target	Score in proportion to performance
Meeting Basic Requirement (No Change)	0
Just Failing Basic Requirement	Score in proportion to performance
Fully Failing Basic Requirement	-5
Totally Failing Basic Requirement (Option Illegal or Totally Unacceptable)	-999

In the MCA the technical objectives measure if an option is robust in terms of operation. Higher scores are allocated to options that do not rely on mechanical, electrical or human intervention to operate effectively. Examples of such interventions include sluice gates, storm water over pumping, or erection of demountable barriers. The technical objectives also consider if the options can be constructed safely and if they can be adapted to future changes.

The adaptability of each option to the possible impacts of climate change is assessed through a qualitative decision tree. This involves identifying what flood risk management measures might be required in the future, what is required now and ensuring that decisions made now are adaptable to permit an effective and efficient transition to the management of potential future flood risk. The decision tree is a graphical representation of how the option can be adapted over time and of the scores given to each option. The decision trees are included in Appendix C.

The scoring for a given option reflects the cost and the degree of difficulty and potential impacts of future adaptions that would be necessary to maintain the Standard of Protection of the option under the MRFS and/or HEFS, whereby the greater the cost, difficulty and impact, the lower the score. The decision tree and scores for each SSA are included in Appendix E. The scores from the decision trees are used in the MCA.

The measurement of the performance of the options against the objective to avoid economic damage is measured in terms of the percentage of economic damage avoided by that option. Certain receptors in Coastal AFAs are at risk from fluvial and tidal flooding. On the basis of historical flood records it can be

said that these flooding mechanisms are independent of each other. For this reason when assessing the potential damage to properties in Coastal AFAs this report considers that the total potential damage is equal to the total potential fluvial damage added to the total potential tidal damage. Similarly when assessing the damage avoided by a particular option the total damage avoided is equal to the total fluvial damage plus the total tidal damage avoided. When calculating the percentage reduction in damage for a particular option this is calculated relative to the total potential damages in the town. The economic objectives also measure the performance of the option in terms of reducing the risk to transportation routes, utility infrastructure and agricultural land.

The social objectives in the MCA include the reduction of flood risk to people, high vulnerability properties such as hospitals and fire stations and to social infrastructure and amenities. Under social objectives the MCA also measures the performance of the option to reduce the risk to local employment in relation to the number of non-residential properties at risk.

Under the Environmental criteria the MCA measures the performance of the option under environmental headings such as:

- Promote achievement of good status in waterbodies
- Avoiding damage to protected habitats
- Minimising the risk of environmental pollution
- Avoid damage to the flora and fauna of the catchment
- Avoid damage to fisheries habitats
- Protect landscape character and visual amenity within the river corridor
- Avoid damage to features of architectural value
- Avoid damage to features of archaeological importance

Once all of the options have been analysed with reference to their performance against each of the sub-objectives the MCA score for each criteria can be calculated. This is done by multiplying the score for each sub objective by the Global and the local Weighting and then by summing the weighted scores for all the sub objectives under that criteria.

The **MCA Benefit Score** is calculated by adding the weighted score for the Economic, Social and Environmental Criteria together. This score represents the net benefits of the option.

The **Option Selection MCA Score** is calculated by adding the weighted scores of all the criteria together. This score includes the technical score and therefore includes all of the aspects that should be taken into account in considering the preferred option for a given location.

The **Total Construction Cost €** is the cost of the FRM option as outlined in Section 9.

The **MCA Benefit – Cost Ratio** is calculated by dividing the **MCA Benefit Score** by the cost of the option. This is a numerical but non monetised ratio that indicates the overall benefits that can be delivered per euro of investment.

The **Economic Benefit €** is the cost of the damage avoided for the FRM Option.

The **Economic Benefit – Cost Ratio** is calculated by dividing the cost of the damage avoided by adopting the FRM Option by the cost of the option. This is the traditional method used by OPW in assessing the economic case for proceeding with a flood relief scheme. In general terms a flood relief scheme would be considered economically viable if the benefit cost ratio is greater than 1.

10.4 Measures Being Undertaken under Other Policy Areas

Flood related measures being undertaken under other policy areas have the potential to have an impact on flood risk in the UoM. The relevant policy areas may relate to EU Directives 85/337/EEC (EIA Directive), 96/82/EC (Seveso II Directive), 2001/42/EC (SEA Directive) and 2000/60/EC (Water Framework Directive).

11 Selection of Preferred Options

11.1 Preferred Flood Risk Management Options – UoM

The preferred Flood Risk Management Options selected for inclusion in the Flood Risk Management Plan for UoM 21 are set out below:

- Planning Control
- Building Regulations
- SUDS
- Public Awareness
- Individual Property Flood Resilience
- Land Use Management

The non-structural measures highlighted above do not mitigate existing flood risk. However, they should be implemented as national policy to the SSAs to minimise future risk.

11.2 Preferred Flood Risk Management Options – AFAs

11.2.1 MCA Scores

The Scores achieved by each viable option under consideration are listed in Table 11.1 below. The initial rank is based on the MCA Benefit Cost Ratio. Details of the MCA undertaken for each AFA are contained in Appendix F.

Table 11.1: MCA Scores for Potential Options

AFA / Option	Cost Estimate €	Capped Scheme Benefit €	MCA Benefit Score	Option Selection MCA Score	MCA Benefit Cost Ratio (Millions)	Economic Benefit Cost Ratio	Initial Rank
Bantry							
Do Nothing	-	-	-184.00	-184.00	0.0	0.00	3
Fluvial & Tidal Flood Defences	6,693,304.51	42,962,484.53	201.35	1101.35	30.08	6.42	1
Fluvial Flood Defences & Tidal Barrage	75,572,581.09	42,962,484.53	-265.66	634.35	-3.52	0.57	2
Castletownbere							
Do Nothing		-	-36.00	-36.00	0.0	0.00	2
Flood Defences	2,564,578.74	2,954,218.63	556.26	1156.26	216.90	1.15	1
Kenmare							
Do Nothing		-	-72.00	-72.00		0.00	5
Flood Defences	15,457,087.66	10,671,145.95	671.30	1602.31	43.43	0.69	4
Storage & Flood Defences	3,654,349.79	10,671,145.95	-24130.71	-23295.89	-6603.28	2.92	6
Conveyance & Flood Defences	5,432,188.34	10,671,145.95	719.30	1650.31	132.41	1.96	1
Flow Diversion & Flood Defences	10,591,632.75	10,671,145.95	569.30	1224.90	53.75	1.01	3
Flow Diversion, Conveyance & Flood Defences	7,840,851.90	10,671,145.95	569.30	1224.90	72.61	1.36	2

11.2.2 Feedback Provided on Options

At the public consultations for Preliminary Flood Risk Management Options the public were asked to rank the potential options in terms of their preference. The feedback received is included in Table 11.2 below.

Table 11.2: Public Preference for Potential Options

AFA	Option	Nr of Rank 1 Received	Rank
Bantry	Fluvial & Tidal Flood Defences	-	-
	Fluvial Flood Defences & Tidal Barrage	-	-
	Do Nothing	-	-
Castletownbere	Tidal Flood Defences	2	1
	Do Nothing	0	2
Kenmare	Flood Defences	5	2
	Storage & Flood Defences	0	3
	Conveyance & Flood Defences	6	1
	Flow Diversion & Flood Defences	Flow Diversion suggested at PCD	-
	Conveyance, Flow Diversion & Flood Defences	Flow Diversion suggested at PCD	-
	Do Nothing	0	4

In addition to the options selected for the UoM, the preferred options for each of the AFAs are listed below.

The selection of the preferred Flood Risk Management Option for each of the AFAs is based on the MCA and the feedback provided during the public consultation.

11.2.2.1 Bantry

The preferred option identified in the MCA is Flood Defences. There was no feedback provided at the Bantry PCD.

11.2.2.2 Castletownbere

The preferred option identified in the MCA is Flood Defences. The limited feedback provided at the Castletownbere PCD indicated that the public agreed with the preferred option indicated in the MCA.

11.2.2.3 Kenmare

The preferred option identified in the MCA is Conveyance and Flood Defences. The feedback provided at the Kenmare PCD indicated that the public agreed with the preferred option indicated in the MCA. Based on the feedback provided at the PCD alternative options including a flow diversion of the Kealnagower Stream were considered. However, the preferred option remains Conveyance and Flood Defences.