

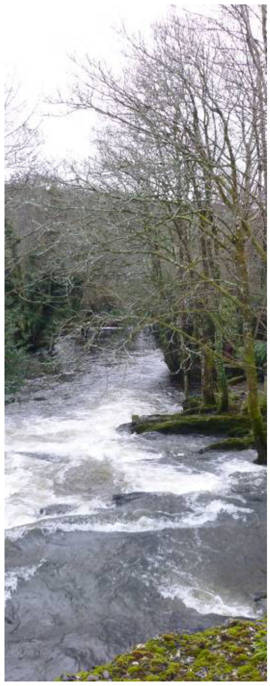

South Western CFRAM Study

Preliminary Options Report UoM 22

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

South Western CFRAM Study

Preliminary Options Report UoM 22

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 22 (The Laune / Maine / Dingle 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 22 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 options selected for inclusion in the Flood Risk Management Plan for each of the AFAs are set out below:

The preferred option for Castleisland as identified in the MCA is Flow Diversion & Western Flood Defences. This option was developed after the PCD based on feedback received from the public and the Local Authority. It should be noted that this option only mitigates the flood risk for the design event in the Tullig area and in localised areas around Castleisland town. This option was developed as there is significant risk and benefit in the Tullig area. The economic benefit cannot be achieved if all areas in the Castleisland AFA are to be protected.

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

The preferred option for Glenflesk as identified in the MCA is Flood Defences. However, the preferred option is not cost beneficial. A range of non-structural measures were considered and put on display at the Glenflesk PCD. The feedback provided at the PCD indicated that the public’s preference is for a combination of Emergency Response Procedures and Land Use Management.

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

The preferred option for Milltown as identified in the MCA is Flood Defences. However, the preferred option is not cost beneficial. A range of non-structural measures were considered and put on display at the Milltown PCD. There was no feedback received at the PCD. A range of non-structural measures as outlined for the UoM should be adopted. These should include planning control, land use management, emergency response procedures and public awareness.

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 22

Within UoM 22 Glenflesk and Killarney form a sub-catchment along the River Flesk. However, flood risk between the AFA's is not linked due to the scale of the sub-catchment. Also, as demonstrated through hydraulic modelling, the proposed flood risk management options at Glenflesk and Killarney do not impact upon each other.

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

Based on the above, UoM 22 is split into 2 Spatial Scales of Assessment (SSAs). These are:

- The Unit of Management (UoM)
- Areas for Further Assessment (AFAs)
  - Castleisland
  - Dingle
  - Glenflesk
  - Killarney
  - Milltown
  - Portmagee

However, based on the Flood Risk Assessment and Mapping described in this report there is low risk in Portmagee and there are no structural flood risk management options proposed.

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 22.

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 22. The FRM methods considered and the outcome of the screening process are shown in Table 3.1 below.

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Table 3.1: Screening of Possible Flood Risk Management Methods

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

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 22 to the economy and society for extreme events in the current and future scenarios.

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 22.

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, Portmagee was identified as having a low existing risk as there is only 1Nr. property within the 0.1% AEP tidal event flood extent. As a result, Portmagee 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 Portmagee, 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 Castleisland – Improve Existing Defences

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

3.5.4 Castleisland – Relocate Properties

There are no isolated properties at risk within Castleisland. This measure would require the relocation of 76 Nr. residential and 26 Nr. non-residential properties. The scheme benefit is approx. €7.7M. It is not economically viable to relocate a property at a cost of €76k per property. Also, it would cost considerably more to relocate non-residential properties / businesses which may also suffer from moving away from the town centre.

3.5.5 Dingle – Improve Existing Defences

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

3.5.6 Dingle – Relocate Properties

There are no isolated properties at risk within Dingle. This measure would require the relocation of 35 Nr. residential and 54 Nr. non-residential properties. The scheme benefit is approx. €8.6M. It is not economically viable to relocate a property at a cost of €96k per property. Also, it would cost considerably more to relocate non-residential properties / businesses which may also suffer from moving away from the town centre.

3.5.7 Dingle – Channel or Flood Defence Maintenance Works

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

3.5.8 Glenflesk – Fluvial Storage

No suitable locations for fluvial storage. Floodplain storage would only increase risk to already vulnerable properties outside the AFA. Storage in the upper reaches of the Flesk or along its tributaries would be less effective as they are within steep sided valleys which would not store enough volume to mitigate risk along the Flesk which has a flow of 178m3/s for the 1% AEP fluvial event. This measure is not applicable.

3.5.9 Glenflesk – Improve Existing Defences

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

3.5.10 Glenflesk – Relocate Properties

There are no isolated properties at risk within Glenflesk. This measure would require the relocation of 7 Nr. residential and 8 Nr. non-residential properties. The scheme benefit is approx. €220k. It is not economically viable to relocate a property at a cost of €15k per property.

3.5.11 Glenflesk – Channel or Flood Defence Maintenance Works

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

3.5.12 Killarney – Fluvial Storage

In order to be effective a storage measure would have to reduce flood levels along the Flesk by 1.3m and store flows of approx. 300m3/s for several hours. Storing this flow for only 3 hours would require storage capacity of 810,000m3. With a depth of 3m, this would require an area of 270,000m2. Based on a scheme benefit of €1.7M, it is not economically viable to construct a storage area of the required size.

3.5.13 Killarney – Flow Diversion

In order to divert the River Flesk to Lough Leane upstream of Killarney would require a diversion of approx. 2.5km at an approximate cost of €9.4M. Based on a scheme benefit of €1.7M this measure is not economically viable.

3.5.14 Killarney – Improve Existing Defences

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

3.5.15 Killarney – Relocate Properties

There are no isolated properties at risk within Killarney. This measure would require the relocation of 10 Nr. residential and 4 Nr. non-residential properties. The scheme benefit is approx. €1.7M. It is not economically viable to relocate a property at a cost of €119k per property. Also, it would cost considerably more to relocate non-residential properties / businesses which may also suffer from moving away from the town centre.

3.5.16 Killarney – Channel or Flood Defence Maintenance Works

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

3.5.17 Milltown – Fluvial Storage

The existing risk and potential benefit of a scheme (€177k) are low which would not justify the construction and operation of a storage area. Based on the cost of a 1.8m sluice gate alone combined with preliminaries, optimism bias, site investigations, design fees and allowances for compensation and archaeology the costs are in excess of €177k. Fluvial storage is not economically viable.

3.5.18 Milltown – Improve Existing Defences

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

3.5.19 Milltown – Relocate Properties

There are no isolated properties at risk within Milltown. This measure would require the relocation of 6 Nr. residential and 9 Nr. non-residential properties. The scheme benefit is approx. €178k. It is not economically viable to relocate a property at a cost of €12k per property.

3.5.20 Milltown – Channel or Flood Defence Maintenance Works

Milltown 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 22 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 or business 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		
Castleisland		
Glenshearoon	> 6 Hours	Rain gauges River level gauges
Upper Maine	> 6 Hours	Rain gauges River level gauges
Dingle (Fluvial)		
Dingle Stream	< 5 Hours	Unlikely to be effective due to short time to peak
Mill River	> 6 Hours	Rain gauges River level gauges
Dingle (Tidal)	> 6 Hours	Use the existing OPW storm surge forecasting system to predict high tide levels
Glenflesk	> 6 Hours	Rain gauges River level gauges
Killarney	> 6 Hours	Rain gauges River level gauges
Milltown	< 5 Hours	Unlikely to be effective due to small steep catchment with short time to peak
Portmagee	> 6 Hours	Use the existing OPW storm surge forecasting system to predict high tide levels

Source: UoM 22 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.

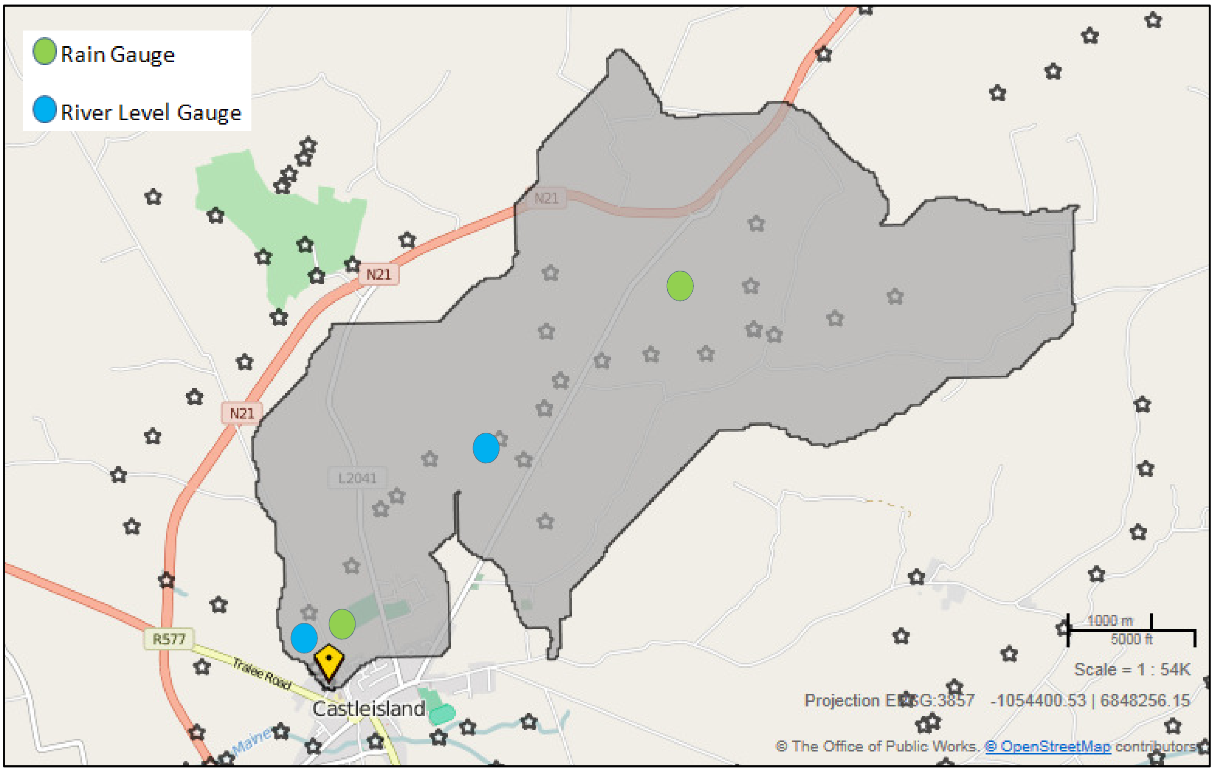
4.2.4.1 Castleisland – Glenshearoon

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

Table 4.2: Castleisland – Glenshearoon – Flood Forecasting Infrastructure

Equipment	Quantity
Rain Gauges	2
River Level Gauge (Hydrometric Gauging Station)	2

Figure 4.1: Castleisland – Glenshearoon – Proposed Gauges



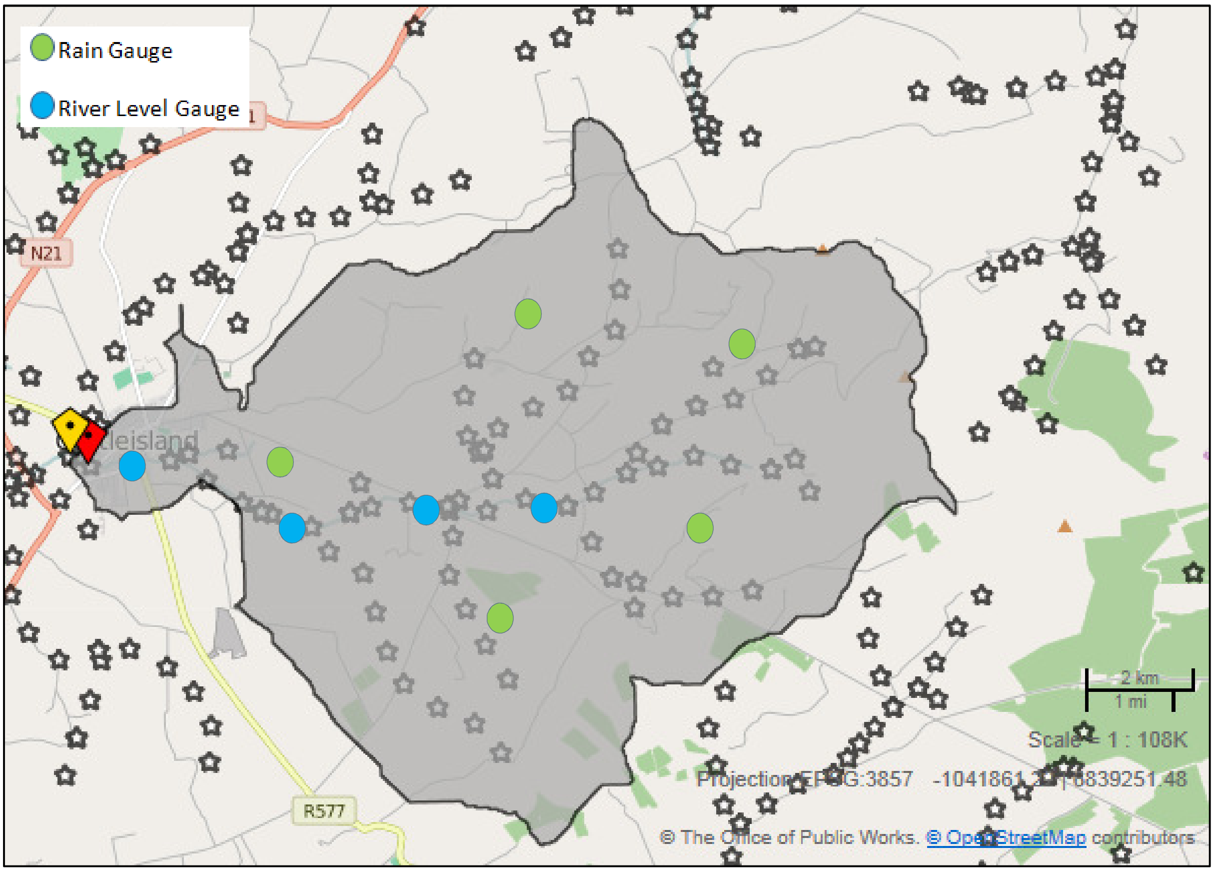
4.2.4.2 Castleisland – Upper Maine

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

Table 4.3: Castleisland – Upper Maine – Flood Forecasting Infrastructure

Equipment	Quantity
Rain Gauges	5
River Level Gauge (Hydrometric Gauging Station)	4

Figure 4.2: Castleisland – Upper Maine – Proposed Gauges



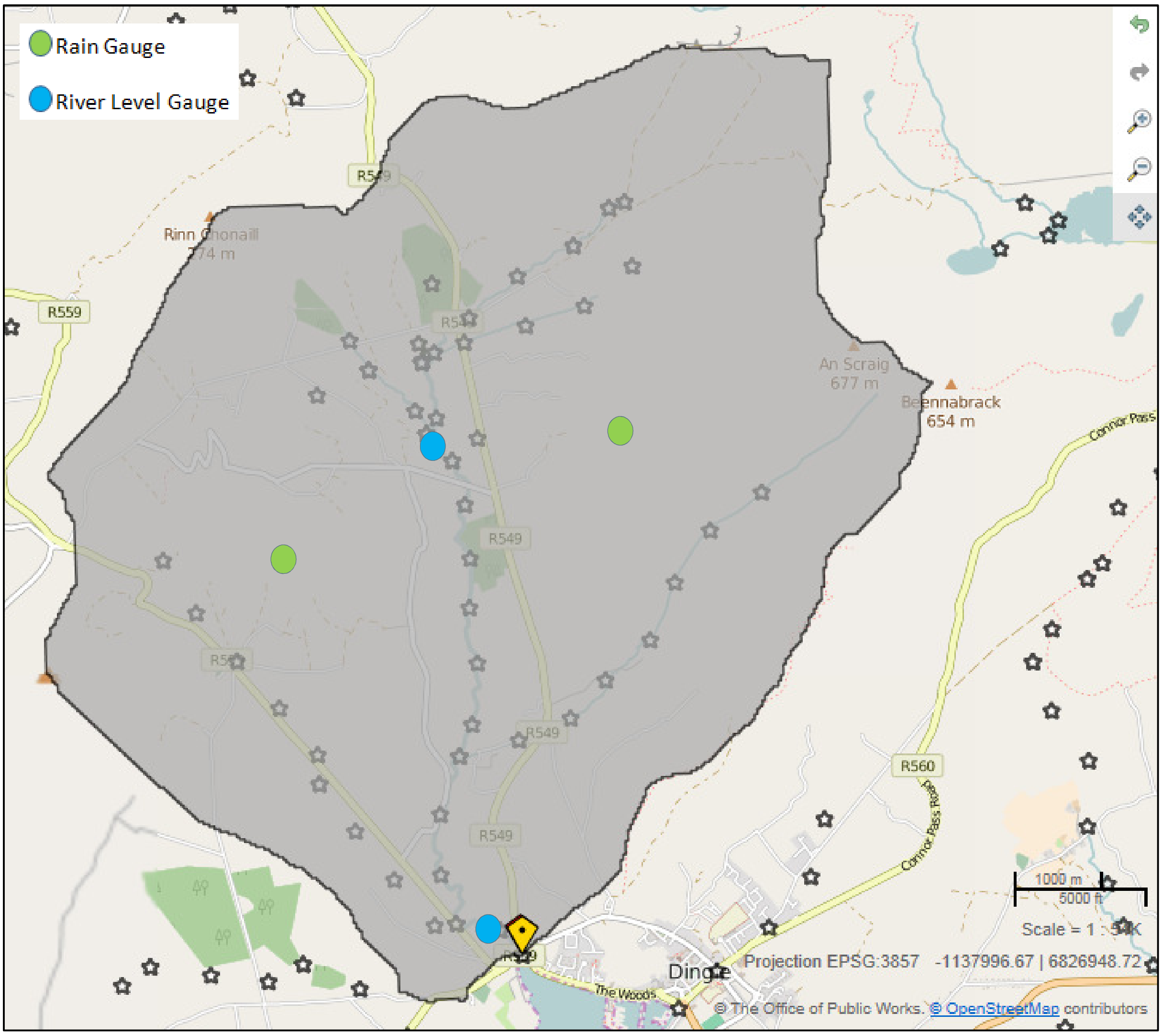
4.2.4.3 Dingle – Mill River

The infrastructure required for a flood forecasting and warning system on the Mill River in Dingle (AFA) is listed in Table 4.4 and the proposed locations are shown in Figures 4.3.

Table 4.4: Dingle – Mill River – Flood Forecasting Infrastructure

Equipment	Quantity
Rain Gauges	2
River Level Gauge (Hydrometric Gauging Station)	2

Figure 4.3: Dingle – Mill River – Proposed Gauges



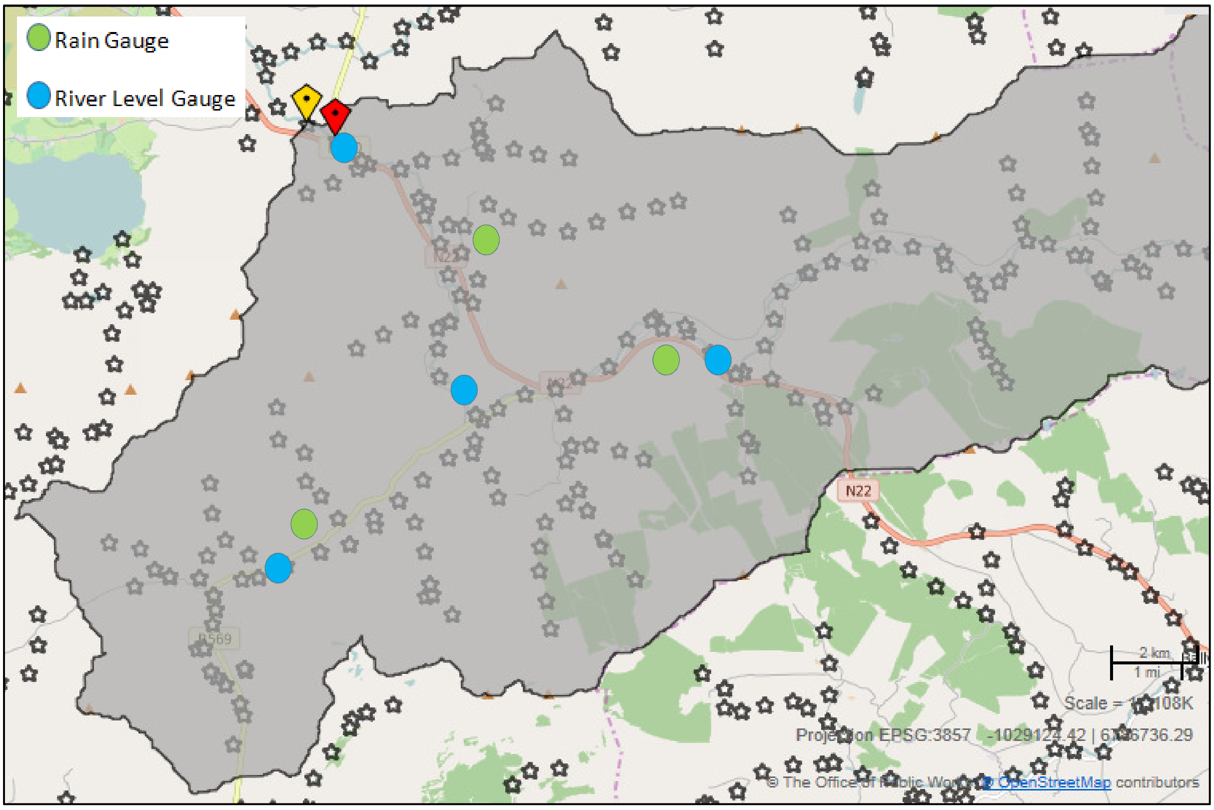
4.2.4.4 Glenflesk

The infrastructure required for a flood forecasting and warning system in Glenflesk (AFA) is listed in Table 4.5 and the proposed locations are shown in Figures 4.4.

Table 4.5: Glenflesk – Flood Forecasting Infrastructure

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

Figure 4.4: Glenflesk – Proposed Gauges



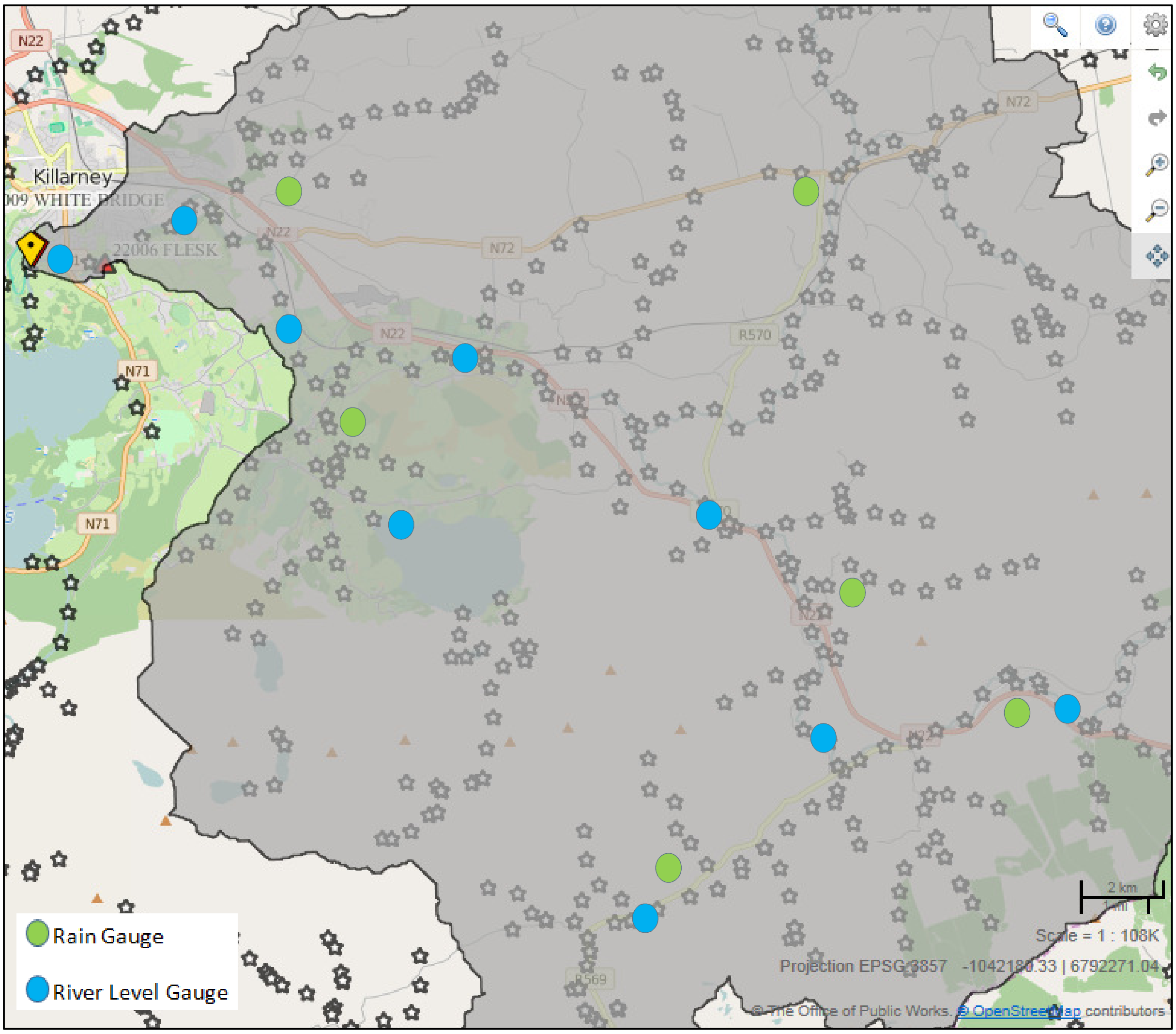
4.2.4.5 Killarney

The infrastructure required for a flood forecasting and warning system in Killarney (AFA) is listed in Table 4.6 and the proposed locations are shown in Figures 4.5. It should be noted that this also includes the area covered by the Glenflesk catchment.

Table 4.6: Killarney – Flood Forecasting Infrastructure

Equipment	Quantity
Rain Gauges	6
River Level Gauge (Hydrometric Gauging Station)	9

Figure 4.5: Killarney – 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 22 AFAs. The dissemination of this information to the public will increase awareness.

4.2.6 Individual Property Flood Resilience

It is possible to reduce the damage caused by flooding to a property by carrying out works that make the property more flood resilient. Such works could include replacing porous floor and wall coverings with tiles or other non-porous finishes or raising electrical sockets to a level above the design flood level. Table 4.6 below shows the number of properties at risk from the 1% (or 0.5% for coastal flooding) AEP flood event in each AFA, the potential benefit achievable in each AFA and the total budget available for flood resilience works in each property. This budget is the benefit for the design event divided by the number of properties at risk. When account is taken of Optimism Bias (40%), preliminaries (32%) and design fees (13%) the total construction cost includes 85% of the available budget relates to non-construction costs. This means that only 15% of the total budget is available for the construction of flood resilience measures. This basic flood resilience budget indicates if individual property flood resilience is a viable option in each AFA. It is assumed that a basic budget of €7,500 is required for each property in order for it to be viable.

Table 4.7: Individual Property Flood Resilience

AFA	Residential Properties at Risk	Non-residential Properties at Risk	Capped Benefit €	Total IPFR budget €	Basic IPFP budget €	Viable Y/N
Castleisland	76	26	7,763,804.46	76,115.73	11,417.36	Y
Dingle	35	54	8,581,246.62	96,418.50	14,462.76	Y
Glenflesk	7	8	219,559.67	14,637.31	2,195.60	N
Killarney	10	4	1,659,565.74	118,540.41	17,781.06	Y
Milltown	6	9	177,697.30	11,846.49	1,776.97	N

This analysis indicates that Individual Property Flood Resilience is a viable option for Castleisland, Dingle and Killarney. This flood risk management measure should be explored further if no structural flood risk management measures are found to be viable for these AFAs.

4.2.7 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.

4.2.8 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 4.8 below.

Table 4.8: Possible Structural Measures

AFA	Castleisland	Dingle	Glenflesk	Killarney	Milltown
Fluvial Storage	Y	Y	N	N	N
Flow Diversion	Y	Y	N	N	Y
Increase Conveyance	Y	Y	Y	Y	Y
Flood Defences	Y	Y	Y	Y	Y
Improve Existing Defences	N	N	N	N	N
Relocate Properties	N	N	N	N	N
Localised Protection Works	Y	Y	Y	Y	Y
Channel or Flood Defence Maintenance Works	Y	N	N	N	N
Other works	-	-	-	-	-

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

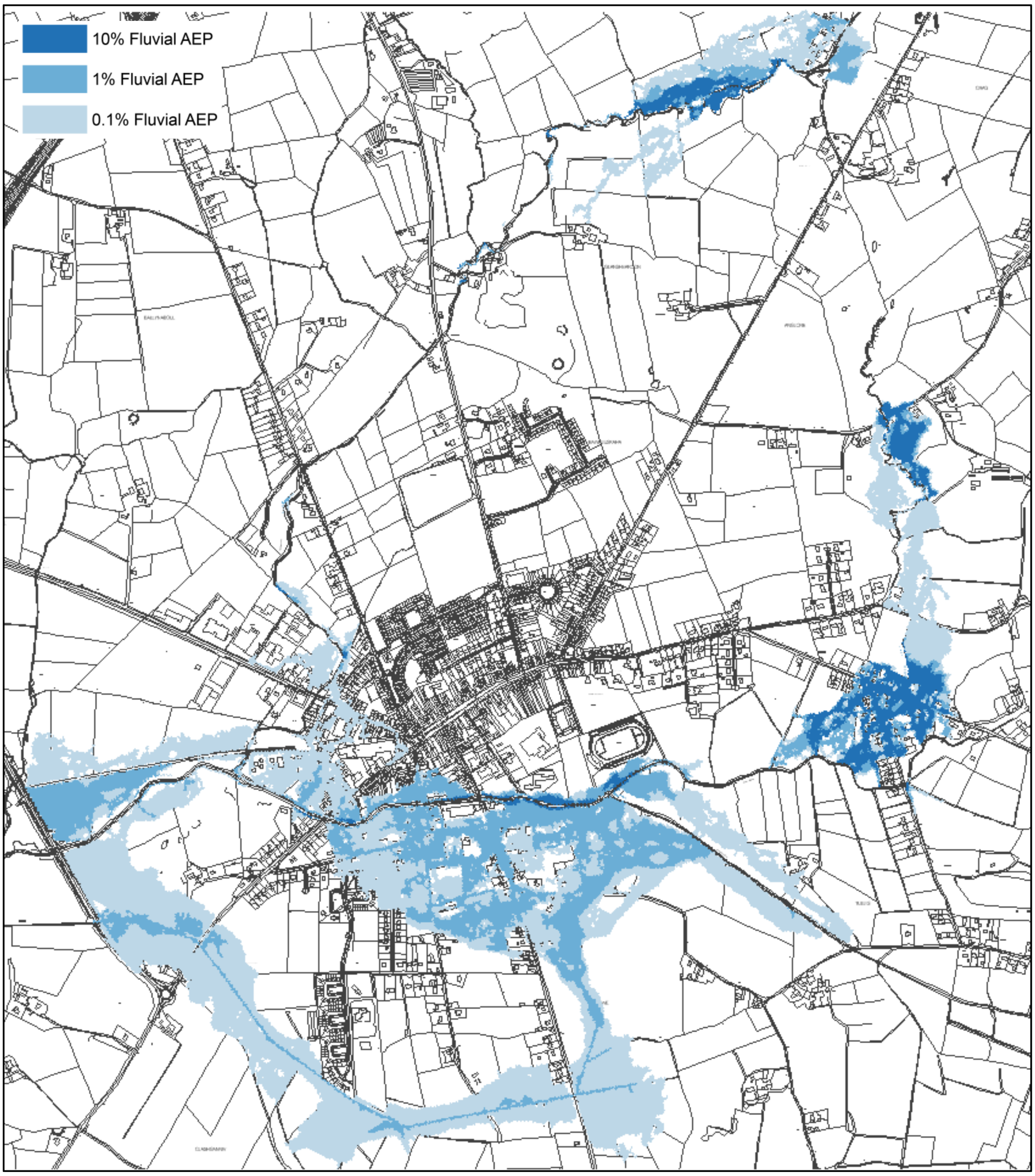
5.1 General

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 22.

5.2 Castleisland, Co. Kerry

Castleisland is located along the River Maine in County Kerry. Castleisland is at risk of fluvial flooding from the River Maine and its tributaries, the Shanowen, the Anglore and the Glenshearoon. The AFA and the existing flood risk are highlighted in Figure 5.1.

Figure 5.1: Castleisland – Current Scenario Fluvial 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:

- Increased Conveyance
- Flow Diversion
- Flood Defences
- Storage

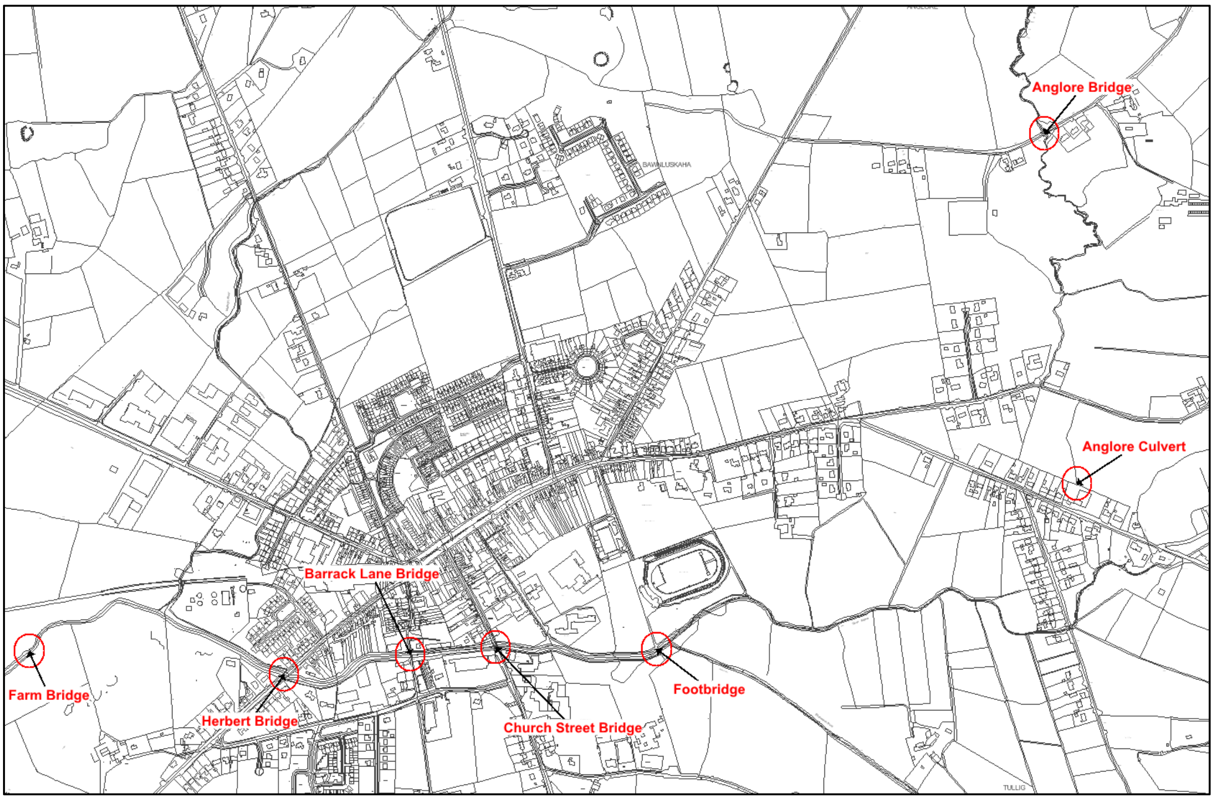
The possible measures were reviewed and assessed further to determine if they were applicable and viable. The measures were modelled individually to determine their effectiveness and impact.

5.2.1.1 Increased Conveyance

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

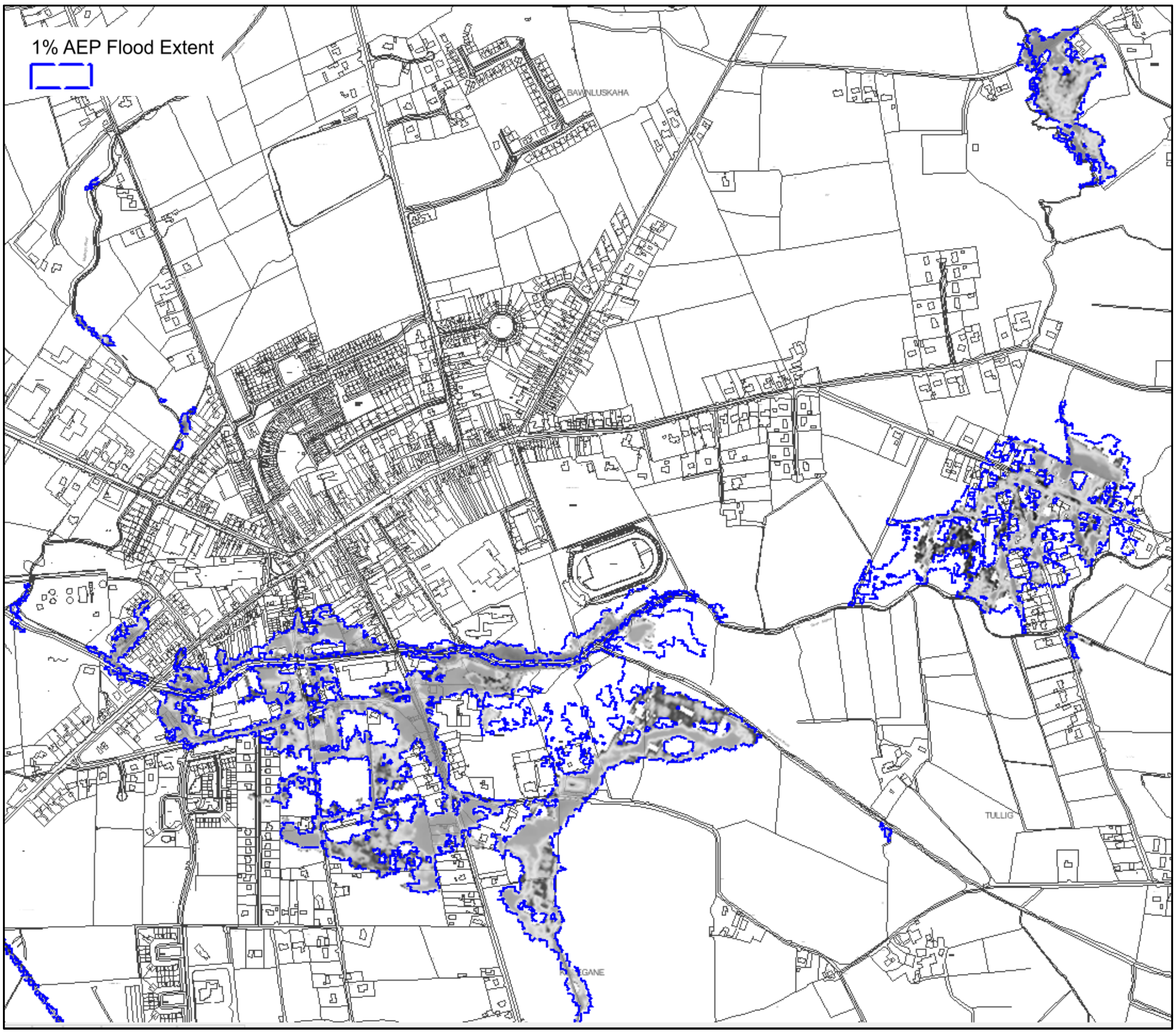
- Anglore Bridge (replace with single span bridge and reprofile cross section)
- Anglore Culvert (culvert capacity tripled)
- Footbridge (replace with single span bridge)
- Church Street Bridge (replace with single span bridge)
- Barrack Lane Bridge (replace with single span bridge)
- Herbert Bridge (replace with single span bridge)
- Farm Bridge (replace with single span bridge)

Figure 5.2: Castleisland – Conveyance Measure - Structures



This measure aims to mitigate the fluvial flood risk by maximising improvements in conveyance through a series of works. The proposed works to improve conveyance were represented in the hydraulic model which indicated that there was a minor reduction in flood extent considering the scale of the improvement works. The reduction in flood extent is shown in Figure 5.3. The maximum reduction in flood depth was 0.74m which occurred at the upstream end of the Anglore Culvert. However, as a result of the conveyance improvements on the Anglore, there were increases in flood depth of 0.25m further downstream on the Maine.

Figure 5.3: Castleisland – Conveyance Measure – Reduction in Flood Extent

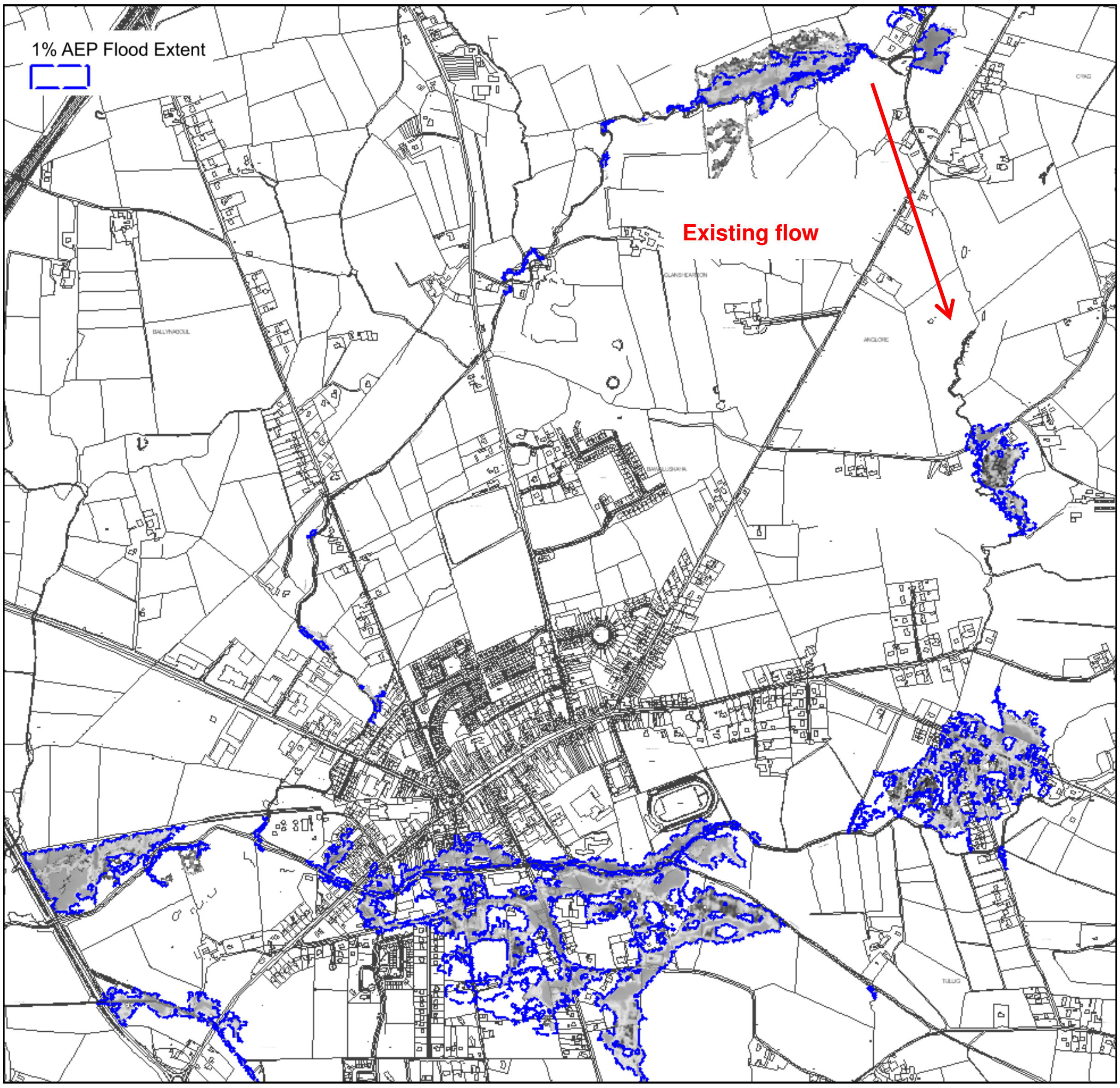


Based on this assessment, this measure is not deemed to be a viable measure individually or in combination.

5.2.1.2 Glenshearoon Flow Diversion

When flooding occurs in the upper reach of the Glenshearoon, flood water can make its way to the Anglore River through a series of caves. This measure aims to mitigate the flooding along the Anglore by removing this existing flow path.

Figure 5.4: Castleisland – Flow Diversion Flood Extent



In the hydraulic model the bank levels were raised in the required areas to prevent flows from the Glenshearoon flowing to the Anglore. This measure resulted in a minor reduction in flood extent along the Anglore with a maximum reduction in flood depth of 0.33m at the confluence of the Anglore and the Maine. The average difference in flood levels was -0.13m which did not reduce the number of properties flooded. In the Glenshearoon there was an increase in flood extent and depth of 0.13m. However, these increases are limited to agricultural land and do not impact on properties. This is not deemed to be a viable measure.

5.2.1.3 Flood Defences (giving rise to storage)

This measure aims to mitigate the fluvial 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 5.5: Castleisland – Flood Defence Measure

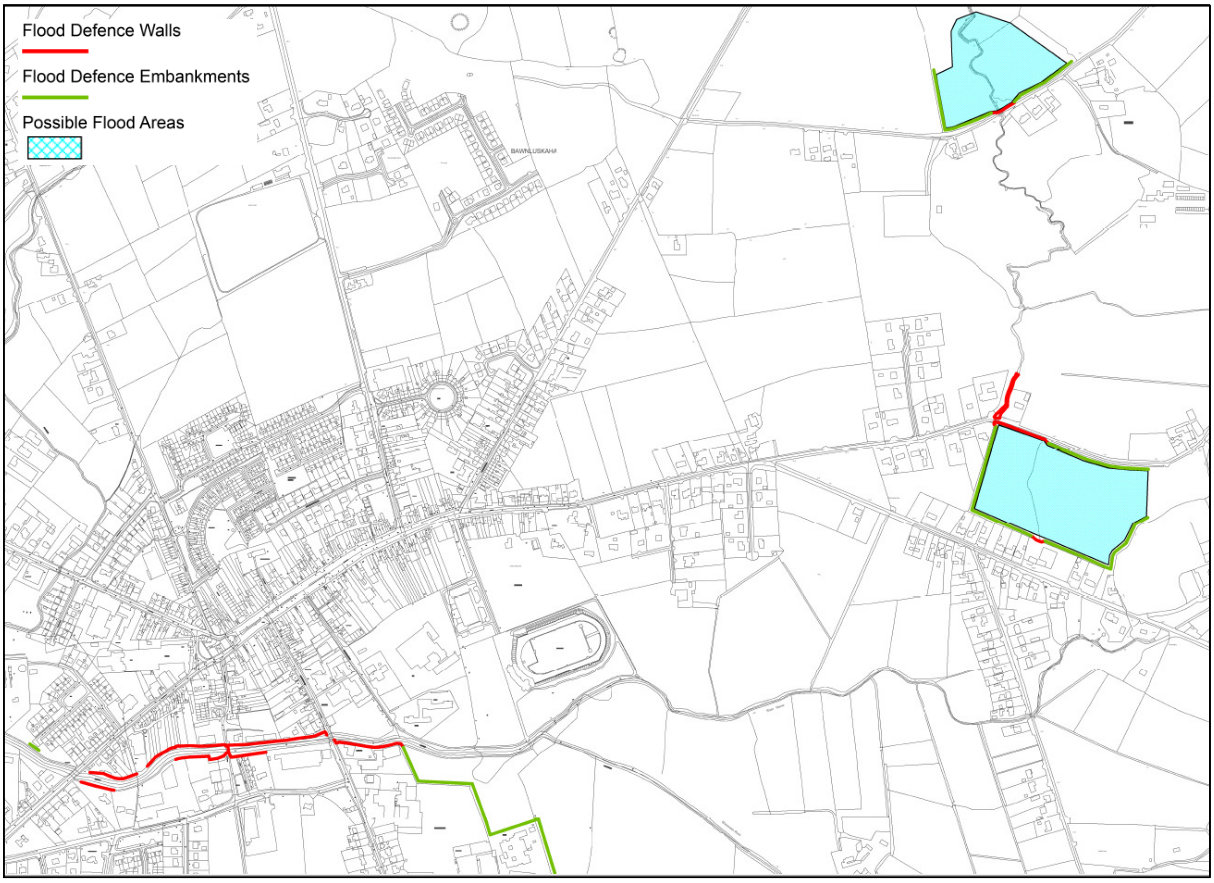


Figure 5.6: Castleisland – Flood Defence Measure (Anglore Upper)

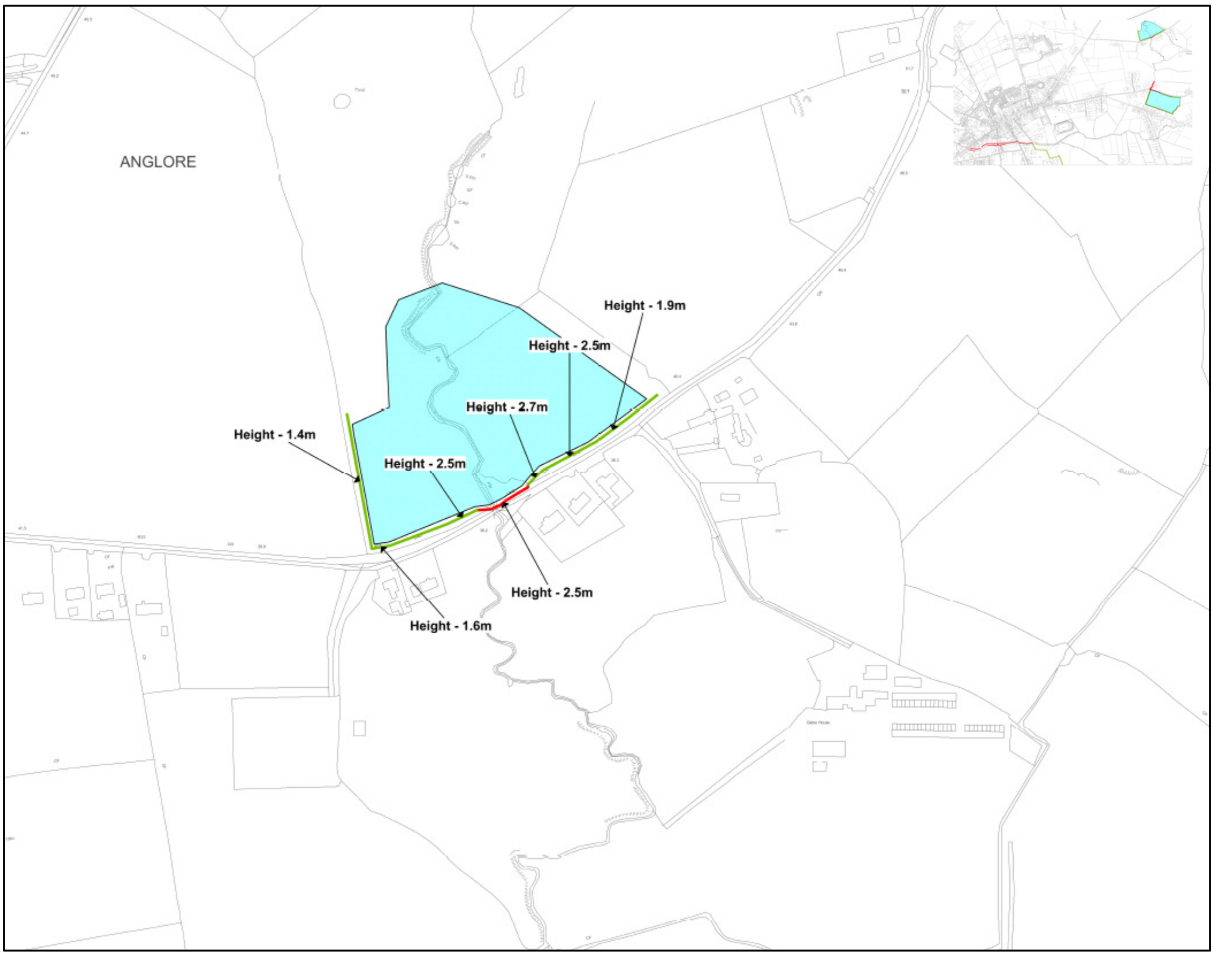


Figure 5.7: Castleisland – Flood Defence Measure (Anglore Lower)

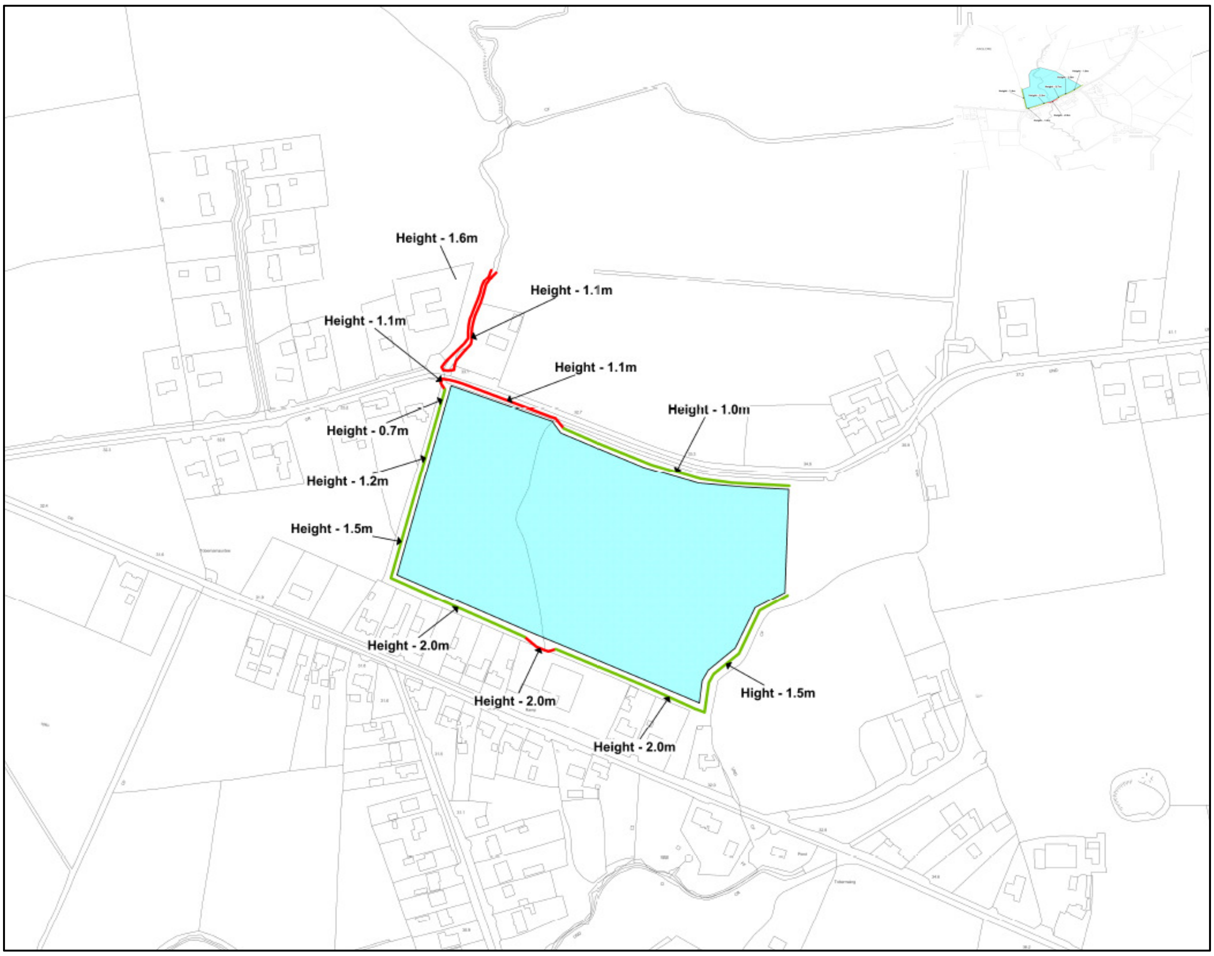
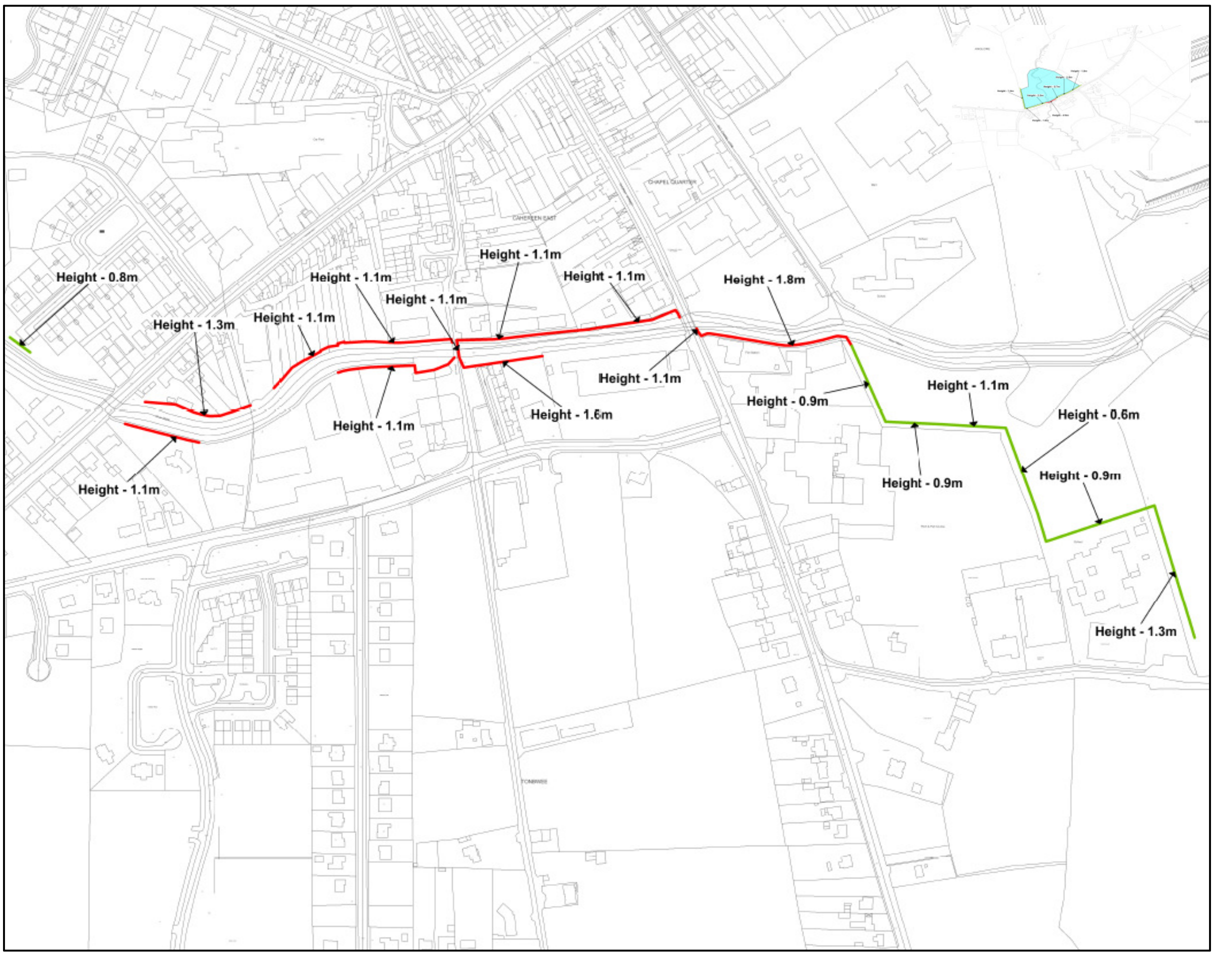


Figure 5.8: Castleisland – Flood Defence Measure



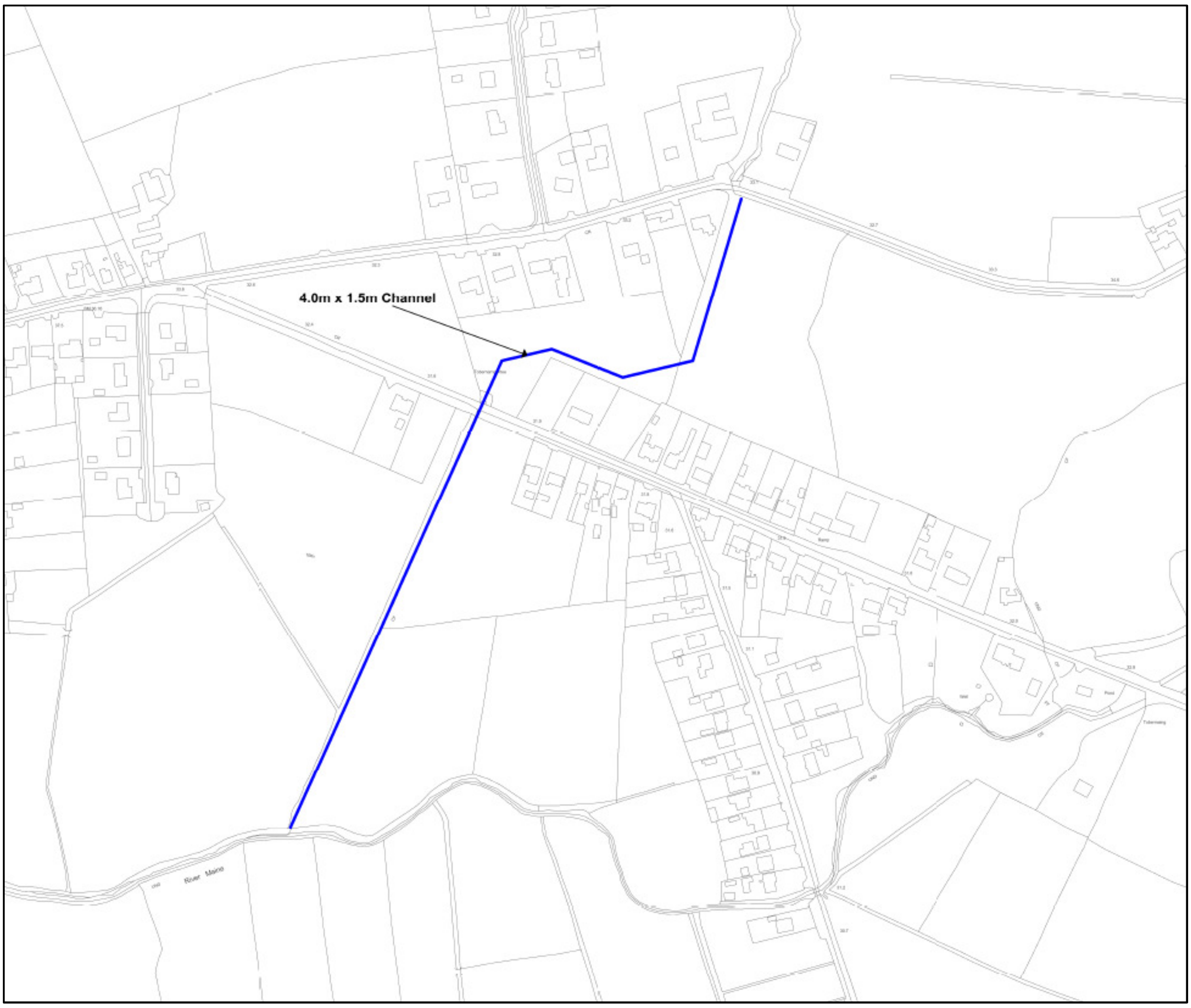
The hydraulic modelling of the proposed flood defences as outlined in the above figures indicates that the measure fully achieves the required standard of protection for the 1% AEP fluvial event.

However, this option gives rise to an increase in the flood extent and depth in certain locations as shown in Figures 5.6 and 5.7. These areas are effectively storage areas formed by the defences. There are currently no flood risk receptors in these areas so the increase in flood risk is considered acceptable. This is deemed to be a viable measure / option.

5.2.1.4 Anglore Flow Diversion

This measure aims to mitigate the fluvial flood risk in Tullig through the construction of a flow diversion channel. The route of the proposed flow diversion channel is shown in figure 5.9.

Figure 5.9: Castleisland – Anglore Flow Diversion



The hydraulic modelling of the proposed flow diversion as outlined above indicates that the measure fully mitigates the fluvial flood risk in Tullig for the 1% AEP fluvial event. This measure can give rise to a slight increase in flood levels downstream. However, if it is combined with upstream flood defences as shown in Figure 5.6 (which are effectively storage) there is an overall reduction in flood levels downstream.

Alternatively, the flow diversion measure can be combined with the downstream flood defences as shown in Figure 5.8 which will mitigate the existing flood risk and the slight increase associated with the flow diversion measure.

Based on this assessment, the Anglore Flow Diversion is deemed to be a viable measure.

5.2.2 Potential FRM Measures

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

- Flood Defences
- Flow Diversion (Anglore)

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 – Flood Defences
- Option 2 – Flood Defences & Flow Diversion
- Option 3 – Flow Diversion & Western Flood Defences

5.3 Dingle, Co. Kerry

Dingle is located on the coast with the Milltown River to the west and the Dingle Stream to the East of the town. Dingle is at risk of both fluvial and tidal flooding. The AFA and the existing flood risk are highlighted in Figures 5.10 and 5.11.

Figure 5.10: Dingle – Current Scenario Fluvial Flood Extents

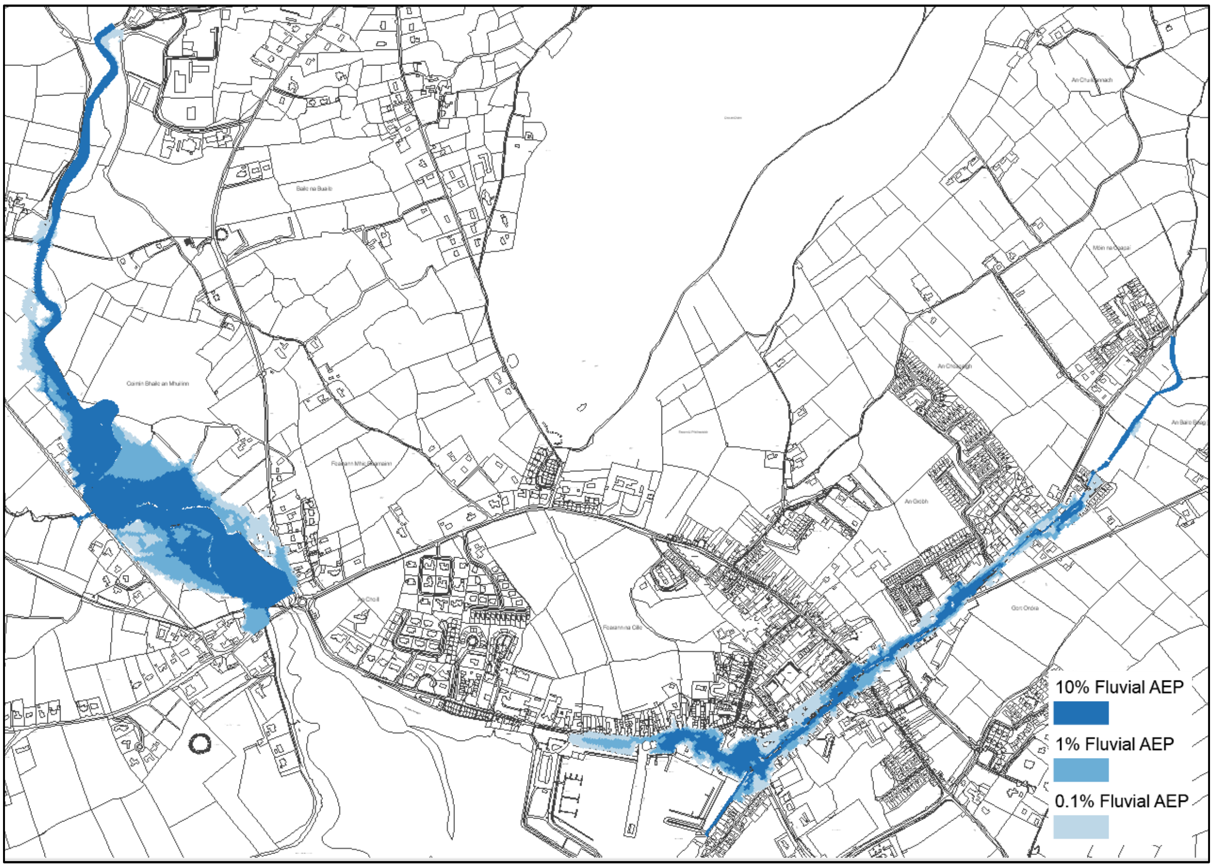
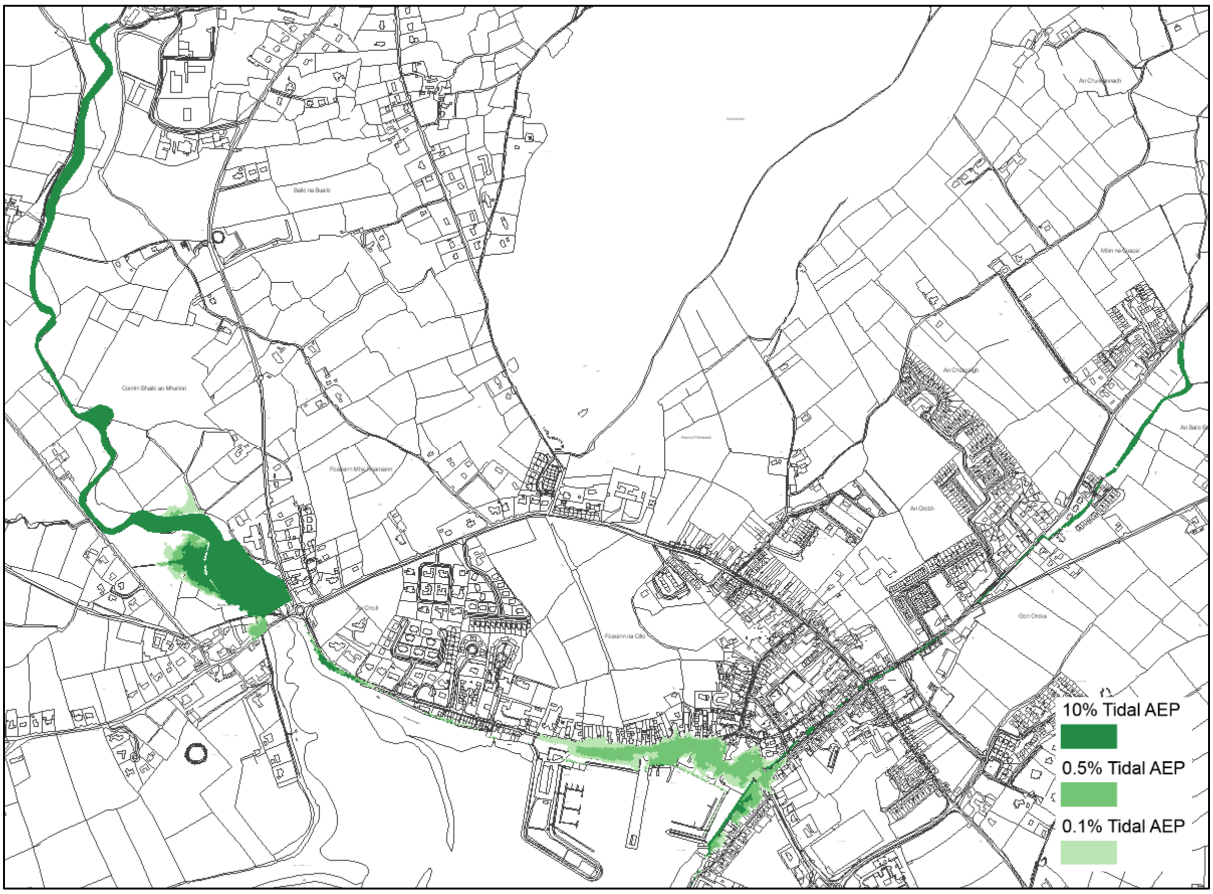


Figure 5.11: Dingle – Current Scenario Tidal Flood Extents



5.3.1 Possible FRM Measures

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

- Storage
- Increased Conveyance
- Flow Diversion
- Flood Defences

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.

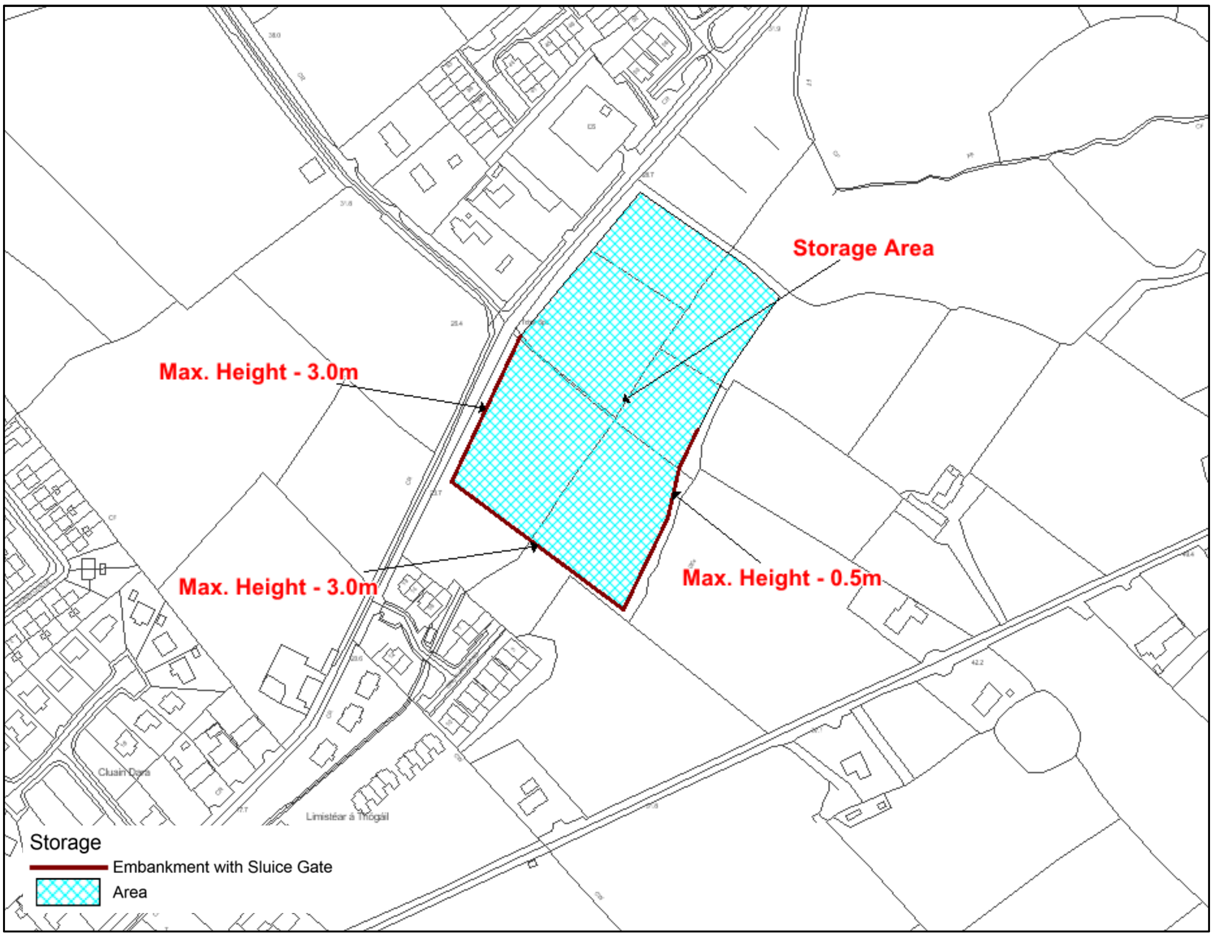
5.3.1.1 Storage – Dingle Stream

This measure aims to mitigate the fluvial flooding in Dingle by storing excess flows in an upstream storage area. An assessment of the storage required to mitigate the flood risk was carried out and a suitable location for storage identified. 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 the flood growth curve have been made.

The peak flow in the downstream reach of the Dingle Stream for the 1% AEP event is 11.24m3/s which results in flooding along the watercourse and through the town. The flooding in the town can be mitigated by providing sufficient storage to reduce the peak flow through the town to 5.1m3/s (QMed). The required storage is approximately 55,000m3. The proposed storage area is approximately 23,100m2 and the required capacity can be achieve in a number of ways.

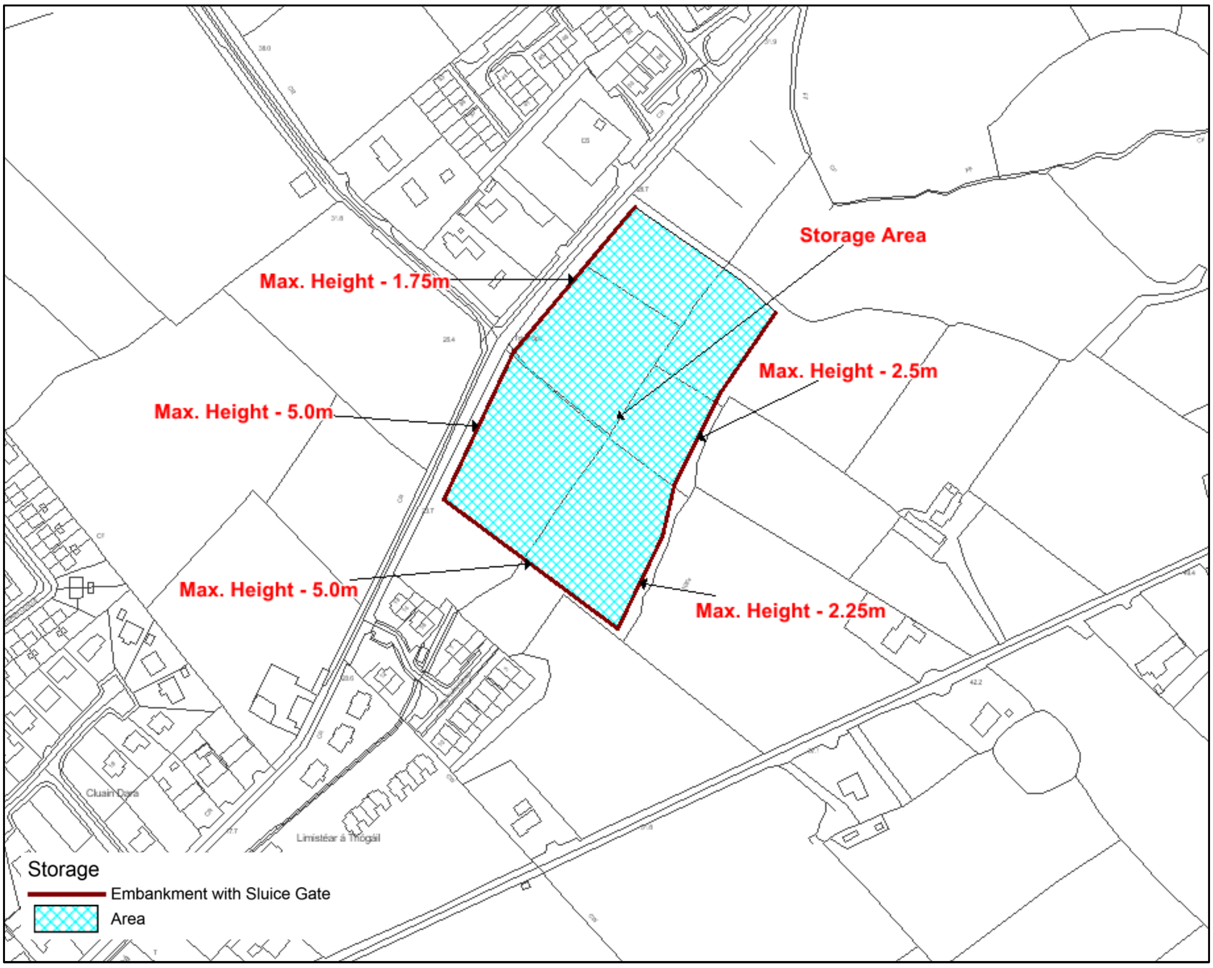
Method 1: The ground level at the downstream end of the storage area where a sluice gate will be located is 24.5m OD Malin. Reducing the entire storage area to this level and allowing storage to a depth of 2.5m will provide sufficient storage capacity. However, this will require a significant amount of excavation and an earth embankment (27.5m OD Malin) around the downstream end of the site. This method is shown in Figure 5.12

Figure 5.12: Dingle – Storage Area – Method 1



Method 2: The requirement for significant excavation can be removed by enclosing the entire storage area within an earth embankment. However, this will result in longer and higher embankments (29.0m OD Malin) and a greater depth of water (4.5m) behind the downstream embankment. This method is shown in Figure 5.13.

Figure 5.13: Dingle – Storage Area – Method 2

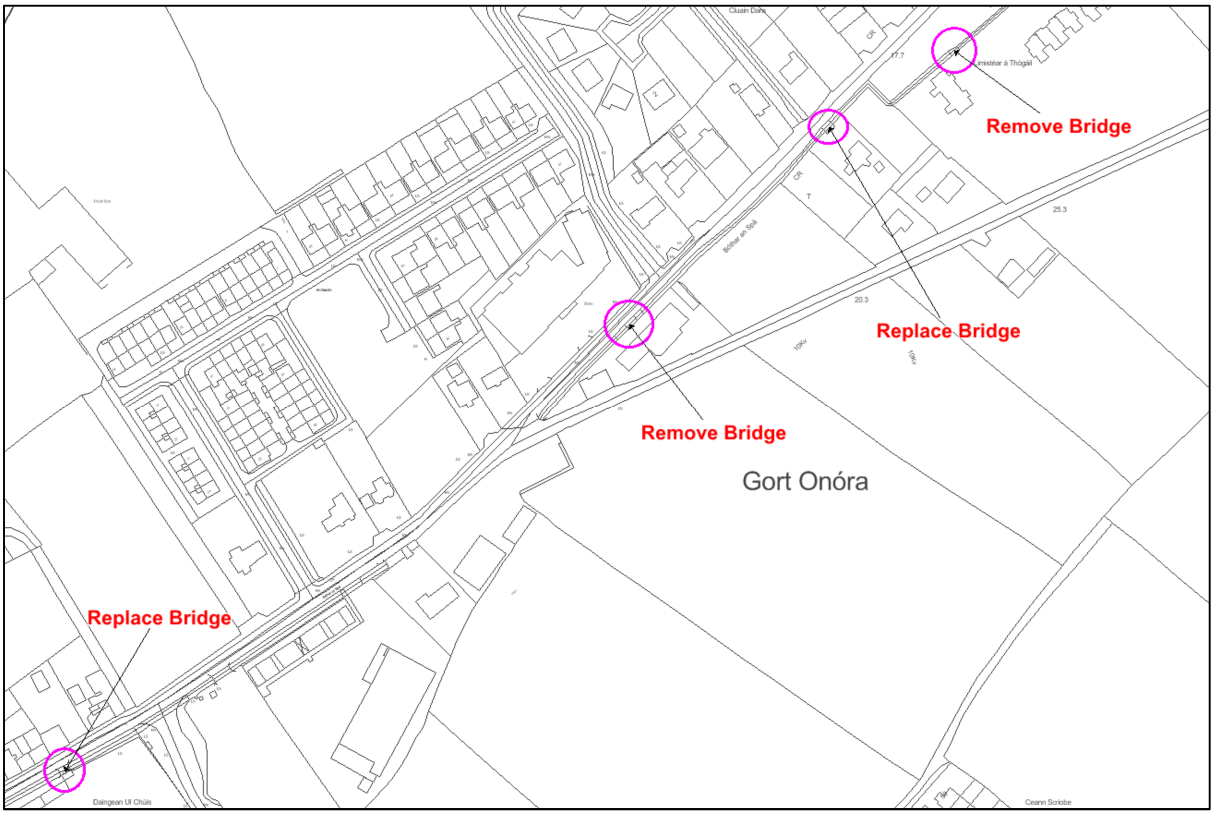


Storage is a viable measure for mitigating fluvial flood risk and can achieve the required standard of protection. However, it does not mitigate against tidal flood risk or mitigate the flood risk from the Milltown River.

5.3.1.2 Conveyance – Dingle Stream

This measure aims to mitigate the fluvial flood risk by increasing the conveyance of a number of critical structures along the Dingle Stream. The Dingle Stream has a significant number of structures along its length, the majority of which have insufficient capacity. However, it is not feasible to upgrade the majority of these as they pass under private houses and gardens where there is no available space. The proposed works include the removal and replacement of 4 Nr. bridges which are highlighted in Figure 5.14.

Figure 5.14: Dingle – Increase Conveyance – Dingle Stream

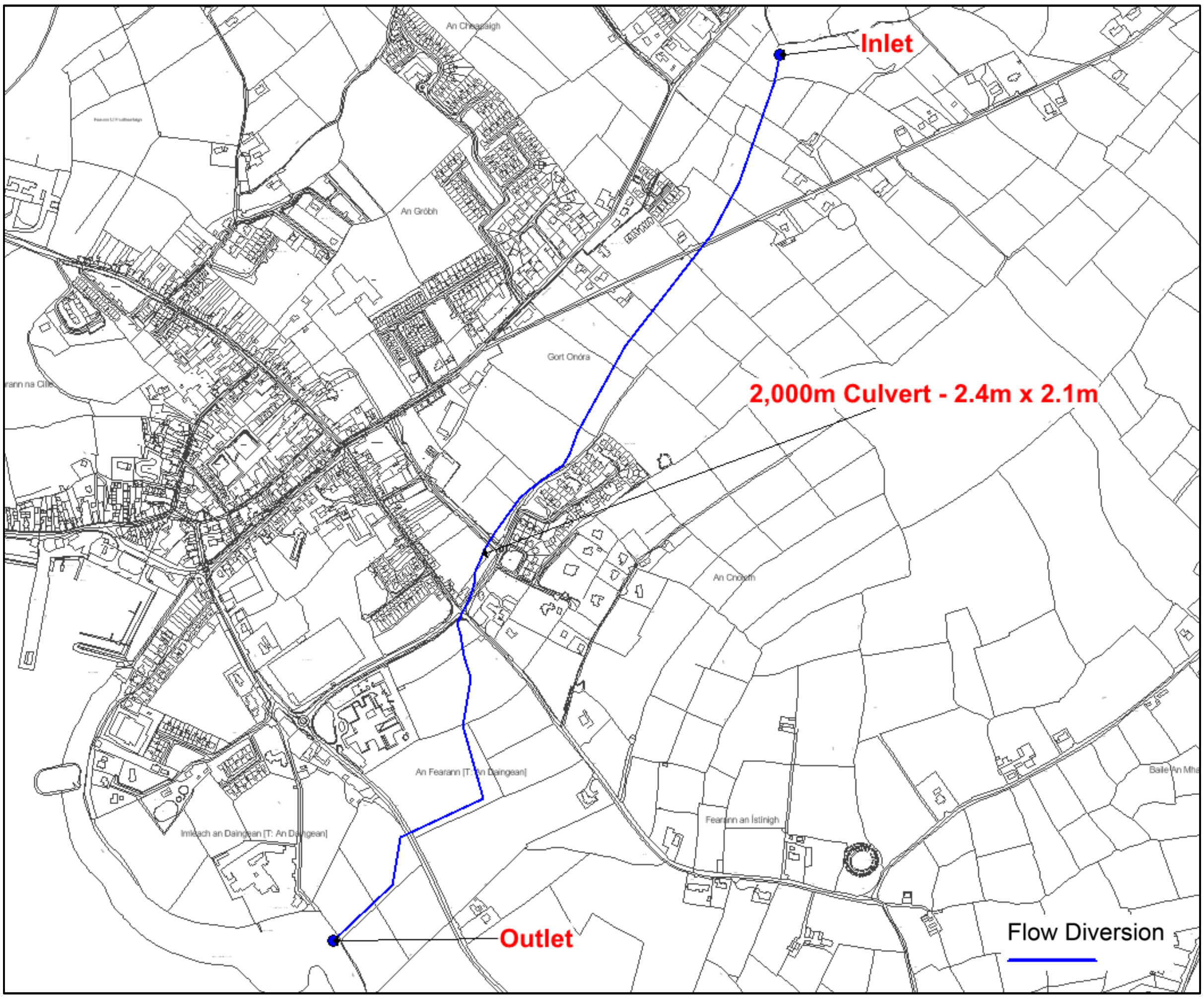


The bridges were removed or upgrade as required in the hydraulic model. The results indicated that there was a very minor reduction in flood extent and a reduction of approx. 0.42m in water level upstream of the works. However, there was an increase in water level downstream of approx. 0.11m where the most significant flooding occurs. Based on this assessment, conveyance is not deemed to be a viable measure.

5.3.1.3 Flow Diversion – Dingle Stream

This measure aims to mitigate the fluvial flood risk by diverting the upstream flow from the Dingle Stream away from the town discharging to the sea through a new outfall. Figure 5.15 shows the location and proposed route of the flow diversion culvert.

Figure 5.15: Dingle – Flow Diversion Culvert



The peak flow in the downstream reach of the Dingle Stream for the 1% AEP event is 11.24m3/s which results in flooding along the watercourse and through the town. The flooding in the town can be mitigated by diverting the upstream flow and reducing the peak flow through the town to 5.1m3/s (QMed).

The peak flow at the proposed inlet to the flow diversion culvert is 7.76m3/s. A minimum of 6.14m3/s must be diverted during peak flow to mitigate the flooding downstream. The proposed culvert size of 2.4m x 2.1m has a capacity of 12.4m3/s at the minimum slope which can accommodate a full diversion of the stream or an allowance for climate change.

Flow diversion is deemed to be a viable measure for mitigating fluvial flood risk and can achieve the required standard of protection. However, it does not mitigate against tidal flood risk or mitigate the flood risk from the Milltown River.

5.3.1.4 Flood Defences – Milltown River & Dingle Stream

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 dimensions of the defences are shown in the following figures.

Figure 5.16: Dingle – Flood Defence Measure

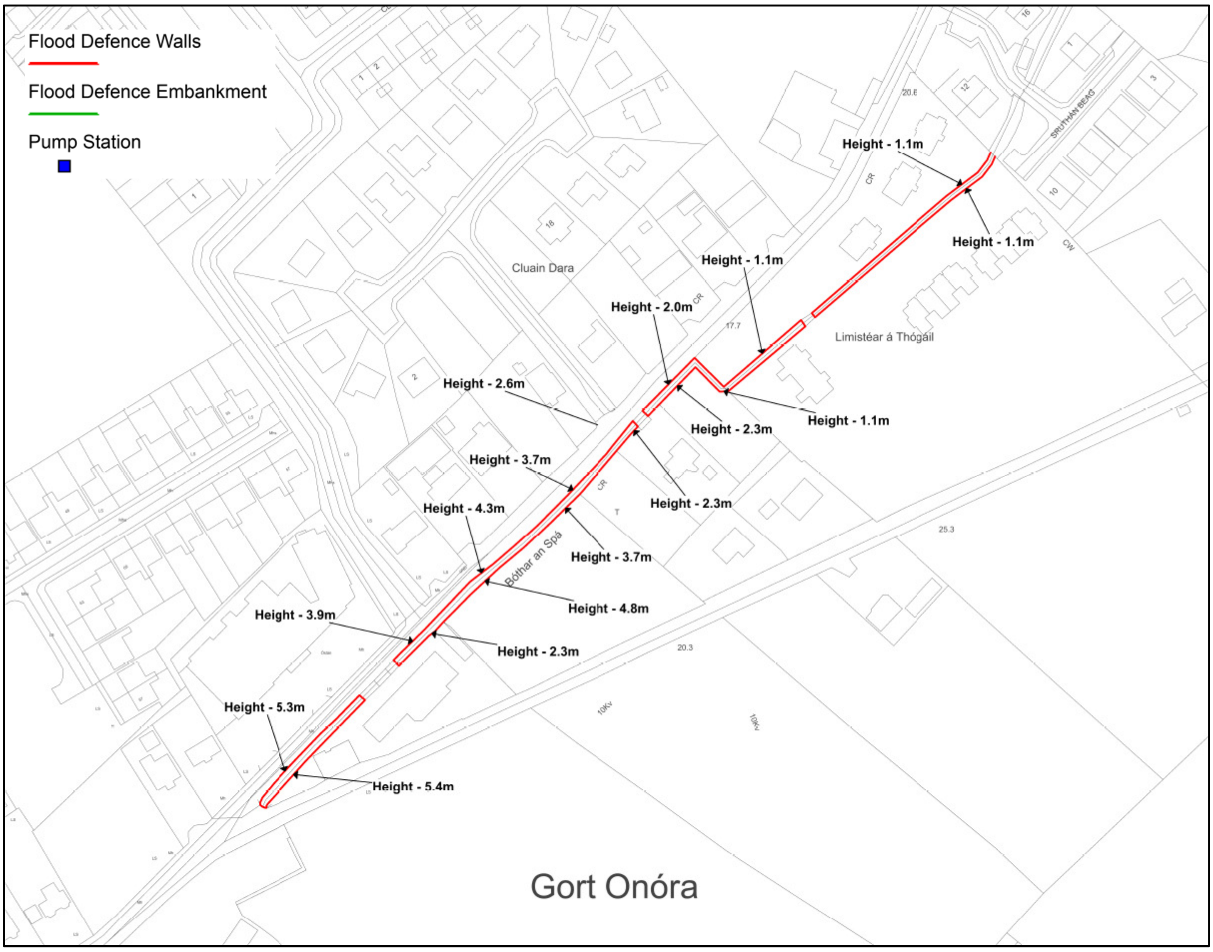


Figure 5.17: Dingle – Flood Defence Measure

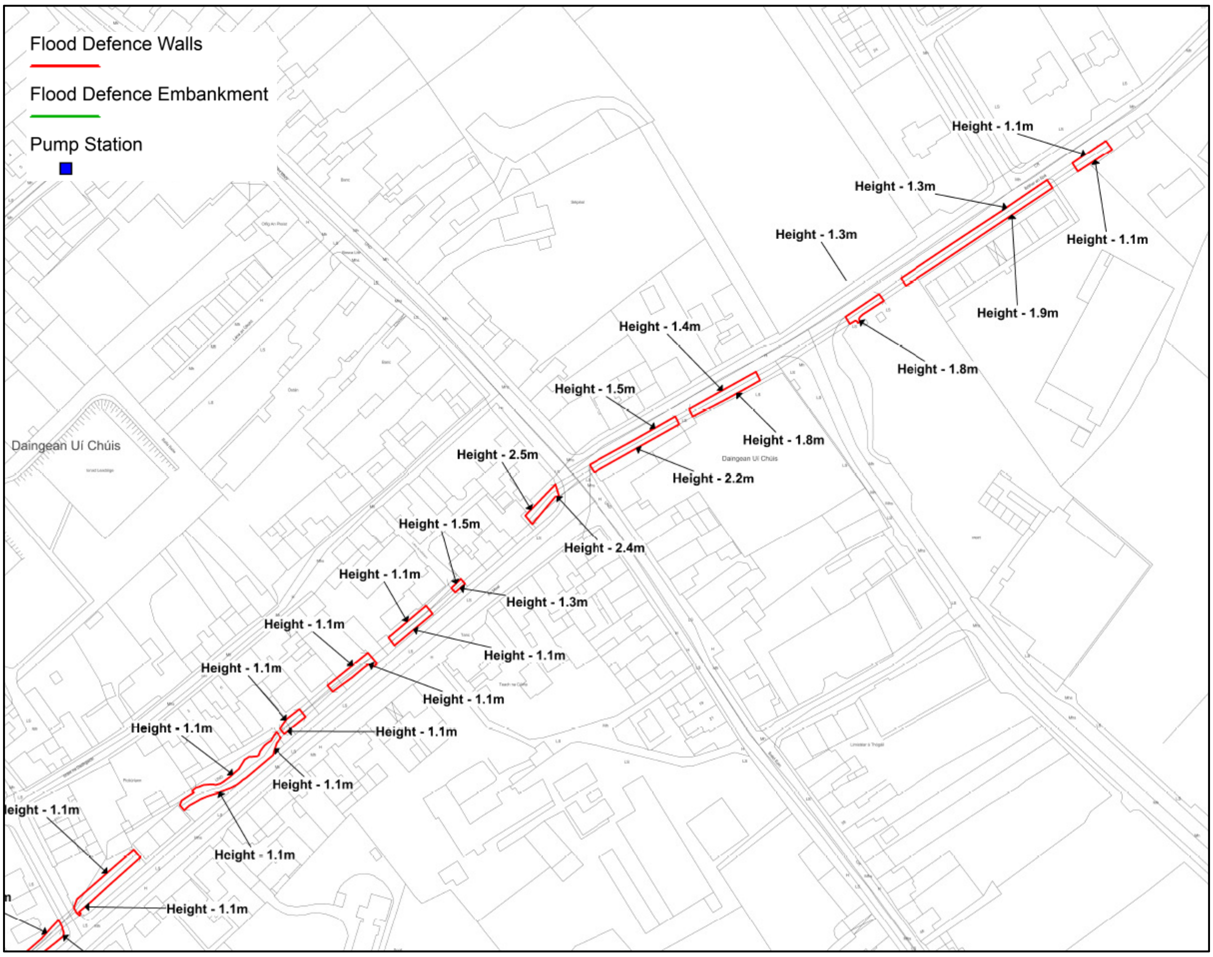


Figure 5.18: Dingle – Flood Defence Measure

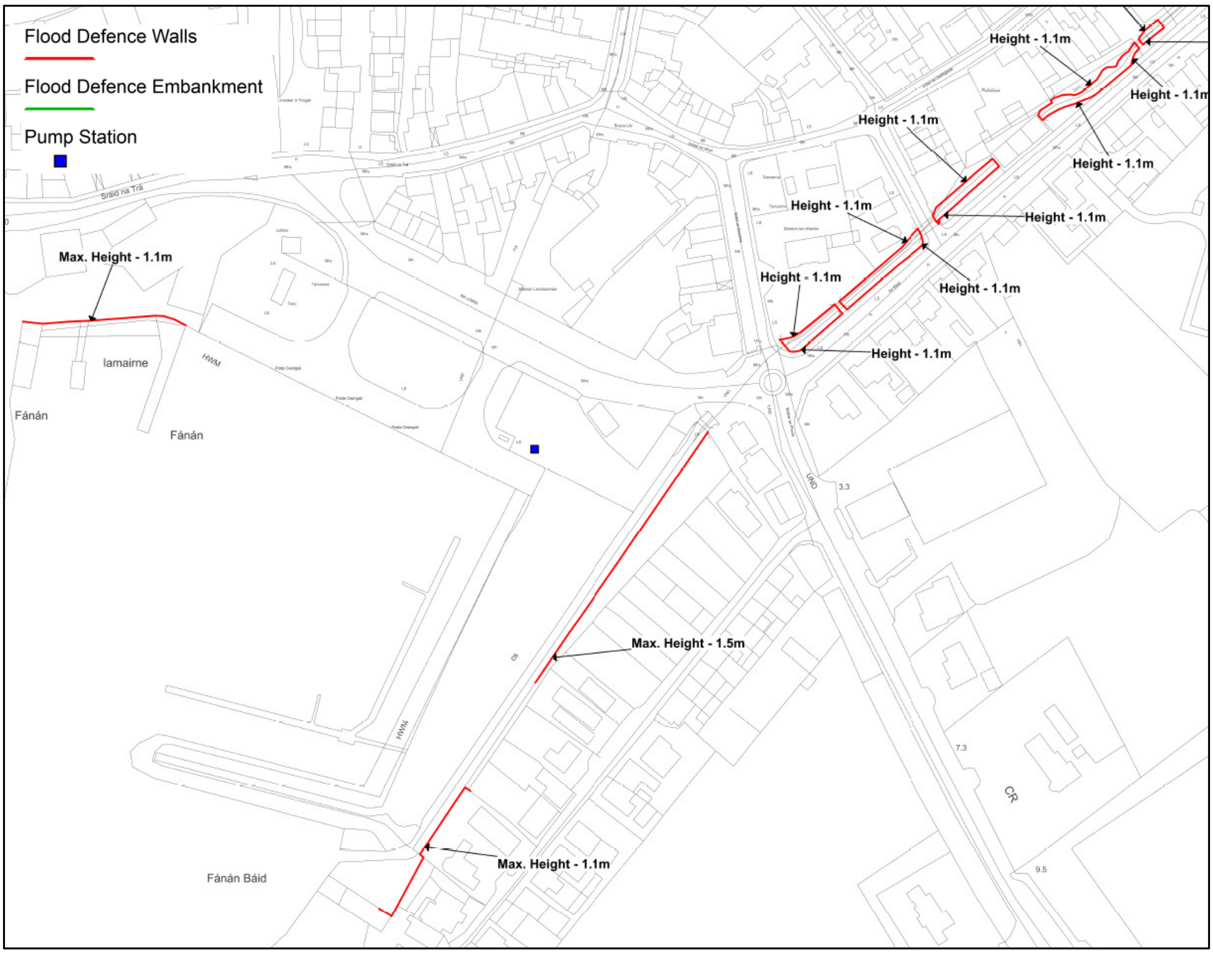
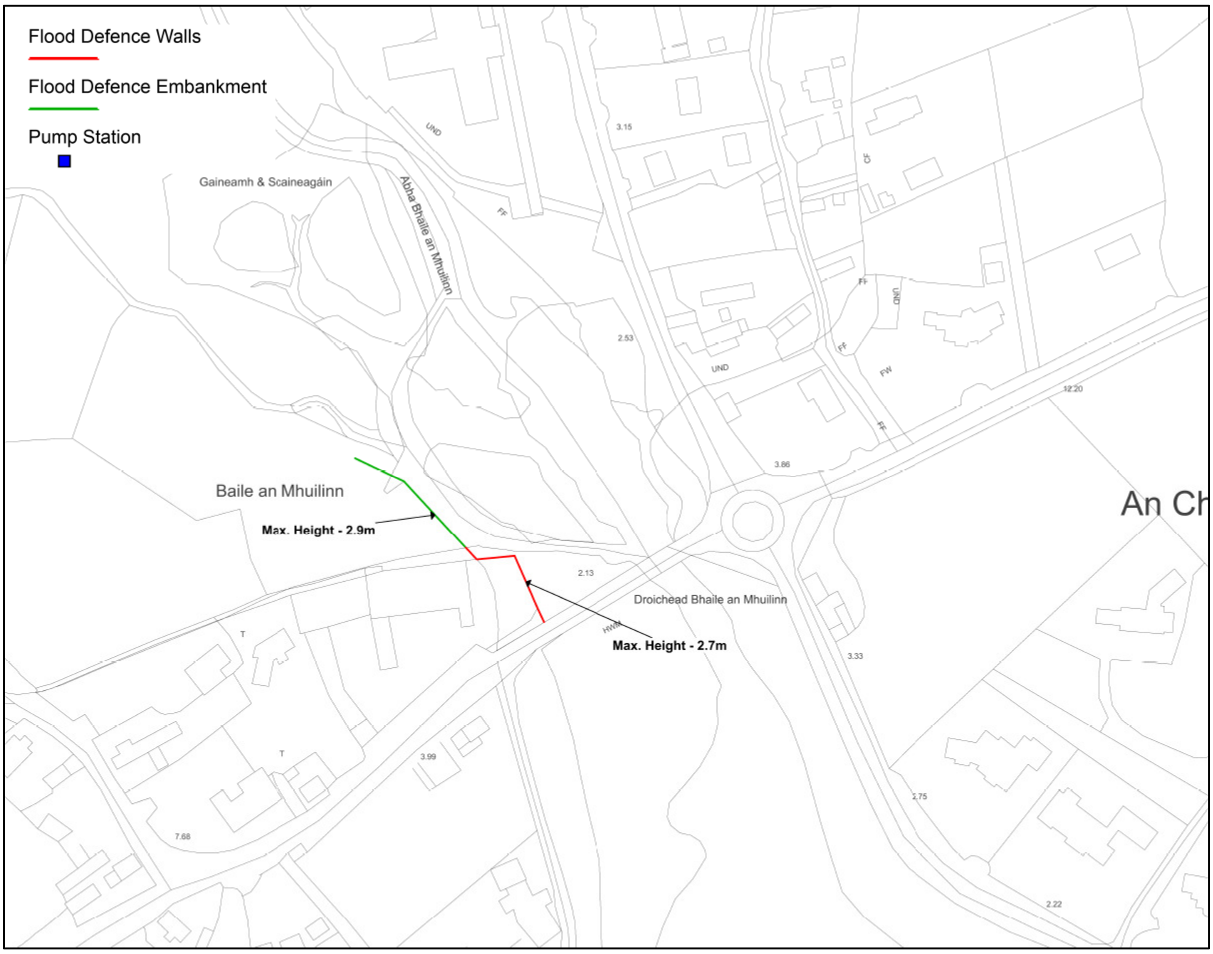


Figure 5.19: Dingle – Flood Defence Measure



The hydraulic modelling of the proposed flood defences as outlined above indicates that the measure fully achieves the required standard of protection for the 1% AEP fluvial event and the 0.5% AEP tidal event. Flood defences are 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:

- Storage – Dingle Stream
- Flow Diversion – Dingle Stream
- Flood Defences – Dingle Stream & Milltown River

5.3.3 Potential FRM Options

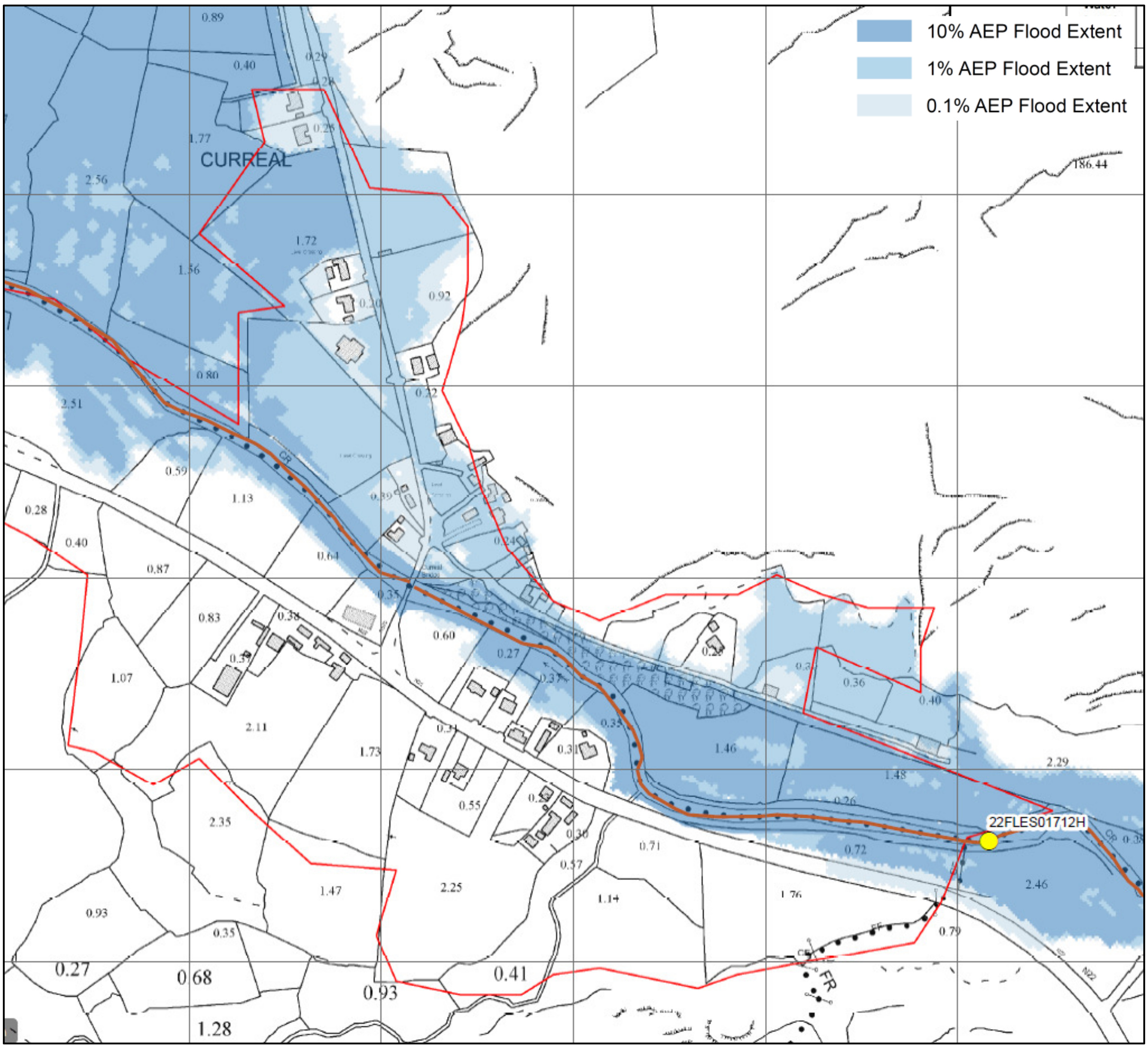
Based on the assessment of the potential (viable) FRM measures and detailed hydraulic modelling of the combined measures, the following are potential FRM options. Full outline drawings are included in Appendix B for each of the potential options.

- Option 1 – Storage (Fluvial) and Flood Defences (Fluvial & Tidal)
- Option 2 – Flow Diversion (Fluvial) and Flood Defences (Fluvial & Tidal)
- Option 3 – Flood Defences (Fluvial & Tidal)

5.4 Glenflesk, Co. Kerry

Glenflesk is located along the Flesk River in County Kerry and is at risk of fluvial flooding. The AFA and the existing fluvial flood risk are highlighted in Figure 5.20.

Figure 5.20: Glenflesk – Current Scenario Fluvial 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:

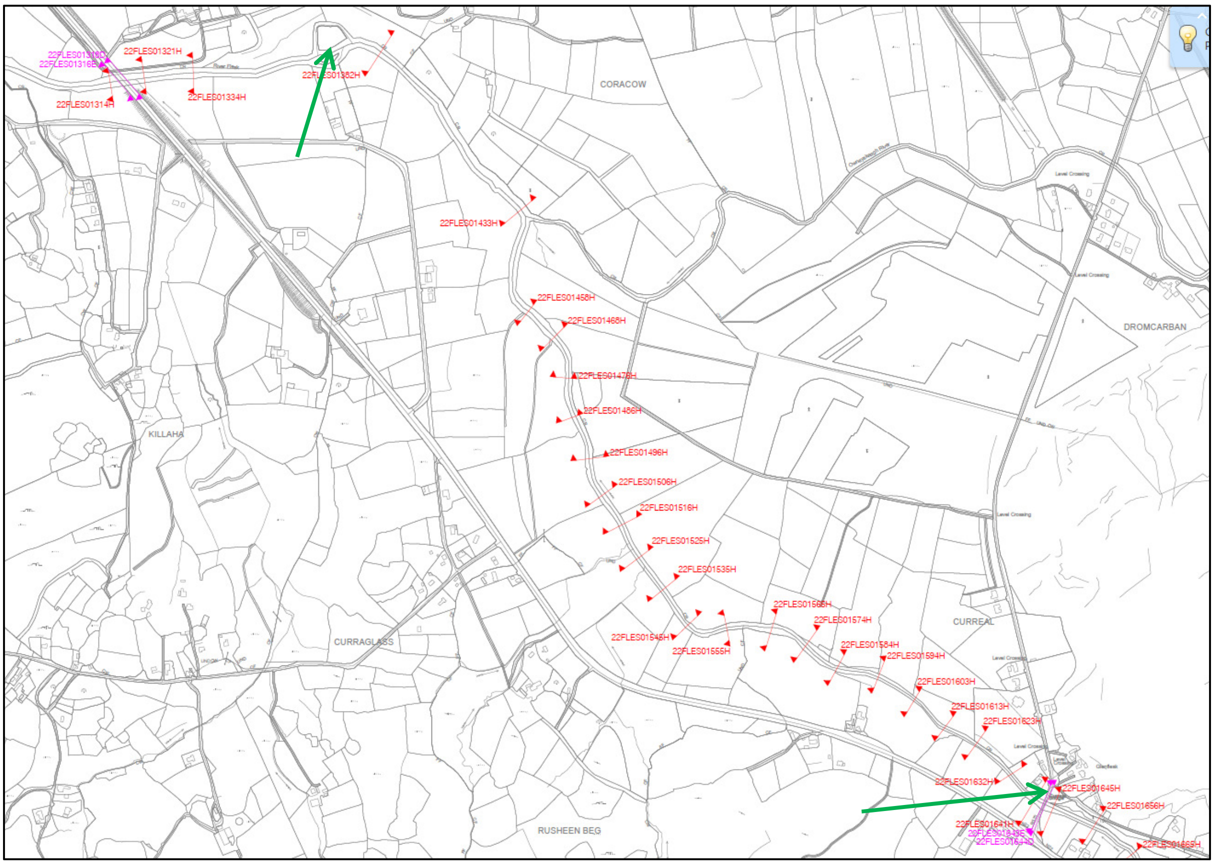
- Flow Diversion
- Increased Conveyance
- Flood Defences

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 Flow Diversion / Bypass

There is an area approximately 2.7km downstream of Curreal Bridge in Glenflesk with a weir and rapids. In the hydraulics report this was identified as a potentially critical area on the Flesk River which could be impacting on water levels upstream in Glenflesk. This is highlighted in Figure 5.21.

Figure 5.21: Glenflesk – Location of Weir / Rapids



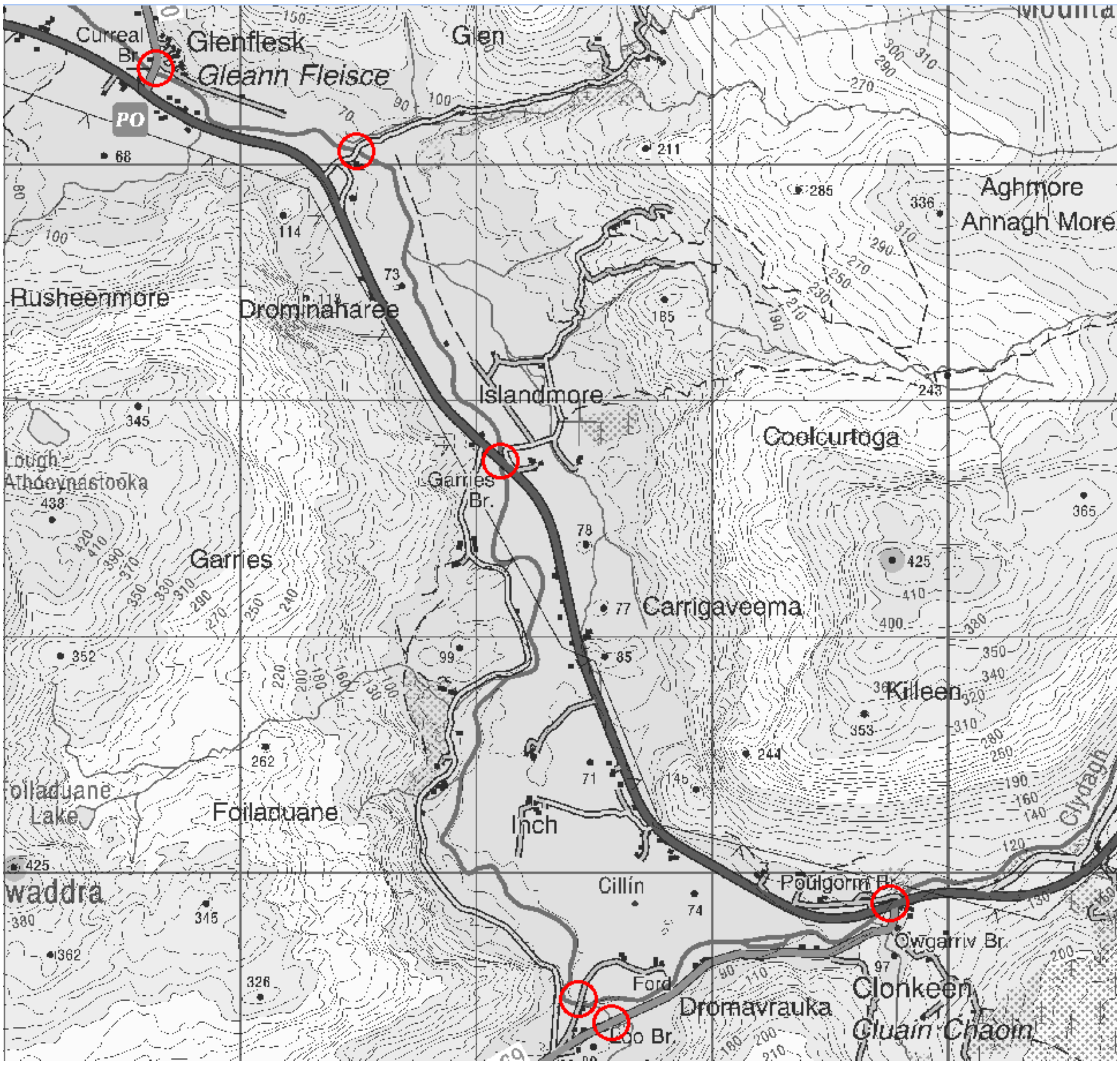
This measure aims to mitigate the flood risk in Glenflesk by diverting flow around the weir and rapids. As a proof of concept for the flow diversion measure, the weir and rapid were removed from the hydraulic model which represented a full diversion. The hydraulic model indicated that there was no reduction in flood extent with only a minor reduction in flood depth in Glenflesk of approx. 0.01m. The maximum decrease in water level was 0.42m which occurred at the weir. This measure is not deemed to be a viable measure individually or in combination.

5.4.1.2 Increased Conveyance - Structures

This measure aims to mitigate the flood risk in Glenflesk by improving the conveyance of all the structures along the watercourse. There are six existing bridges which were replaced in the hydraulic model with single span bridges with the soffit set above the level of the 1% AEP fluvial event.

The hydraulic model indicated that there was a slight increase in flood depth in Glenflesk of approx. 0.05m with no visible increase in extent. The maximum decrease in water level was 0.37m which occurred at the weir. This measure is not deemed to be a viable measure individually or in combination.

Figure 5.22: Glenflesk – Location of Structures



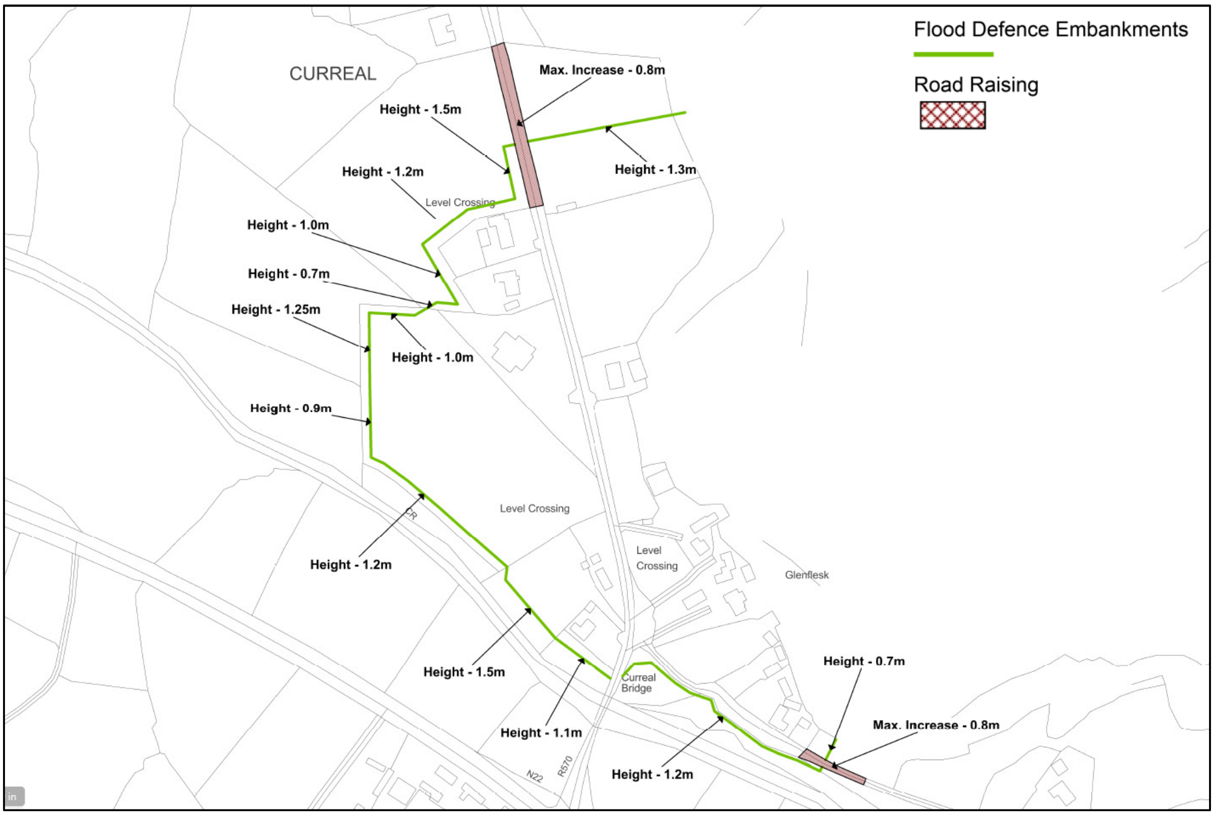
5.4.1.3 Increased Conveyance – Removal of Trees

This measure aims to mitigate the flood risk in Glenflesk by improving the conveyance of the river channel by removing trees and other obstructions along the river bank. Using the hydraulic model a sensitivity test was carried out on the roughness coefficients. This indicated that any improvement works such as the removal of trees etc. would have a negligible reduction in flood extent and depth for the 1% AEP event. This measure is not deemed to be a viable measure individually or in combination.

5.4.1.4 Flood Defences

This measure considers the mitigation of flood risk through the construction of flood defences. These defences include embankments and road raising. The locations and heights of the defences are shown in Figure 5.23.

Figure 5.23: Glenflesk – Flood Defence Measure



The hydraulic modelling of the proposed flood defences as outlined above indicates that the measure fully achieves the required standard of protection for the 1% AEP fluvial event. The average increase in water level is 0.05m. The maximum increase in water level of 0.25m occurs just upstream of the defences with water levels returning to pre-works levels downstream of the defences. These works do not impact on flood risk in Killarney downstream. This is deemed to be a viable measure / option.

5.4.2 Potential FRM Measures

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

- Flood Defences

5.4.3 Potential FRM Options

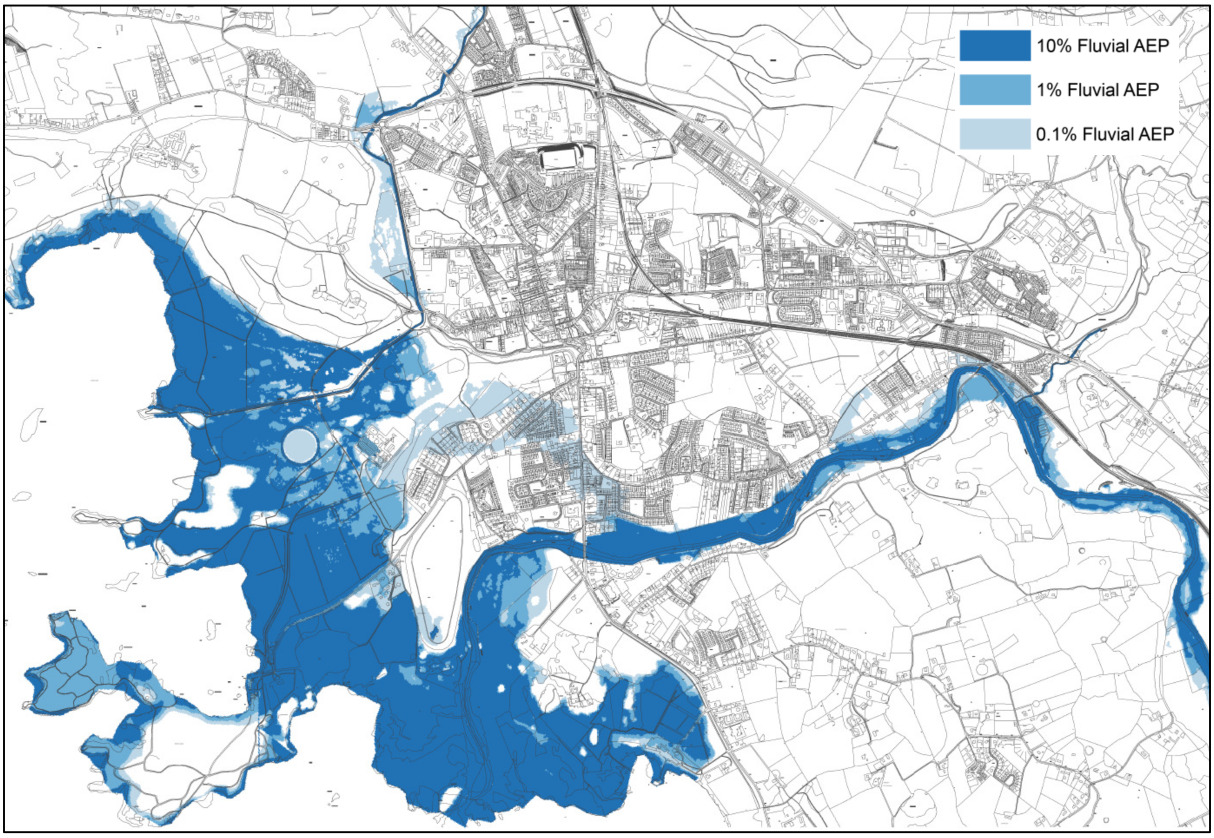
Based on the assessment of the potential (viable) FRM measures and detailed hydraulic modelling of the combined measures, the following are potential FRM options. Full outline drawings are included in Appendix B for each of the potential options.

- Option 1 – Flood Defences

5.5 Killarney, Co. Kerry

Killarney in County Kerry is located along the Flesk River and immediately upstream of Lough Leane. There are a number of other smaller rivers and tributaries which flow through Killarney into Lough Leane. Killarney is at risk of fluvial flooding. The AFA and the existing fluvial flood risk are highlighted in Figure 5.24.

Figure 5.24: Killarney – Current Scenario Fluvial Flood Extents



5.5.1 Possible FRM Measures

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

- Increased Conveyance
- Flood Defences (Fluvial)

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.

5.5.1.1 Increase Conveyance – Removal of Trees and Islands downstream of Flesk Bridge

Immediately downstream of Flesk Bridge there is a weir followed by two separate islands which restrict flow. These are sizable islands within the channel on which trees have developed. The location of the islands is shown in Figure 5.25 and the trees can be seen in the photograph in Figure 5.26.

This measure aims to improve conveyance and channel capacity by removing the trees and islands at the weir.

Figure 5.25: Killarney – Increase Conveyance – Removal of Trees and Islands at Flesk Bridge

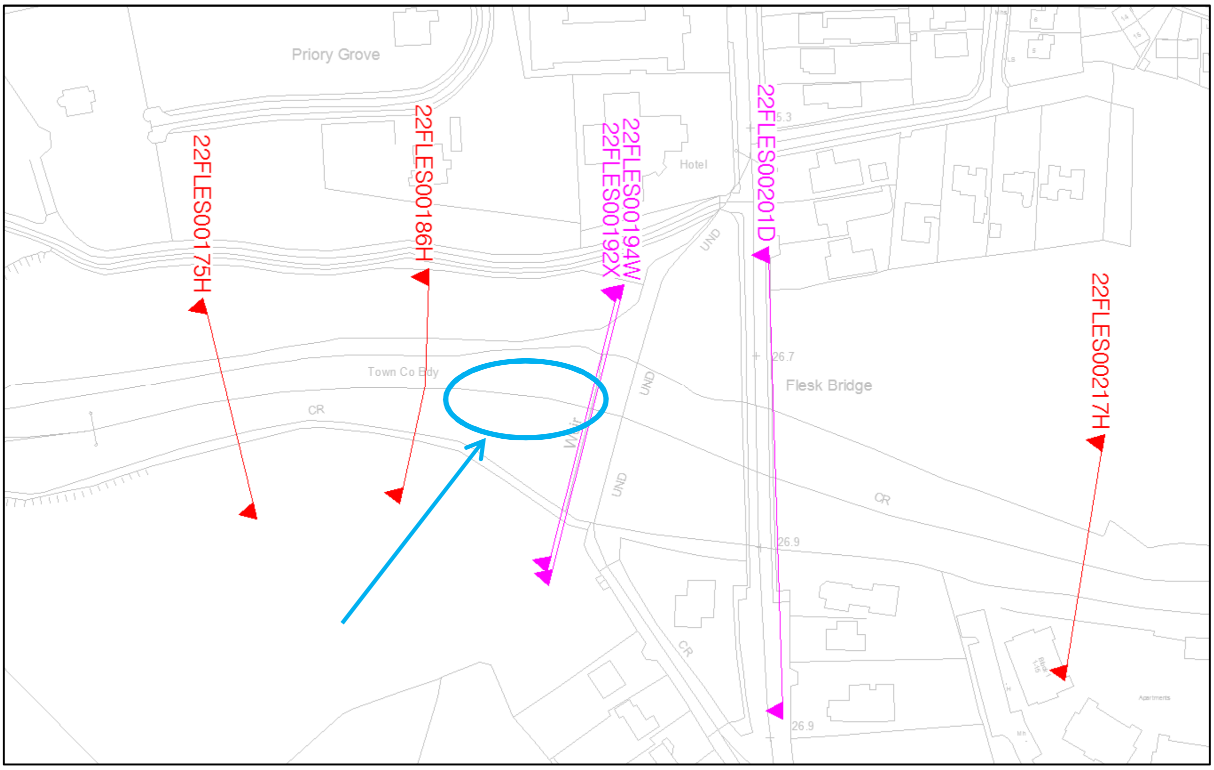


Figure 5.26: Killarney – Photograph of Weir, Island and Trees downstream of Flesk Bridge

The representation of the islands and trees were removed from the hydraulic model which determined that there was no significant reduction in flood extent, depth or duration. This is due to the weir and islands being drowned by the 1% AEP event. The maximum decrease in water level was 0.11m which occurred at the weir. This measure is not deemed to be a viable measure individually or in combination as the reduction in flood extent / level / risk is minimal.

5.5.1.2 Flood Defences

This measure considers the mitigation of flood risk through the construction of flood defences. These defences include walls and embankments. The locations of the defences are shown in Figure 5.27. Subsequent Figures detail the maximum height of the defences.

Figure 5.27: Killarney – Flood Defences - Overview

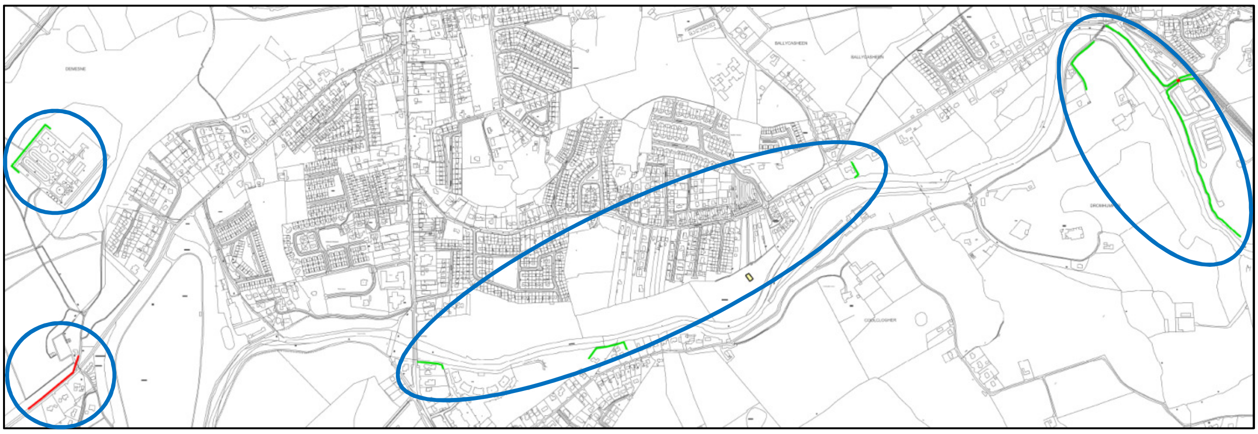


Figure 5.28: Killarney – Flood Defences

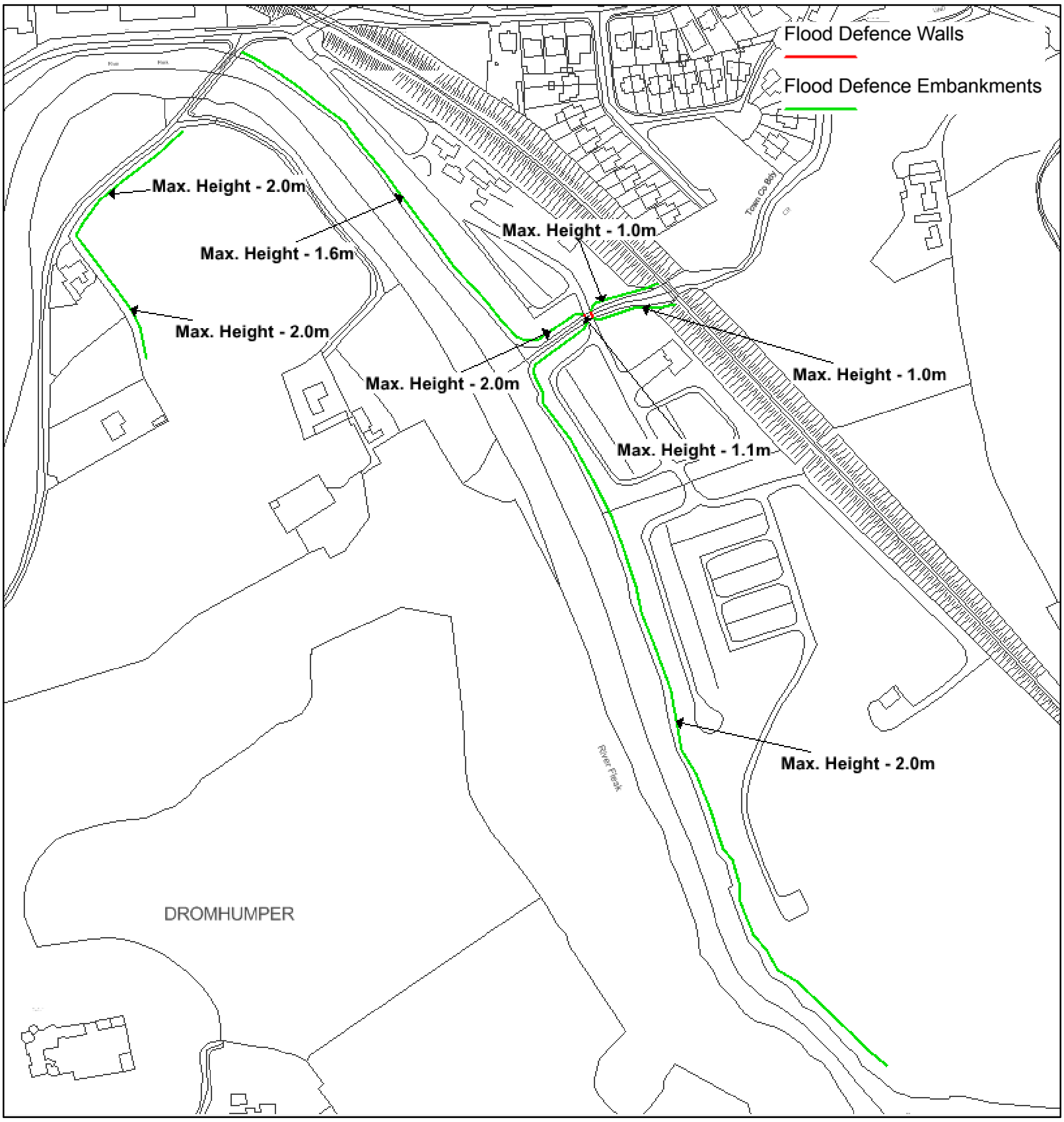


Figure 5.29: Killarney – Flood Defences

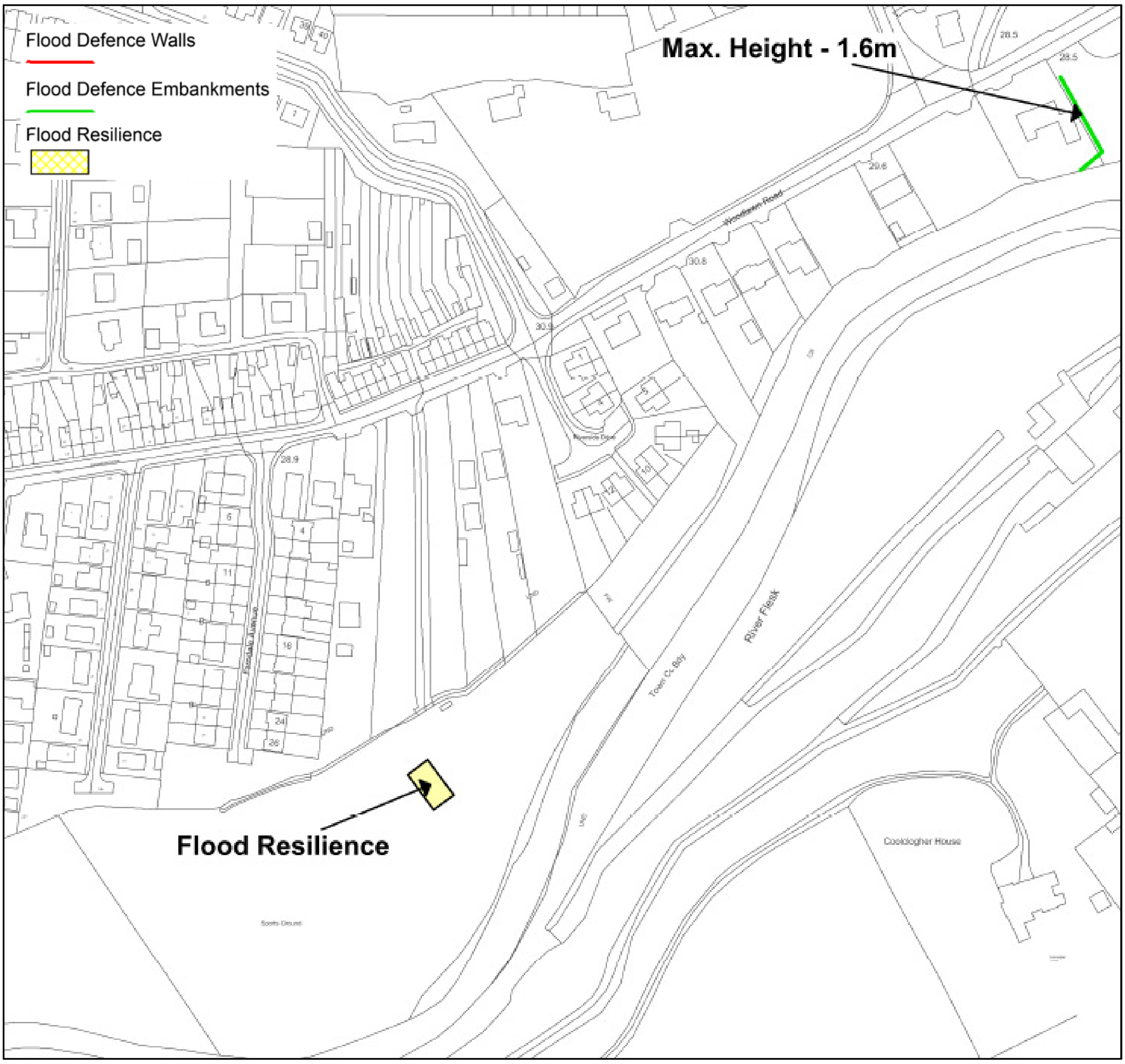


Figure 5.30: Killarney – Flood Defences

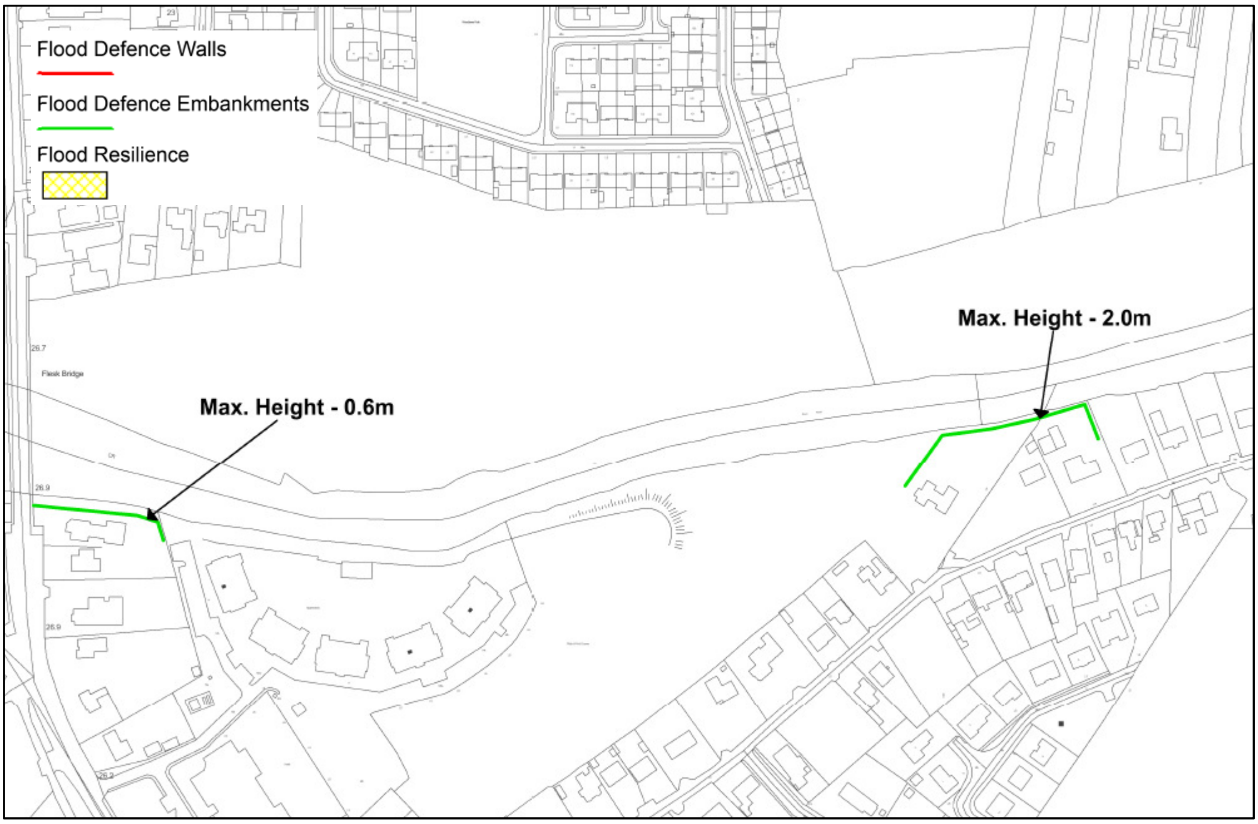


Figure 5.31: Killarney – Flood Defences

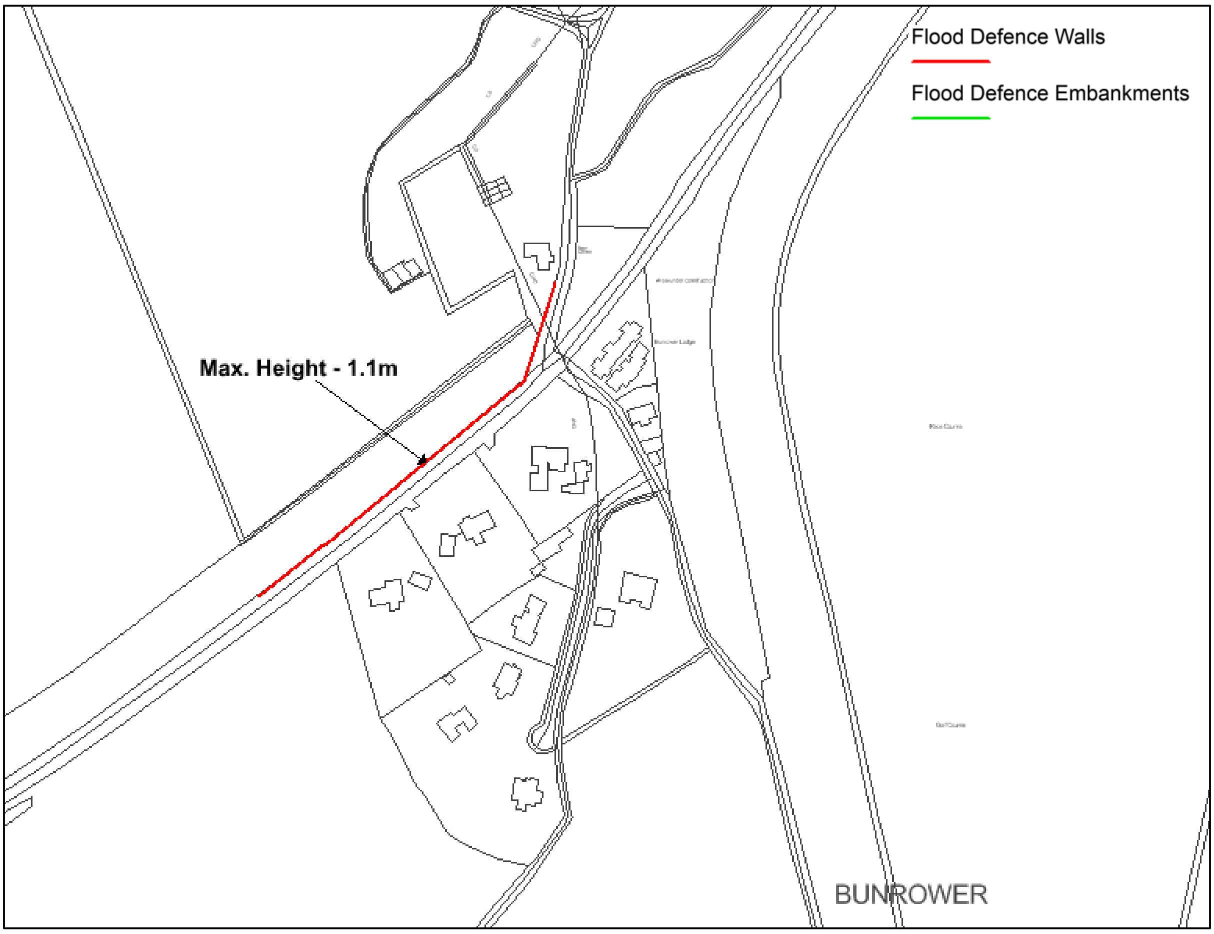
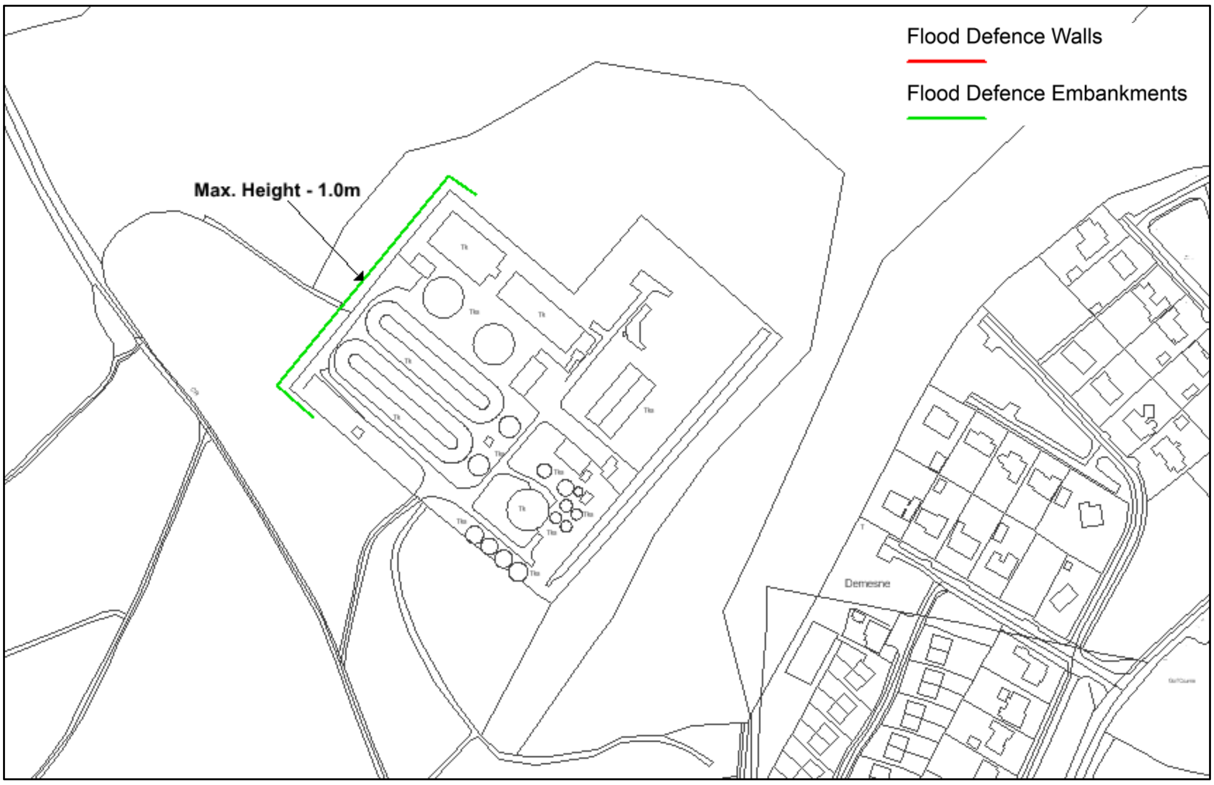


Figure 5.32: Killarney – Flood Defences



The hydraulic modelling of the proposed flood defences as outlined in the Figures above indicates that the measure fully achieves the required standard of protection for the 1% AEP fluvial event. The maximum increase in water level of 0.14m occurs just upstream of the start of the defences as shown in Figure 5.28. Water levels return of pre-works levels within 200m. This is deemed to be a viable measure / option.

5.5.2 Potential FRM Measures

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

- Flood Defences

5.5.3 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 – Flood Defences

5.6 Milltown, Co. Kerry

Milltown in County Kerry is located just upstream of the confluence of the Ashullish and Ballyoughtrough Streams which are tributaries of the River Maine. The Ashullish Stream runs through Milltown which is at risk of fluvial flooding. The AFA and the existing fluvial flood risk are highlighted in Figures 5.33 and 5.34.

Figure 5.33: Milltown – Current Scenario Fluvial Flood Extents - Upstream

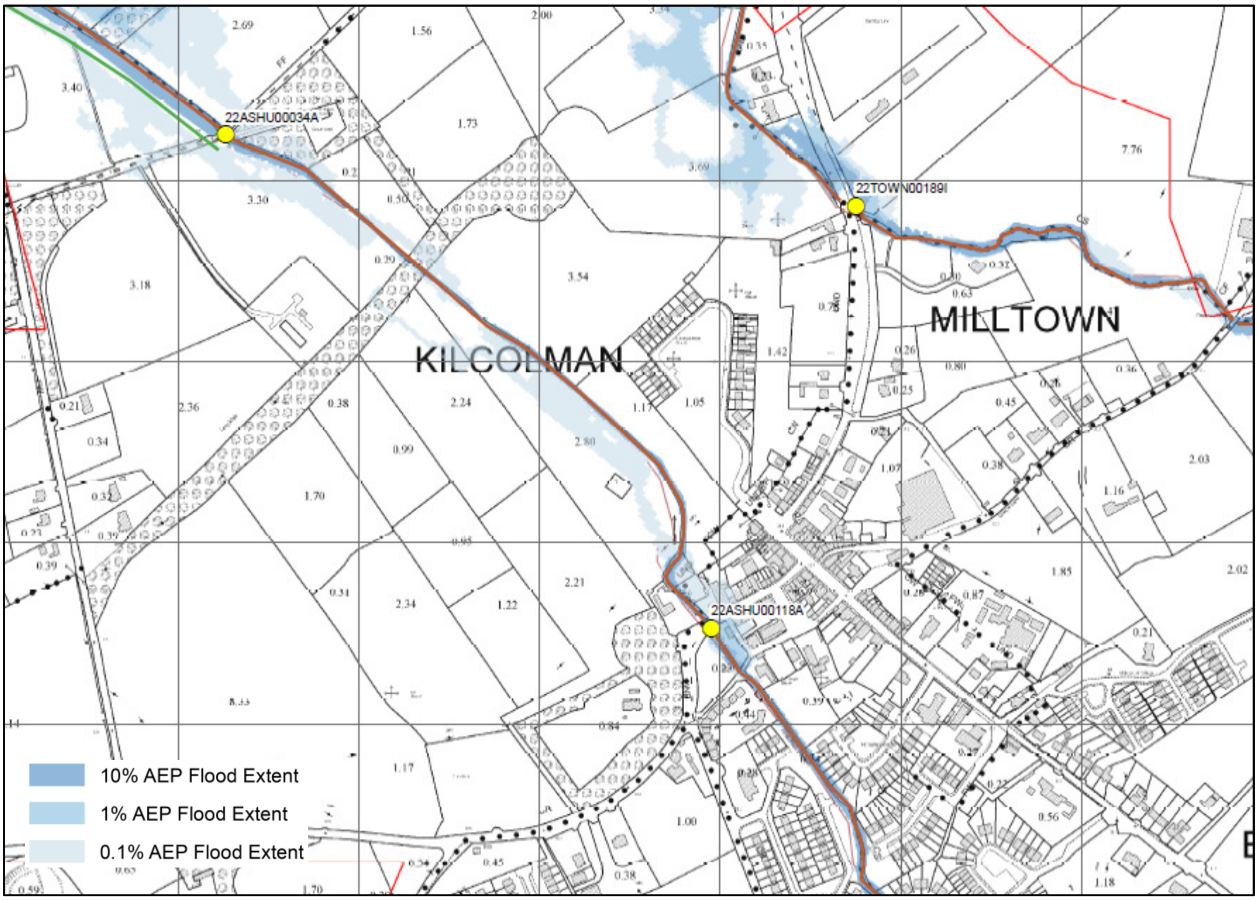
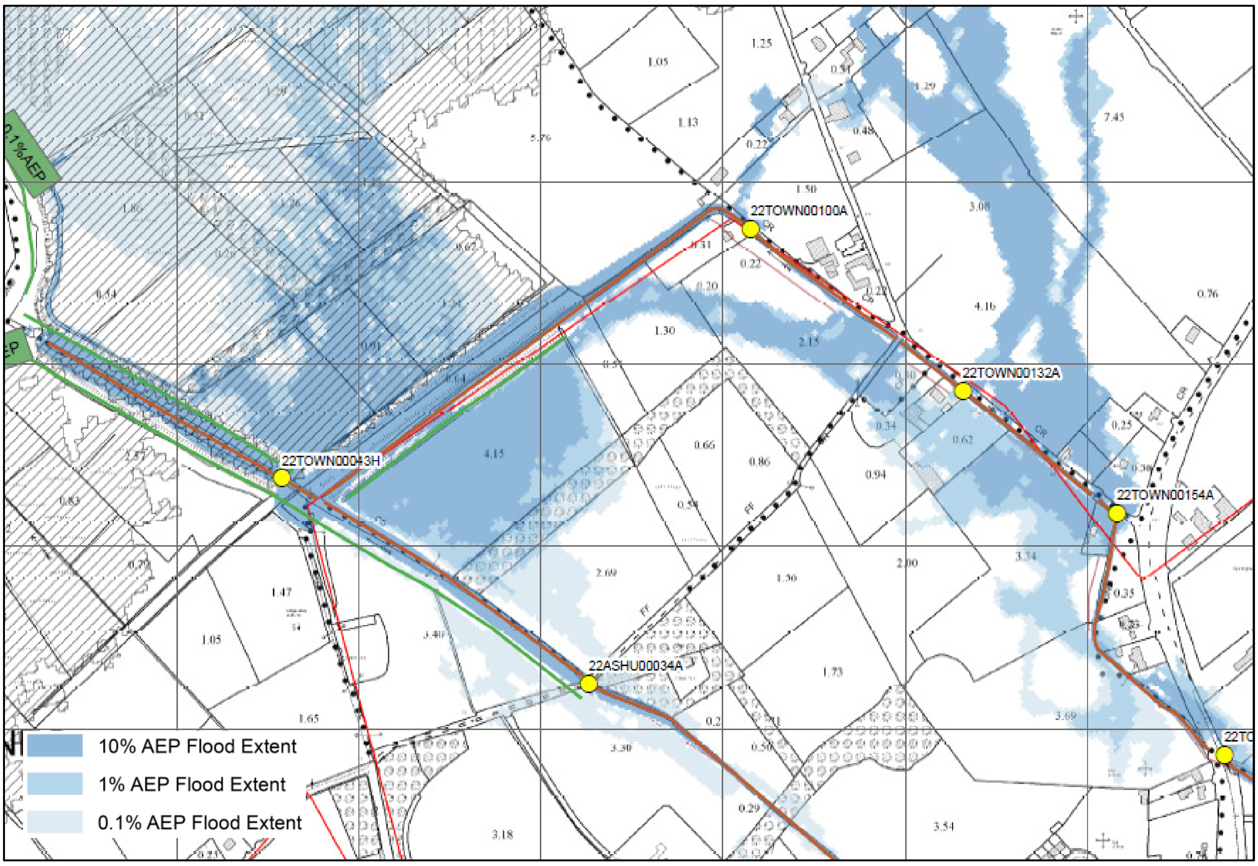


Figure 5.34: Milltown – Current Scenario Fluvial Flood Extents - Downstream



5.6.1 Possible FRM Measures

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

- Flood Defences (Fluvial)
- 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. These are described below.

5.6.1.1 Flood Defences

This measure considers the mitigation of flood risk through the construction of flood defences. These defences include walls and embankments. The locations of the defences are shown in Figure 5.35. Subsequent Figures detail the maximum height of the defences.

Figure 5.35: Milltown – Flood Defences

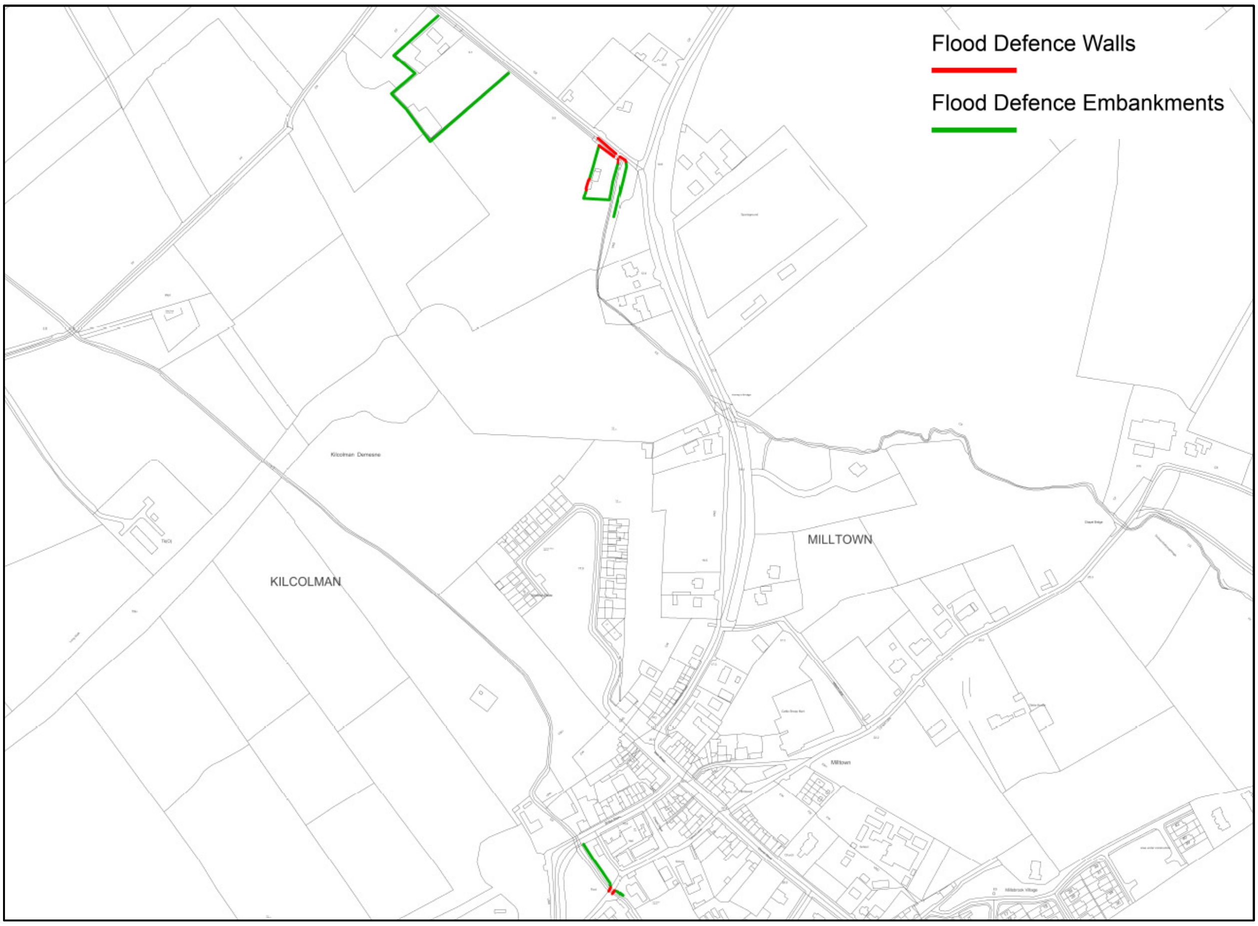


Figure 5.36: Milltown – Flood Defences – Ashullish Stream

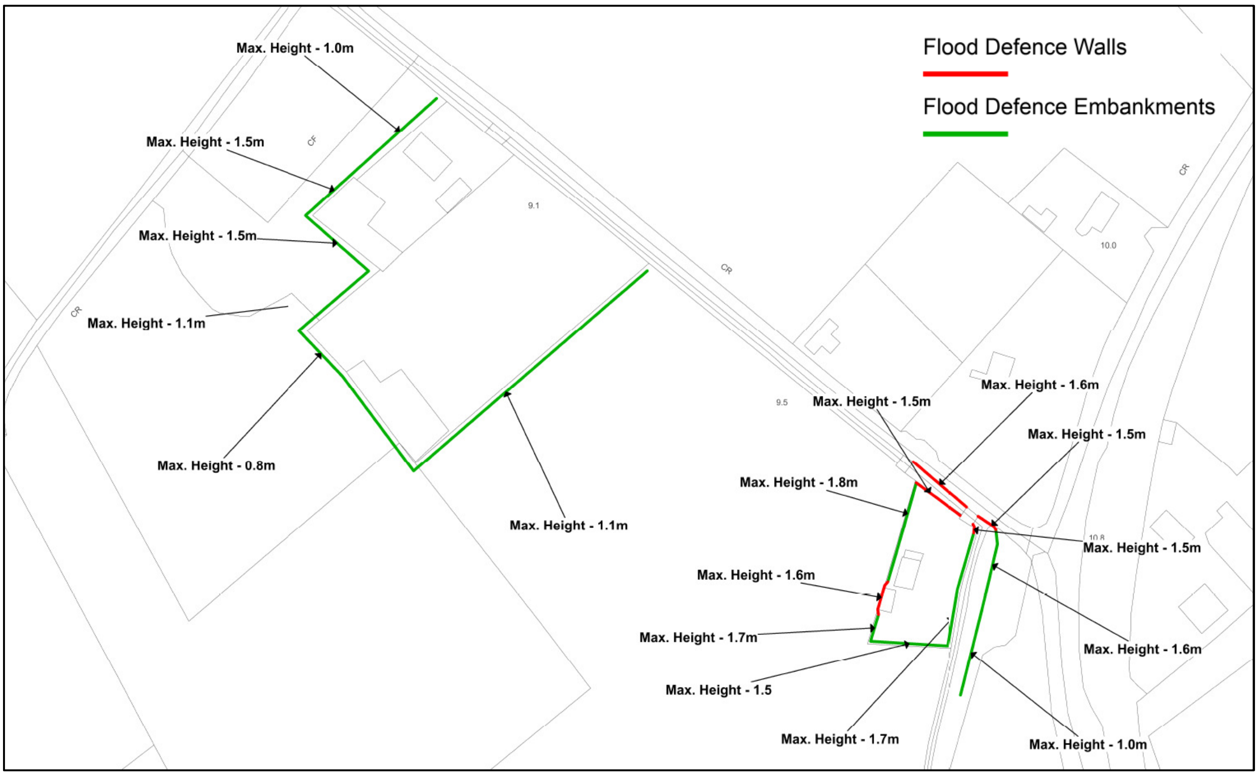
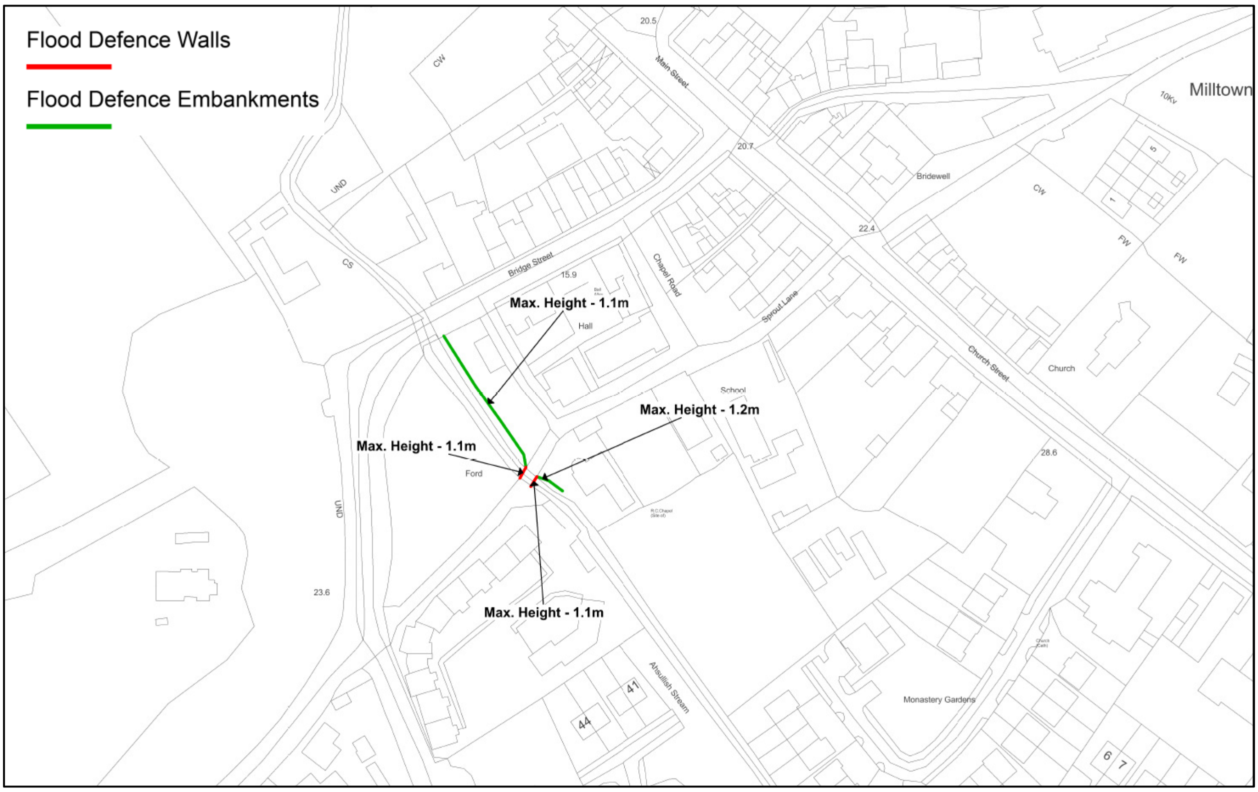


Figure 5.37: Milltown – Flood Defences – Ballyoughtrough

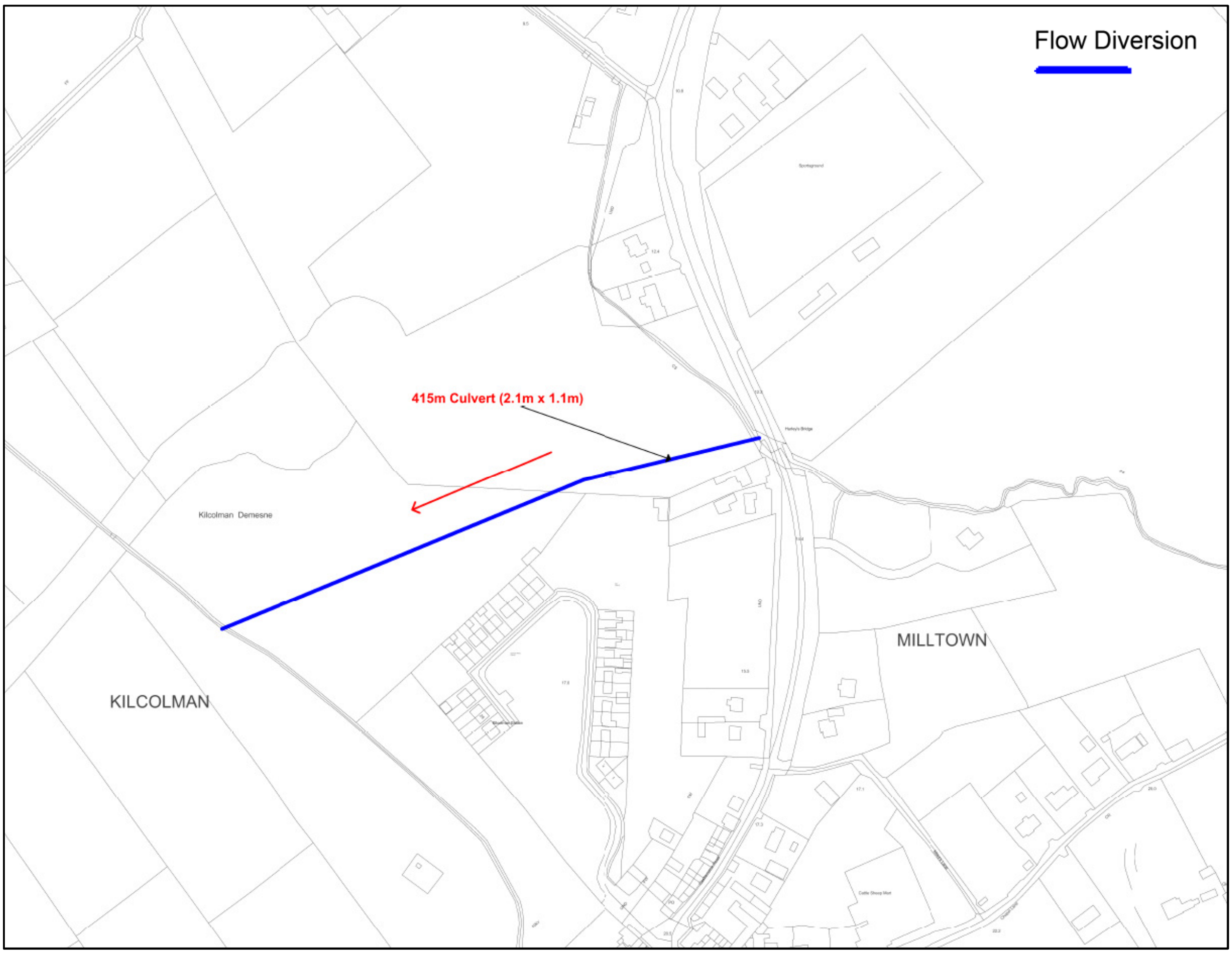


The hydraulic modelling of the proposed flood defences as outlined in the Figures above indicates that the measure fully achieves the required standard of protection for the 1% AEP fluvial event. The average increase in water level is 0.07m. The maximum increase in water level of 0.75m occurs on the Ashullish Stream between the defences shown in Figure 5.36. This increase occurs due to the capacity of the culvert under the entrance to the residential property. This increase is localised, extending less than 100m upstream with no increase in water levels downstream. This is deemed to be a viable measure / option.

5.6.1.2 Flow Diversion

This measure aims to mitigate the flood risk by diverting the flow from the Ashullish Stream to the Ballyoughtrough Stream. Figure 5.38 shows the location and proposed route of the flow diversion culvert.

Figure 5.38: Milltown – Flow Diversion – Ashullish Stream to Ballyoughtrough Stream



The peak flow in the Ashullish Stream for the 1% AEP event is 4.71m3/s which results in flooding along the watercourse and of adjacent properties. It is proposed to divert the stream to the Ballyoughtrough Stream using a 2.1m wide by 1.0m high culvert. The proposed route has been selected to minimise the amount of excavation required while also reducing the impact on landowners.

The hydraulic modelling of the flow diversion measure indicated that the flooding along the Ashullish is fully mitigated. There is a minor increase in flood extent and depth on the Ballyoughtrough downstream of the culvert outlet. However, there are no existing properties in this area.

While this measure does not mitigate the flooding upstream on the Ballyoughtrough at the town, it is deemed to be a viable measure which can be used in combination with another measure.

5.6.2 Potential FRM Measures

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

- Flood Defences
- Flow Diversion

5.6.3 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 – Flood Defences
- Option 2 – 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) 22 in October and November 2014. 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 22 AFAs are shown in Table 7.1 below.

Table 7.1: Draft Flood Mapping PCDs

AFA	Date	Venue	Nr of Attendees
Castleisland	29th October 2014	Kerry County Council Area Office, Castleisland	14
Dingle	6th November 2014	Dingle Library	14
Glenflesk	21st October 2014	Glenflesk GAA Club	36
Killarney	23rd October 2014	Killarney Area Office	11
Milltown	16th October 2014	Milltown Community Centre	16
Portmagee	30th October 2014	The Community Centre, Portmagee	7

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?
Glenflesk	Raise ends of roads, clear trees and bushes from rivers and drains in fields
	Cutting of trees in river - road drainage. Raise both end of road
	Trees cut and road raised on both ends
	Clearing vegetation into Killarney - treat them to stop them re-growing. Walls/embankments would only make the problem worse.
	Clear stream between Gortacoor bridge and new bridge
	Cut trees and bushes by river
	Clear the river. Free the blocked eyes of bridges - islands below Flesk Bridge
	At least clear river and free blockages at bridges and islands below Flesk River
	Remove excess vegetation from river banks. Better management of drainage on roads to remove rainwater faster
	Clear river. Raise the road level
	Cut over-hanging trees and clear silt and islands
	Raise road and clear rivers
Milltown	Cleaning of ditches
	Deepen river

7.3 Preliminary Options PCDs

On the 5th November 2015 a stakeholder workshop was held with Local Authority Engineers to discuss the emerging preferred options. Feedback received at this work shop 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 22 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
Castleisland	9th December 2015	KCC Area office, Castleisland	22
Dingle	9th December 2015	Library, Dingle	12
Glenflesk	8th December 2015	GAA Clubhouse, Glenflesk	32
Killarney	8th December 2015	Avenue Hotel, Killarney	20
Milltown	10th December 2015	Community Hall, Milltown	12

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 22 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
Castleisland	Flood Defences	2	1
	Do Nothing	0	2
Dingle	Storage & Flood Defences	3	1
	Flow Diversion & Flood Defences	1	2
	Flood Defences	0	3
	Do Nothing	0	4
Glenflesk	Planning & Development Control	1	4
	Building Regulations	1	6
	Flood Forecasting	0	4
	Emergency Response Procedures	5	1 (tied)
	Targeted Public Awareness	0	7
	Individual Property Flood Resilience	0	3
	Land Use Management	3	1 (tied)
Killarney	Flood Defences	4	1
	Do Nothing	0	2

AFA	Option	Nr of Rank 1 Received	Rank
Milltown	Planning & Development Control	-	-
	Building Regulations	-	-
	Flood Forecasting	-	-
	Emergency Response Procedures	-	-
	Targeted Public Awareness	-	-
	Individual Property Flood Resilience	-	-
	Land Use Management	-	-

It should be noted that the Flood Defence & Flow Diversion option and the Flow Diversion and Western Flood Defence option for Castleisland were developed after the PCDs.

Prior to the PCDs at Glenflesk and Milltown it was identified that the potential structural FRM options would not be cost beneficial based on the flood risk assessment and cost estimates. As a result, the structural options were not displayed at the PCD. The viable non-structural options were displayed and the study team were on hand to discuss the options and gather feedback from members of the public.

There was no feedback received at the Milltown PCD.

8 Flood Risk Assessment

8.1 General

Flood risk mapping for the UoM 22 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 22 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 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%
Castleisland	29	55	73	86	127	198	325	517	57	75	96	153	265	343	489	616	156	442	658
Dingle	21	26	68	75	78	91	143	177	52	78	88	91	140	161	174	226	94	195	250
Glenflesk	0	0	0	3	13	18	39	78	0	3	8	13	39	49	73	94	13	68	96
Killarney	0	0	0	0	5	26	42	614	0	3	5	5	31	257	749	1011	5	595	1154
Milltown	0	3	5	8	8	16	16	23	5	8	13	16	18	23	23	26	16	23	29

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%
Castleisland	11	21	28	33	49	76	125	199	22	29	37	59	102	132	188	237	60	170	253
Dingle	8	10	26	29	30	35	55	68	20	30	34	35	54	62	67	87	36	75	96
Glenflesk	0	0	0	1	5	7	15	30	0	1	3	5	15	19	28	36	5	26	37
Killarney	0	0	0	0	2	10	16	236	0	1	2	2	12	99	288	389	2	229	444
Milltown	0	1	2	3	3	6	6	9	2	3	5	6	7	9	9	10	6	9	11

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%
Castleisland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dingle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glenflesk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Killarney	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3	0	2	3
Milltown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

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%
Castleisland	0	0	0	0	1	1	2	3	0	0	0	0	2	1	2	3	1	2	3
Dingle	0	0	1	2	3	3	3	4	0	2	3	3	3	3	4	4	3	4	4
Glenflesk	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	0	1	1
Killarney	0	0	1	1	1	1	1	1	1	1	1	1	1	3	8	9	1	7	9
Milltown	0	0	0	0	0	1	1	1	0	0	1	1	1	1	2	2	1	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%
Castleisland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dingle	1	1	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	4	4
Glenflesk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Killarney	0	0	1	1	1	1	1	1	0	1	1	1	1	17	20	20	2	20	20
Milltown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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%
Castleisland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dingle	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1
Glenflesk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Killarney	1	2	5	5	5	5	5	5	1	5	5	5	5	5	5	5	5	6	8
Milltown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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%
Castleisland	2	2	5	5	14	26	36	64	2	5	7	14	30	33	52	86	14	42	91
Dingle	4	11	41	50	49	54	70	83	25	50	55	52	71	81	83	92	53	89	95
Glenflesk	0	0	0	3	5	8	14	18	0	3	5	5	12	16	17	23	5	17	24
Killarney	1	1	3	3	4	4	6	30	3	3	4	4	5	43	87	106	4	75	125
Milltown	0	1	1	1	7	9	9	9	1	5	9	9	9	9	10	11	9	10	12

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%
Castleisland	2	2	2	2	7	7	8	8	2	2	2	7	8	8	8	8	6	8	9
Dingle	0	6	7	7	8	9	10	10	7	7	8	9	10	10	10	10	6	9	10
Glenflesk	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	3
Killarney	0	1	1	1	2	2	3	10	1	2	3	3	4	7	12	15	11	15	17
Milltown	1	2	2	2	2	3	2	3	2	2	3	3	3	4	4	4	3	6	6

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%
Castleisland	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1
Dingle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glenflesk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Killarney	0	0	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Milltown	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, Dingle and Portmagee in UoM 22 are at risk from tidal flooding. Table 8.12 and 8.13 below list the receptors at risk from tidal flooding in these AFAs.

Table 8.12: Dingle – Tidal Flood Risk

Receptor	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
	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	10	10	10	16	16	23	31	55	44	55	60	78	86	107	120	130	130	185	200
Residences	4	4	4	6	6	9	12	21	17	21	23	30	33	41	46	50	50	71	77
High Vulnerability Properties	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	1	1	1	1	1	1	1	1	1	3	3	3	3	3	3
Architectural Sites	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	3	3
Non-residential properties	3	4	4	5	17	24	30	40	38	40	43	45	51	57	61	63	64	78	83
Roads	0	0	0	0	2	2	3	3	4	4	4	4	4	4	5	6	6	6	6
Utilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.13: Portmagee – Tidal Flood Risk

	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	3	3	3	3	3	3	3	3	5	5	5	5	8	10	21	29	39	52
Residences	0	1	1	1	1	1	1	1	1	2	2	2	2	3	4	8	11	15	20
High Vulnerability Properties	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	0	0	0	0	0	1	1	1	1	2	3	3	3	3
Architectural Sites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-residential properties	0	0	0	0	0	0	0	0	0	1	1	2	2	2	3	6	7	7	8
Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
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 numbers of people per house was taken from CSO data. For UoM 22 the average occupancy rate is 2.6 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 22 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.

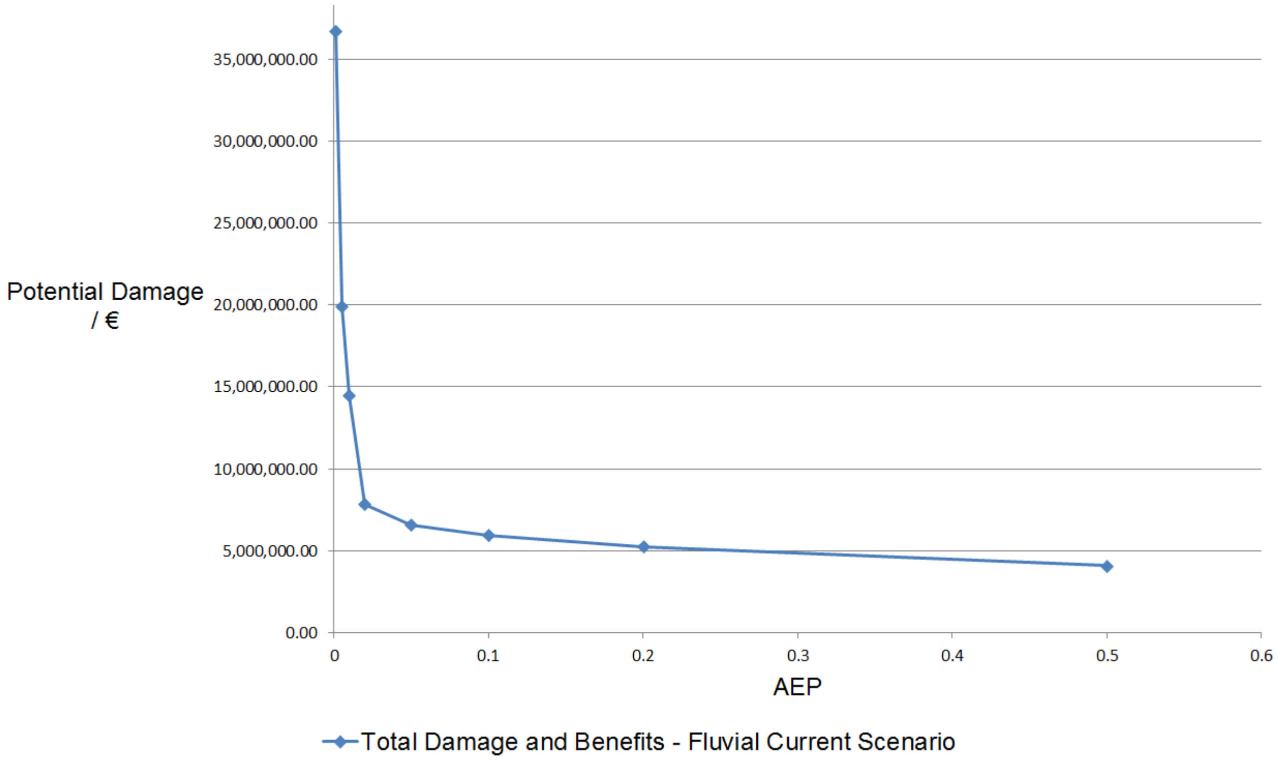
8.3.3.1 Annual Average Damage

The potential economic damage that could be caused by flooding was calculated for every property in each of the UoM 22 AFAs. The damage to a property is related to the type, use, area 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 €
Castleisland	522,449.93	1,672,862.35	2,288,548.29
Dingle	608,737.64	3,781,642.92	6,567,786.34
Glenflesk	24,361.84	94,289.18	123,383.06
Killarney	187,553.59	450,589.47	682,734.76
Milltown	11,729.33	61,372.21	96,801.97
Portmagee	9,706.75	71,602.08	497,482.21

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
Castleisland	Bungalow	2616551	44,263.87	N/A	3.34%
	Bungalow	2616560	44,263.87	N/A	3.28%
	Bungalow	2616593	33,304.23	N/A	2.79%
	Bungalow	2616594	56,561.84	N/A	2.21%
	Bungalow	2616605	33,304.23	N/A	1.43%
	Bungalow	2616626	49,646.03	N/A	3.30%
	Bungalow	2616692	56,561.84	N/A	3.59%
	Bungalow	2616694	44,263.87	N/A	3.30%
	Bungalow	2616697	51,374.98	N/A	3.18%
	Bungalow	2616707	44,263.87	N/A	1.25%
	Bungalow	2616732	47,917.08	N/A	3.24%
	Bungalow	2616733	54,832.89	N/A	3.41%
	Bungalow	2616741	40,610.66	N/A	3.07%
	Bungalow	2616744	49,646.03	N/A	3.34%
	Bungalow	2616790	51,374.98	N/A	1.79%
	Bungalow	2616795	20,152.66	N/A	1.20%
	Bungalow	2616813	49,646.03	N/A	1.65%
	Bungalow	2616825	47,917.08	N/A	2.09%
	Bungalow	2616835	49,646.03	N/A	1.40%
	Bungalow	2616859	33,304.23	N/A	2.49%
	Bungalow	2616860	47,917.08	N/A	2.88%
	Bungalow	2616971	51,374.98	N/A	2.54%
	Bungalow	2622828	69,842.20	N/A	1.30%
	Bungalow	2617153	60,988.63	N/A	4.03%
	Detached	2616832	46,761.56	N/A	3.72%
	Factory	2616604	29,291.45	N/A	2.47%

AFA	Property Type	Object ID	Fluvial Damages 0.1% AEP €	Tidal Damages 0.1% AEP €	PVd - 1% of Total
	Factory	2616792	99,710.44	N/A	6.31%
	Mill	2622800	673,135.54	N/A	1.31%
	School	2622976	1,081,121.67	N/A	3.38%
Dingle	Detached	3221879	61,565.42	0.00	1.19%
	Detached	3222319	77,369.21	1,897.18	4.78%
	Detached	2611787	42,591.87	72,667.84	1.03%
	Detached	3222390	63,813.55	0.00	1.49%
	Detached	2611621	38,422.19	70,194.90	1.45%
	Semi	3222298	56,271.34	0.00	2.84%
	Semi	3222120	54,410.71	57,309.74	3.01%
	Semi	3222477	48,718.31	15,702.32	5.33%
	Terrace	3222227	44,934.68	0.00	1.17%
	Terrace	3221886	48,022.62	0.00	1.37%
	Terrace	3222270	46,478.65	47,729.78	1.73%
	Terrace	3222480	49,674.00	42,634.68	9.14%
	Terrace	3221893	40,302.77	0.00	1.13%
	Terrace	3222220	67,326.44	44,333.04	9.59%
	Terrace	3222086	46,478.65	0.00	1.57%
	Terrace	3222324	44,934.68	0.00	1.35%
	Terrace	3222217	40,302.77	0.00	1.20%
	Terrace	3222232	43,390.71	0.00	1.34%
	Boarding	3221965	41,606.88	0.00	1.02%
	Boarding	2611560	40,292.40	54,663.36	1.08%
	Cafe	3222474	78,111.22	68,165.19	2.56%
	Factory	2611494	38,397.15	66,445.75	1.11%
	Pub	3222655	37,095.85	40,805.43	1.05%
	Pub	3222196	66,529.16	59,610.52	2.99%
	Pub	3221887	77,856.82	0.00	1.78%
	Restaurant	3222077	56,409.20	0.00	1.66%
	Shop	3222144	36,082.31	31,122.96	1.41%
	Shop	3222258	89,421.90	0.00	1.64%
	Storage	2617350	265,758.04	124,310.19	5.34%
	Surgery	13358	25,923.73	23,344.82	1.47%
	Warehouse	3222353	13,468.60	2,634.48	2.07%
Glenflesk	Bungalow	10476	69,842.20	N/A	2.03%
	Bungalow	2939012	77,884.46	N/A	6.41%
	Bungalow	2939205	70,960.74	N/A	2.35%
	Bungalow	1933659	63,202.02	N/A	2.05%
	Bungalow	2321151	72,079.28	N/A	5.71%
	Detached	2938997	76,211.70	N/A	3.02%
	Detached	2939201	83,311.13	N/A	3.05%

AFA	Property Type	Object ID	Fluvial Damages 0.1% AEP €	Tidal Damages 0.1% AEP €	PVd - 1% of Total
	Detached	1933727	80,841.72	N/A	19.06%
	Detached	1933676	83,311.13	N/A	11.11%
	Detached	1933668	59,438.58	N/A	1.23%
	Detached	2939009	75,054.20	N/A	2.51%
	Detached	2939022	75,054.20	N/A	2.39%
	Detached	2938958	75,054.20	N/A	2.39%
	Detached	1933677	75,054.20	N/A	11.31%
	Detached	1933686	72,806.07	N/A	3.28%
	ComCentre	1933936	61,558.28	N/A	1.06%
	Storage	1933903	66,437.70	N/A	9.00%
	Storage	2938946	46,979.79	N/A	2.07%
Killarney	Bungalow	3097774	75,434.90	N/A	2.26%
	Bungalow	2396987	73,197.82	N/A	1.18%
	Bungalow	2396990	74,316.36	N/A	1.28%
	Bungalow	2395890	75,434.90	N/A	1.03%
	Bungalow	2395918	67,628.81	N/A	1.20%
	Detached	2395908	85,934.96	N/A	1.05%
	Boarding	2396193	202,200.50	N/A	2.10%
	Boarding	10899	221,333.37	N/A	8.83%
	Boarding	2395590	260,417.82	N/A	40.87%
	ComCentre	2396284	55,411.27	N/A	1.63%
	RetailWH	3217220	568,713.19	N/A	3.63%
Milltown	Bungalow	1889737	44,263.87	N/A	2.08%
	Bungalow	1910975	9,178.40	N/A	28.27%
	Bungalow	1910890	40,610.66	N/A	1.06%
	Bungalow	1889401	40,610.66	N/A	6.86%
	Bungalow	1889476	12,962.63	N/A	6.01%
	Detached	1889720	38,422.19	N/A	35.95%
	Semi	1889786	47,027.58	N/A	6.87%
	Shop	1889818	98,956.93	N/A	6.08%
	Surgery	1889781	63,752.60	N/A	5.26%

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) €
Castleisland	522,449.93	11,223,365.79	9,594,618.00	7,763,804.46
Tullig	419,628.67	9,014,540.56	7,385,792.77	6,865,488.69
Dingle	608,737.64	13,077,014.43	9,816,825.52	8,581,246.62
Glenflesk	24,361.84	523,345.47	523,345.47	219,559.67
Killarney	187,553.59	4,029,060.81	2,744,263.75	1,659,565.74
Milltown	11,729.33	251,971.73	251,971.74	177,697.30
Portmagee	9,706.75	208,522.30	208,522.30	201,707.66

It is clear from Table 8.16 that there are low potential damages in Glenflesk, Milltown and Portmagee with a corresponding low benefit for implementing a scheme.

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		
Castleisland		
Glenshearoon	Rain gauges River level gauges	7,889.97
Upper Maine	Rain gauges River level gauges	1,451,147.58
Dingle (Fluvial)		
Dingle Stream	Unlikely to be effective due to short time to peak	1,282,813.89
Mill River	Rain gauges River level gauges	104,689.04
Dingle (Tidal)	Use the existing OPW storm surge forecasting system to predict high tide levels	312,508.95
Glenflesk	Rain gauges River level gauges	68,034.91
Killarney	Rain gauges River level gauges	523,777.91
Milltown	Unlikely to be effective due to small steep catchment with short time to peak	32,756.32
Portmagee	Use the existing OPW storm surge forecasting system to predict high tide levels	27,107.90

Source: UoM 22 Hydraulics Report

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			
Castleisland			
Glenshearoon	2 Nr. Rain Gauges 2 Nr. River Level Gauges (Hydrometric Station)	7,889.97	550,115.00
Upper Maine	5 Nr. Rain Gauges 4 Nr. River Level Gauges (Hydrometric Station)	1,451,147.58	742,654.00
Dingle (Mill River)	2 Nr. Rain Gauges 2 Nr. River Level Gauges (Hydrometric Station)	104,689.04	546,295.00
Dingle (Tidal)	Use the existing OPW storm surge forecasting system to predict high tide levels	312,508.95	< 100k
Glenflesk	3 Nr. Rain Gauges 4 Nr. River Level Gauges (Hydrometric Station)	68,034.91	671,729.00
Killarney	6 Nr. Rain Gauges 9 Nr. River Level Gauges (Hydrometric Station) (includes gauges covered by Glenflesk)	523,777.91	981,764.00
Portmagee	Use the existing OPW storm surge forecasting system to predict high tide levels	27,107.90	< 27k

From Table 9.1 it can be seen that flood forecasting is not a viable measure for the Glenshearoon River in Castleisland, the Mill River in Dingle or along the River Flesk in Glenflesk and Killarney.

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

Spatial Scale of Assessment	Option	Estimated Cost / €	Benefit of Scheme €
AFA			
Castleisland	Flood Defences	18,708,896.66	7,763,804.46
	Flood Defences & Flow Diversion	17,680,272.85	
	Flow Diversion & Western Flood Defences	5,204,062.90	6,865,488.69
Dingle	Storage & Flood Defences	4,212,790.63	8,581,246.62
	Flow Diversion & Flood Defences	11,644,122.22	
	Flood Defences	15,995,881.43	
Glenflesk	Flood Defences	251,720.87	219,559.67
Killarney	Flood Defences	1,315,190.38	1,659,565.74
Milltown	Flood Defences	859,174.77	177,697.30
	Flow Diversion & Flood Defences	1,454,168.03	

From Table 9.2 it can be seen that structural FRM options are not cost beneficial in Glenflesk and Milltown.

In relation to Castleisland AFA there is only one structural FRM option that is cost beneficial (i.e. Option 3 – Flow Diversion & Western Flood Defences). This option was developed after the PCD based on feedback received from the public and the Local Authority. It should be noted that this option only mitigates the flood risk for the design event in the Tullig area and in localised areas around Castleisland town. This option was developed as there is significant risk and benefit in the Tullig area. The economic benefit cannot be achieved if all areas in the Castleisland AFA are to be protected. This option was hydraulically modelled and does not result in an increase in flood extent or depth in the undefended areas.

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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	Castleisland	Dingle	Glenflesk	Killarney	Milltown	Calculation Method
1(a)(i)	5	5	5	5	5	Constant
1(b)(i)	5	5	5	5	5	Constant
1(c)(i)	5	5	5	5	5	Constant
2(a)(i)	5	5	0.2	3.12	0.1	AAD / €75,000
2(b)(i)	5	5	5	5	5	Based on calculated assessment, adjusted by professional judgement
2(c)(i)	0.25	0	0	0	0	Based on calculated assessment, adjusted by professional judgement
2(d)(i)	1.88	1.88	4.46	2.5	4.5	By professional judgement assisted by local advice
3(a)(i)	5	5	0.41	0.74	0.77	Based on calculated assessment, adjusted by professional judgement
3(a)(ii)	0	0	0	0	0	Based on calculated assessment, adjusted by professional judgement
3(b)(i)	0.65	4.28	0.25	2.5	0.25	Based on calculated assessment, adjusted by professional judgement
3(b)(ii)	5	5	1.27	3.77	1.7	Based on calculated assessment, adjusted by professional judgement
4(a)(i)	5	5	5	5	5	Constant
4(b)(i)	0	2	5	5	5	By professional judgement assisted by local advice
4(c)(i)	4	3	5	5	2	By professional judgement assisted by local advice
4(d)(i)	4	1	3	4	2	By professional judgement assisted by local advice
4(e)(i)	1	3	1	5	4	By professional judgement assisted by local advice
4(f)(i)	1	3	1	3	1	By professional judgement assisted by local advice
4(f)(ii)	1	1	0	3	1	By professional judgement assisted by local advice

Source: GN 28

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 22 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 Ration. 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
Castleisland							
Do Nothing	-	-	0.00	0.00	0.00	0.00	4
Flood Defences	18,708,896.66	7,763,804.46	1013.46	2113.46	54.17	0.41	2
Flood Defences & Flow Diversion	17,680,272.85	7,763,804.46	909.46	1834.46	51.44	0.44	3
Flow Diversion & Western Defences	5,204,062.90	6,865,488.69	497.38	1422.38	95.57	1.32	1
Dingle							
Do Nothing	-	-	-95.00	-95.00	0.00	0.00	4
Storage & Flood Defences	4,212,790.63	8,581,246.62	522.37	1422.37	124.00	2.04	1
Flow Diversion & Flood Defences	11,644,122.22	8,581,246.62	473.37	1173.37	40.65	0.74	2
Flood Defences	15,995,881.43	8,581,246.62	520.37	1270.37	32.53	0.54	3
Glenflesk							
Do Nothing	-	-	0.00	0.00	0.00	0.00	2
Flood Defences	251,720.87	219,559.67	-261.44	988.56	-1038.60	0.87	1
Killarney							
Do Nothing	-	-	-364.00	-364.00	0.00	0.00	2
Flood Defences	1,315,190.38	1,659,565.67	419.50	1269.50	318.96	1.26	1
Milltown							
Do Nothing	-	-	0.00	0.00	0.00	0.00	2
Flood Defences	859,174.77	177,697.30	-181.59	818.41	-211.35	0.21	1
Flow Diversion & Flood Defences	1,454,168.03	177,697.30	-283.59	516.41	-195.02	0.12	3

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
Castleisland	Flood Defences	2	1
	Do Nothing	0	2
Dingle	Storage & Flood Defences	3	1
	Flow Diversion & Flood Defences	1	2
	Flood Defences	0	3
	Do Nothing	0	4
Glenflesk	Planning & Development Control	1	4
	Building Regulations	1	6
	Flood Forecasting	0	4
	Emergency Response Procedures	5	1 (tied)
	Targeted Public Awareness	0	7
	Individual Property Flood Resilience	0	3
	Land Use Management	3	1 (tied)
Killarney	Flood Defences	4	1
	Do Nothing	0	2
Milltown	Planning & Development Control	-	-
	Building Regulations	-	-
	Flood Forecasting	-	-
	Emergency Response Procedures	-	-
	Targeted Public Awareness	-	-
	Individual Property Flood Resilience	-	-
	Land Use Management	-	-

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 Castleisland

The preferred option for Castleisland as identified in the MCA is Flow Diversion & Western Flood Defences. This option was developed after the PCD based on feedback received from the public and the Local Authority. It should be noted that this option only mitigates the flood risk for the design event in the Tullig area and in localised areas around Castleisland town. This option was developed as there is significant risk and benefit in the Tullig area. The economic benefit cannot be achieved if all areas in the Castleisland AFA are to be protected.

11.2.2.2 Dingle

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

11.2.2.3 Glenflesk

The preferred option identified in the MCA is Flood Defences. However, the preferred option is not cost beneficial. A range of non-structural measures were considered and put on display at the Glenflesk PCD. The feedback provided at the PCD indicated that the public's preference is for a combination of Emergency Response Procedures and Land Use Management.

11.2.2.4 Killarney

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

11.2.2.5 Milltown

The preferred option identified in the MCA is Flood Defences. However, the preferred option is not cost beneficial. A range of non-structural measures were considered and put on display at the Milltown PCD. There was no feedback received at the PCD. A range of non-structural measures as outlined for the UoM should be adopted. These should include planning control, land use management, emergency response procedures and public awareness.