



# SWRBD CFRAM Study

Inception Report - Unit of Management 22

September 2013  
Office of Public Works



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Office of Public Works

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# 1. Introduction

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. In order to assess and develop a Flood Risk Management Plan (FRMP) 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, the OPW have commissioned a number of Catchment Flood Risk Assessment and Management (CFRAM) Studies.

Mott MacDonald Ireland Ltd. has been appointed by the OPW to undertake the CFRAM Study for the South Western River Basin District. Under the project, Mott MacDonald 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 Aims and Objectives

The objectives of this Project are to:

- Identify and map the existing and potential future flood hazard within the Study Area.
- Assess and map the existing and potential future flood risk within the Study Area.
- Identify viable structural and non-structural options and measures for the effective and sustainable management of flood risk in the Areas for Further Assessment Risk (AFA's) and within the Study Area as a whole.
- Prepare a FRMP for each Unit of Management within the Study Area, and associated Strategic Environmental and, as necessary, Habitats Directive (Appropriate) Assessment, that sets out the policies, strategies, measures and actions that should be pursued by the relevant bodies, including the OPW, Local Authorities and other Stakeholders, to achieve the most cost-effective and sustainable management of existing and potential future flood risk within the Study Area, taking account of environmental plans, objectives and legislative requirements and other statutory plans and requirements.

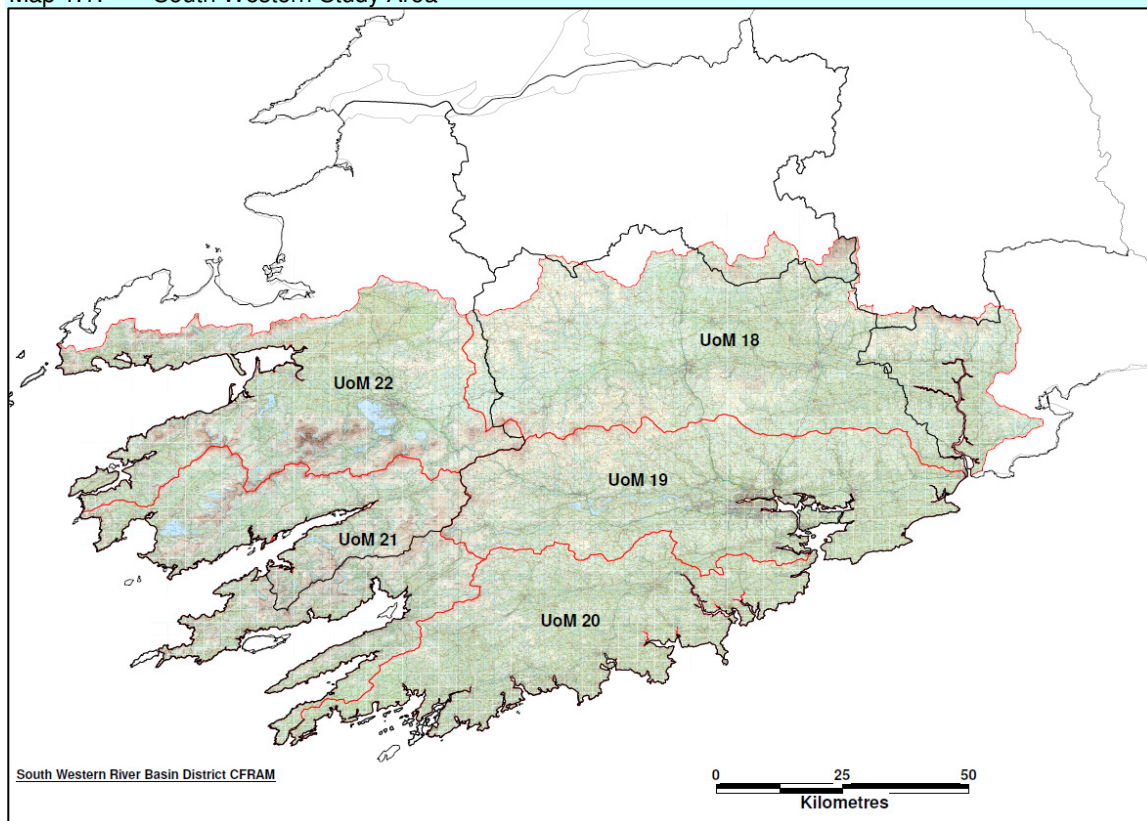
## 1.2 Description of the South Western Study Area

The South Western River Basin District (SWRBD), which forms the Study Area, covers an area of approximately 11,160 km<sup>2</sup>. 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. In total, 6 Local Authorities administer the regions within the Study Area: Cork County Council, Cork City Council, Kerry County Council, Waterford County Council, South Tipperary County Council and Limerick County Council. Much of the Study Area is rural and the predominant land usage is agriculture. The Study Area contains Cork City (pop. 119,418) and a number of other large towns such as Killarney (pop. 13,497), Mallow (pop. 7,864) and Bandon (pop. 6,640).

The Study Area includes the rivers, Munster Blackwater, Lee, Bandon, Maine, Laune, their associated tributaries, and a large number of smaller coastal catchments. There are five Units of Management within the Study Area, which are listed below:

- Unit of Management 18
- Unit of Management 19
- Unit of Management 20
- Unit of Management 21
- Unit of Management 22

Map 1.1: South Western Study Area



The Study includes 26 Nr. Areas for Further Assessment (AFA's) which are listed in Table 1.1 below.

Table 1.1: Areas for Further Assessment (AFAs)

| UoM | Name                 | Unique ID | Fluvial | Coastal | County    | Easting | Northing |
|-----|----------------------|-----------|---------|---------|-----------|---------|----------|
| 18  | Aglish               | 180247    | Yes     | No      | Waterford | 212250  | 91500    |
| 18  | Ballyduff            | 180248    | Yes     | No      | Waterford | 196500  | 99500    |
| 18  | Fermoy               | 180252    | Yes     | No      | Cork      | 182750  | 99500    |
| 18  | Freemount            | 180253    | Yes     | No      | Cork      | 139500  | 114250   |
| 18  | Kanturk              | 180254    | Yes     | No      | Cork      | 138250  | 102750   |
| 18  | Mallow               | 180262    | Yes     | No      | Cork      | 155250  | 98500    |
| 18  | Rathcormac           | 180265    | Yes     | No      | Cork      | 181750  | 91000    |
| 18  | Tallow               | 180266    | Yes     | No      | Waterford | 199750  | 93750    |
| 18  | Youghal              | 180267    | Yes     | Yes     | Cork      | 210250  | 78750    |
| 19  | Killeagh             | 190274    | Yes     | No      | Cork      | 200750  | 75750    |
| 19  | Castlemartyr         | 190277    | Yes     | No      | Cork      | 196250  | 73250    |
| 19  | Ballingeary          | 195499    | Yes     | No      | Cork      | 115090  | 67135    |
| 20  | Clonakilty           | 200294    | Yes     | Yes     | Cork      | 138000  | 41250    |
| 20  | Dunmanway            | 200297    | Yes     | No      | Cork      | 122250  | 52750    |
| 20  | Inishannon           | 200298    | Yes     | No      | Cork      | 155000  | 57000    |
| 20  | Schull               | 200303    | Yes     | No      | Cork      | 92500   | 31500    |
| 21  | Bantry               | 210307    | Yes     | Yes     | Cork      | 99750   | 48500    |
| 21  | Castletown Bearhaven | 210308    | No      | Yes     | Cork      | 68000   | 46000    |
| 21  | Durrus               | 210309    | Yes     | No      | Cork      | 95000   | 42000    |
| 21  | Kenmare              | 210312    | Yes     | Yes     | Kerry     | 90750   | 70500    |
| 22  | Castleisland         | 220323    | Yes     | No      | Kerry     | 97750   | 110000   |
| 22  | Dingle               | 220327    | Yes     | Yes     | Kerry     | 44500   | 101000   |
| 22  | Glenflesk            | 225502    | Yes     | No      | Kerry     | 106621  | 85316    |
| 22  | Killarney            | 220337    | Yes     | No      | Kerry     | 97000   | 90500    |
| 22  | Milltown             | 220339    | Yes     | No      | Kerry     | 82500   | 101000   |
| 22  | Portmagee            | 220340    | No      | Yes     | Kerry     | 36500   | 73000    |

This report outlines how Mott MacDonald proposes to carry out the South Western RBD CFRAM study in respect of the AFAs and the MPWs in **Unit of Management 22**, the Laune-Maine-Dingle Bay Catchment.

### 1.3 Unit of Management 22

Unit of Management 22, which forms part of the SWRBD, covers an area of approximately 2,031km<sup>2</sup>. The large majority of the area is in County Kerry with parts in County Cork. The main rivers within UoM 22 are the Maine, the Flesk and the Laune. UoM 22 also has a number of large lakes including Lough Leane and Muckross Lake.

### 1.4 Areas for Further Assessment

Unit of Management 22 contains six Areas for Further Assessment (AFAs). These are listed in Table 1.2 below. Associated with the AFA's is over 134km of high and medium priority watercourse. Further details are provided in Section 4.0.

Table 1.2: Areas for Further Assessment within Unit of Management 18

| UoM | Name         | Unique ID | Fluvial | Coastal | County | Easting | Northing |
|-----|--------------|-----------|---------|---------|--------|---------|----------|
| 22  | Castleisland | 220323    | Yes     | No      | Kerry  | 97750   | 110000   |
| 22  | Dingle       | 220327    | Yes     | Yes     | Kerry  | 44500   | 101000   |
| 22  | Glenflesk    | 225502    | Yes     | No      | Kerry  | 106621  | 85316    |
| 22  | Killarney    | 220337    | Yes     | No      | Kerry  | 97000   | 90500    |
| 22  | Milltown     | 220339    | Yes     | No      | Kerry  | 82500   | 101000   |
| 22  | Portmagee    | 220340    | No      | Yes     | Kerry  | 36500   | 73000    |

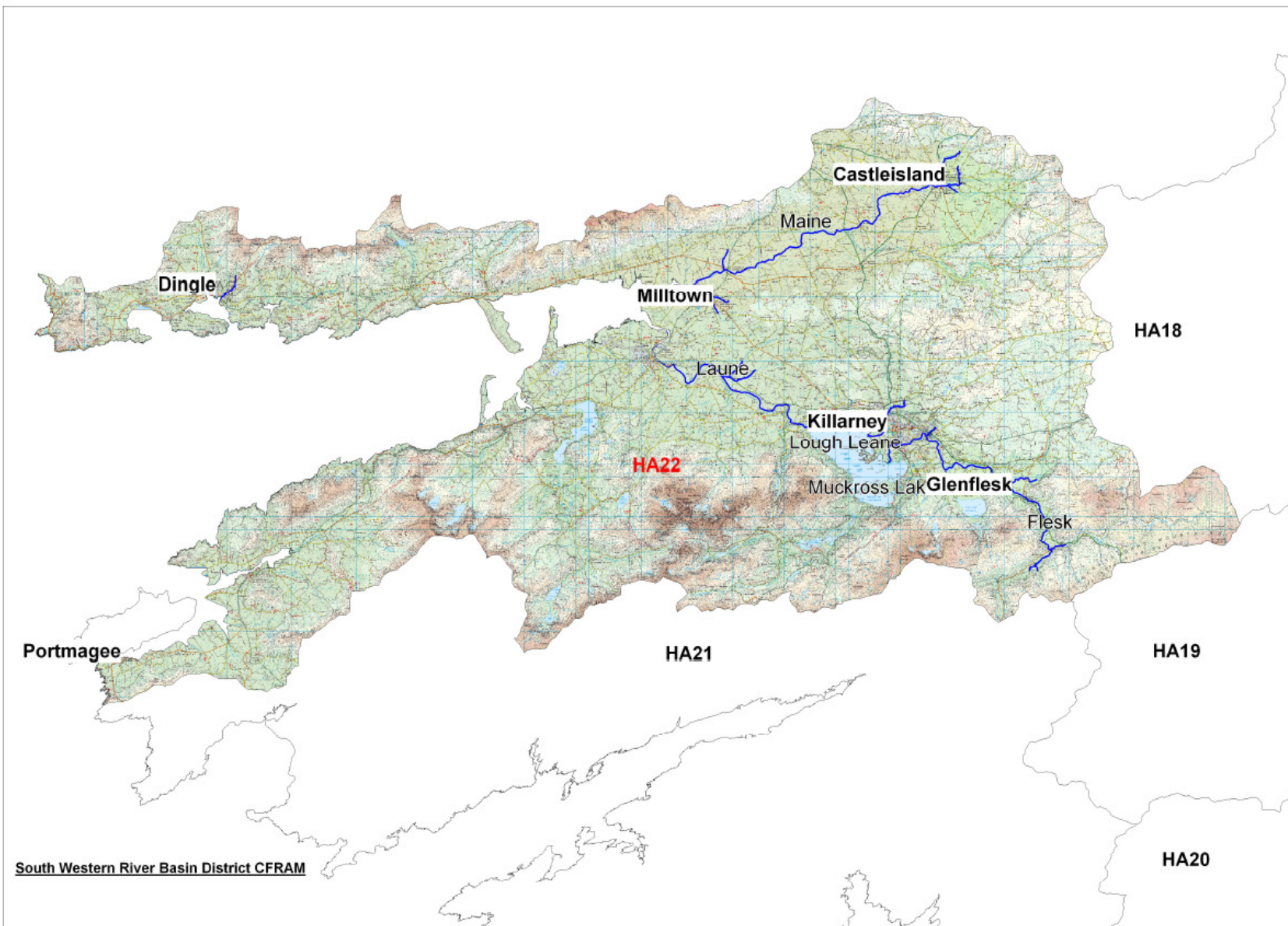
### 1.5 SW CFRAMs Project Delivery

The CFRAM programme is split up into four key steps that have to be completed by certain deadlines. These deadlines are set out in the European Communities (Assessment and Management of Flood Risks) Regulations of 2010 (SI 122/2010). These are;

- The Preliminary Flood Risk Assessment (PFRA) – Completed December 2011
- Flood Risk Review – Completed December 2011
- Flood Risk Mapping – To be completed by December 2013
  - This involves the mapping of areas that are at significant risk from flooding. The maps will show the extent of flooding likely, how deep the water could get and how fast the water will flow.
- Flood Risk Management Plans – To be completed by December 2015
  - This involves the development of flood risk management options to mitigate the risk of damage resulting from flooding in areas at significant risk. The options considered could include the construction of flood walls or embankments, the installation of a flood warning system or the use of catchment management techniques to reduce the risk from flooding.



Map 1.2: Unit of Management 22



## 2. Data Availability and Requirements

### 2.1 Data Collection

This section details the data collected and highlights any data that is currently outstanding or unavailable.

### 2.2 Hydrometric Data

Hydrometric data for river flow and level gauges in UoM 22 was provided by OPW and the EPA. Table 2.1 summarises the available hydrometric gauges from both OPW and EPA.

Table 2.1: Available Hydrometric Gauges

| Type                                       | OPW gauges | EPA gauges (operated by Kerry County Council ) | Total Gauges Available |
|--|------------|--|------------------------|
| River Flow and Water Level Gauges          | 7          | 3  | 20                     |
| River Level Gauges                         | 3          | 5  | 8                      |
| River Flow and Level Observation Locations | 0          | 16   | 16                     |

River level data is available from 1973 to 2012 within UoM 22. However, only 2 river level gauges have records over 10 years. The river level gauges have recorded water level at 15 minute intervals using telemetry since 2000 to 2003 (dependent on gauge site). All water level records prior to this were recorded on an irregular basis but do capture peak levels. The river levels gauges will be used to inform the calibration of the hydraulic models and extreme lake levels for Lough Leane. The data quality and coverage has been reviewed in Chapter 4 of this report.

River flow data is available from 1947 to 2012 in UoM 22. There are 6 river flow and water level gauges with records over 10 years. Flesk Bridge gauge (22006) on the River Flesk has the longest flow records dating from 1947 to present. Since 2000 to 2003 all river flow gauges have recorded flows at 15 minute intervals via telemetry. For gauges installed prior to 2000, flows were recorded at irregular intervals up to 2000 although peak flows were captured. The river flow data will be used to inform the derivation of design flows. Therefore, the data quality and coverage of the key flow gauges has been reviewed in Chapter 4 of this report.

EPA has also provided spot river flow and level measurements which are observed manually on a regular basis (2 to 8 measurements per year). These spot gaugings are often observed during periods of low flow to monitor water resource and environmental demands as well as to minimise health and safety risks. It is not appropriate to use these observations in the analysis of high flows for UoM 22. Therefore, these spot gaugings have not been taken forward to the preliminary hydrological assessment in Chapter 4.



## 2.3 Meteorological Data

Meteorological data for rainfall gauges in and around UoM 22 was provided by Met Éireann and OPW. Table 2.2 summarises the available meteorological gauges.

Table 2.2: Available Rainfall Gauges

| Type   | Met Éireann gauges | OPW gauges | Total Gauges Available |
|--|--------------------|------------|------------------------|
| Daily Rainfall Gauges  | 86                 | 0          | 18                     |
| Synoptic Stations (weather forecasting locations including rainfall) | 1                  | 0          | 1                      |

There are 14 daily rain gauges which have data over 10 years with the longest data record at Valentia (146 years of rainfall records). The Valentia rain gauge also provides more detailed hourly rainfall data from 1939 to present (73 years' record). Chapter 4 of this report provided further analysis of the rainfall data coverage, quality and suitability for derivation of design rainfall.

## 2.4 Coastal Data

There was no observed sea level data available for UoM 22. The Irish Coastal Protection Strategy Study (ICPSS) data has been approved by OPW for use in the South Western CFRAM models. The extreme sea levels will be used to define the magnitude of the tidal events in Dingle Bay.

The Irish Coastal Water Level and Wave Study (ICWWS) will also provide extreme water level and wave conditions at Dingle and within Castlemaine Harbour at Inch Beach and Tullig. This will inform the assessment of the water level profile as discussed in Section 5.2.

Further analysis of data coverage, quality and suitability of coastal data can be found in Chapter 4 of this report.

## 2.5 Survey Data (including LIDAR & IFSAR)

Chapter 3 outlines the required survey data which is being procured under Survey Contract 5 which is currently underway. However, final delivery dates are not yet clear due to issues with Fresh Water Pearl Mussels. IFSAR data has been provided.

## 2.6 Environmental Data

An extensive range of environmental and land use information has been gathered for use in the study. We shall draw upon this information for the purpose of meeting our project deliverables. The data will be used to inform environmental site surveys, to cross compare Water Framework Directive and Flood Studies Update catchment boundaries, to inform the Strategic Environmental Assessment and Appropriate Assessment and as necessary to portray relevant information at public consultation. A list of the environmental data collected is contained in Table 2.3 below.

Table 2.3: Environmental Data

| Description  | Format | Owner                                | Date       | Fitness for purpose / Quality |
|--|--------|--------------------------------------|------------|-------------------------------|
| Abstractions   | GIS    |                                      | 17/12/2009 | Fit For Purpose               |
| Alien Species  | GIS    | NPWS                                 | 12/05/2005 | Needs to be updated           |
| Aquaculture Sites (Licensed)                                   | GIS    | -                                    | 22/12/2009 | Fit For Purpose               |
| Artificial Water Bodies  | GIS    | SWRBD                                | 23/10/2008 | Fit For Purpose               |
| Bat Roosts in South West                                       | GIS    | NPWS                                 | 03/01/2012 | Fit For Purpose               |
| Coastal Water Body Status (as per RBMP)                        | GIS    | EPA                                  | 17/02/2010 | Fit For Purpose               |
| Combined Sewer Overflows                                       | GIS    | EPA                                  | 01/03/2005 | Needs to be updated           |
| Corine 2006  | GIS    | EPA                                  | 03/09/2009 | Fit For Purpose               |
| Ecological Information - confidential information              | GIS    | NPWS                                 | 05/04/2012 | Needs to be updated           |
| EPA Biological Stations (Q Stations)                           | GIS    | EPA                                  | 16/11/2005 | Needs to be updated           |
| EPA Waste facilities (including landfills)                     | GIS    | EPA                                  | 20/04/2012 | Fit For Purpose               |
| Fresh Water Pearl Mussel                                       | GIS    | NPWS                                 | 12/05/2005 | Needs to be updated           |
| FWPM SAC   | GIS    | NPWS                                 | 19/08/2009 | Needs to be updated           |
| Groundwater Bodies   | GIS    | EPA                                  | 02/02/2008 | Fit For Purpose               |
| Groundwater Body Status (as per RBMP)                          | GIS    | EPA                                  | 17/02/2010 | Fit For Purpose               |
| Groundwater Monitoring Stations                                | GIS    | EPA                                  | 22/03/2007 | Fit For Purpose               |
| Groundwater Status   | list   | RPS                                  | 17/02/2010 | Fit For Purpose               |
| Heavily Modified Water Bodies                                  | GIS    | SWRBD                                | 12/12/2008 | Fit For Purpose               |
| IPPC Licenses  | GIS    | EPA                                  | 20/04/2012 | Fit For Purpose               |
| Lake Status  | list   | RPS                                  | 17/02/2010 | Fit For Purpose               |
| Lake Topography & Bathymetry                                   | GIS    | SWRBD                                | 26/06/2008 | Fit For Purpose               |
| Lake Water Bodies  | GIS    | EPA                                  | 04/05/2005 | Fit For Purpose               |
| Lake Water Body Status (as per RBMP)                           | GIS    | EPA                                  | 17/02/2010 | Fit For Purpose               |
| Landscape  | pdf    | -                                    | 02/12/2011 | Needs to be updated           |
| License Aquaculture  | GIS    | -                                    | 12/12/2009 | Fit For Purpose               |
| Main Lakes   | GIS    | EPA                                  | 01/03/2003 | Fit For Purpose               |
| Mines  | GIS    | GSI                                  | 01/03/2005 | Fit For Purpose               |
| Monuments - Summary of Types in National Monuments Data Series | Excel  | OPW                                  | 02/12/2011 | Fit For Purpose               |
| NHA  | GIS    | NPWS                                 | 04/05/2005 | Needs to be updated           |
| Non-EPA Landfills  | GIS    | LA                                   | 01/03/2005 | Needs to be updated           |
| Quarries   | GIS    | LA's to start reporting in June 2010 | 01/03/2005 | Needs to be updated           |
| Recreational Waters  | GIS    | NPWS                                 | 19/07/2006 | Needs to be updated           |
| River Segments and Status                                      | list   | RPS                                  | 17/02/2010 | Fit For Purpose               |
| River Water Body Basin Polygons                                | GIS    | EPA                                  | 04/05/2005 | Fit For Purpose               |
| River Water Body Status (as per RBMP)                          | GIS    | EPA                                  | 17/02/2010 | Fit For Purpose               |
| River Waterbody Status   | list   | RPS                                  | 17/02/2010 | Fit For Purpose               |
| SAC  | GIS    | NPWS                                 | 16/03/2010 | Fit For Purpose               |

| Description  | Format    | Owner   | Date       | Fitness for purpose / Quality |
|--|-----------|---------|------------|-------------------------------|
| SAC Vulnerability Assessment - habitats & species assessment and overall site classification | Excel     | OPW     | 02/12/2011 | Fit For Purpose               |
| Salmonid Waters  | GIS       | NPWS    | 12/05/2002 | Needs to be updated           |
| SEA Background Information   | Excel     | OPW     | 02/12/2011 | Fit For Purpose               |
| SEA Background Information - AA EPA feedback   | pdf       | EPA     | 02/12/2011 | Fit For Purpose               |
| SEA Background Information - emails and feedback   | pdf       | EPA     | 02/12/2011 | Fit For Purpose               |
| SEA Background Information - emails and non-technical summary with review comments           | pdf, Word | OPW     | 02/12/2011 | Fit For Purpose               |
| SEA Background Information - EPA preliminary comments (17.05.10)                             | Word      | EPA     | 02/12/2011 | Fit For Purpose               |
| SEA Background Information - FEMFRAM Scoping Report comments from EPA                        | pdf       | EPA     | 02/12/2011 | Fit For Purpose               |
| SEA Background Information - NPWS comments on FEMFRAM AA                                     | pdf       | NPWS    | 02/12/2011 | Fit For Purpose               |
| SEA Background Information - Suir Scoping Report comments from EPA                           | pdf       | EPA     | 02/12/2011 | Fit For Purpose               |
| Section 4 Licenses   | GIS       | LA      | 20/04/2012 | Fit For Purpose               |
| Shellfish Designated Areas   | GIS       | DEHLG   | 27/04/2009 | Fit For Purpose               |
| Soils  | GIS       | Teagasc | 30/04/2006 | Fit For Purpose               |
| SPA  | GIS       | NPWS    | -          | Needs to be updated           |
| SPA Vulnerability Assessment - classification  | Excel     | OPW     | 02/12/2011 | Fit For Purpose               |
| Subsoils   | GIS       | Teagasc | 30/04/2006 | Fit For Purpose               |
| Surface Water Monitoring Stations  | GIS       | EPA     | 22/03/2007 | Fit For Purpose               |
| SWRBD Onsite Waste Water treatment systems   | GIS       | -       | 22/12/2009 | Fit For Purpose               |
| SWRBD Private Forestry   | GIS       | RPS     | 15/01/2010 | Fit For Purpose               |
| SWRBD Public Forestry  | GIS       | RPS     | 15/01/2010 | Fit For Purpose               |
| Trac Status  | list      | RPS     | 17/02/2010 | Fit For Purpose               |
| Transitional Water Bodies  | GIS       | EPA     | 04/05/2005 | Fit For Purpose               |
| Transitional Water Body Status (as per RBMP)   | GIS       | EPA     | 17/02/2010 | Fit For Purpose               |
| Waste Water Treatment Plants   | GIS       | EPA     | 04/11/2009 | Needs to be updated           |
| Water Treatment Plants   | GIS       | LA      | -          | Needs to be updated           |

## 2.7 Receptor Data

Extensive receptor data was gathered which when combined with the flood hazard will allow for determination of flood risk. A list of the receptor data is contained in Table 2.4 below.

Table 2.4: Receptor Data

| Category          | Description                                | Format              | Owner  | Date       | Fitness for purpose / Quality |
|-------------------|--|---------------------|--|------------|-------------------------------|
| Cultural Heritage | Monuments - National Datasets              | Mapinfo             | DEHLG  | 02/12/2011 | Fit For Purpose               |
| Cultural Heritage | Museum Directory                           | MapInfo, Excel      | IMA  | 02/12/2011 | Fit For Purpose               |
| Cultural Heritage | National Monuments - National Data Series  | Excel               | OPW  | 02/12/2011 | Fit For Purpose               |
| Cultural Heritage | NIAH Buildings - National Dataset          | Mapinfo             | NIAH   | 02/12/2011 | Fit For Purpose               |
| Economic          | Airports                                   | Mapinfo             | Irish Aviation Authority                                 | 02/12/2011 | Fit For Purpose               |
| Economic          | EPA Waste Facilities (including landfills) | GIS                 | EPA  | 20/04/2012 | Fit For Purpose               |
| Economic          | Harbours & Slips                           | GIS                 | SWRBD  | 09/05/2005 | Fit For Purpose               |
| Economic          | IPPC Licenses                              | GIS                 | EPA  | 20/04/2012 | Fit For Purpose               |
| Economic          | Mines                                      | GIS                 | GSI  | 01/03/2005 | Fit For Purpose               |
| Economic          | Non-EPA Landfills                          | GIS                 | LA   | 01/03/2005 |                               |
| Economic          | NRA Road Network (2010)                    | ESRI                | NRA  | 02/12/2011 | Fit For Purpose               |
| Economic          | Ports and Harbours in Ireland              | MapInfo, Excel, pdf | Department of Agriculture, Fisheries, Food and Transport | 02/12/2011 | Fit For Purpose               |
| Economic          | Quarries                                   | GIS                 | LA's to start reporting in June 2010                     | 01/03/2005 | Needs to be updated           |
| Economic          | Rail Network and Stations                  | AutoCAD             | Iarnród Éireann  | 02/12/2011 | Fit For Purpose               |
| Economic          | Section 4 Licenses                         | GIS                 | LA   | 20/04/2012 | Fit For Purpose               |
| Economic          | Utilities Data                             | MapInfo             | ESB, Bord Gais, Eircom                                   | 02/12/2011 | Fit For Purpose               |
| Economic          | WWTPs & WTPs Locations                     | MapInfo             | EPA  | 02/12/2011 | Needs to be updated           |
| Environmental     | Abstractions                               | GIS                 | -  | 17/12/2009 | Fit For Purpose               |
| Environmental     | Aquaculture Sites (Licensed)               | GIS                 | -  | 22/12/2009 | Fit For Purpose               |
| Environmental     | Bat Roosts in South West                   | GIS                 | NPWS   | 03/01/2012 | Fit For Purpose               |
| Environmental     | Fresh Water Pearl Mussel                   | GIS                 | NPWS   | 12/05/2005 | Needs to be updated           |
| Environmental     | FWPM SAC                                   | GIS                 | NPWS   | 19/08/2009 | Needs to be updated           |
| Environmental     | Groundwater Bodies                         | ESRI &              | EPA  | 02/12/2011 | Fit For Purpose               |

| Category      | Description   | Format             | Owner                   | Date       | Fitness for purpose / Quality           |
|---------------|---|--------------------|-------------------------|------------|---|
|               |   | Excel              |                         |            |   |
| Environmental | Licensed IPPC Facilities  | ArcView            | EPA / LA                | 02/12/2011 | Fit For Purpose                         |
| Environmental | Natural Heritage Areas  | Mapinfo            | NPWS                    | 02/12/2011 |   |
| Environmental | Outstanding Landscapes in Ireland                                 | pdf                |                         | 02/12/2011 | Fit For Purpose                         |
| Environmental | Proposed Natural Heritage Areas                                   | Mapinfo            | NPWS                    | 02/12/2011 | Needs to be updated                     |
| Environmental | Recreational Waters   | GIS                | NPWS                    | 19/07/2006 | Needs to be updated                     |
| Environmental | SAC   | GIS                | NPWS                    | 16/03/2010 | Needs to be updated                     |
| Environmental | SAC Habitats & Species Assessment and Overall Site Classification | Excel              | OPW                     | 02/12/2011 | Needs to be updated                     |
| Environmental | Salmonid Waters   | GIS                | NPWS                    | 12/05/2002 | Needs to be updated                     |
| Environmental | Shellfish Designated Areas  | GIS                | DEHLG                   | 27/04/2009 | Fit For Purpose                         |
| Environmental | SPA   | GIS                | NPWS                    | -          | Needs to be updated                     |
| Environmental | SPA - Classification  | Excel              | OPW                     | 02/12/2011 | Needs to be updated                     |
| Environmental | Special Areas of Conservation                                     | Mapinfo            | NPWS                    | 02/12/2011 | Needs to be updated                     |
| Environmental | Special Protection Areas  | Mapinfo            | NPWS                    | 02/12/2011 | Needs to be updated                     |
| Social        | Civil Defence HQ's  | Mapinfo, Word      | Department of Defence   | 02/12/2011 | Fit For Purpose                         |
| Social        | CSO 2006 Census   | Excel              | An Post GeoDirectory    | 02/12/2011 | Fit For Purpose will need to be updated |
| Social        | Fire Stations   | Mapinfo, Excel     | DEHLG                   | 02/12/2011 | Fit For Purpose                         |
| Social        | Garda Stations  | Mapinfo, Excel     | OPW                     | 02/12/2011 | Fit For Purpose                         |
| Social        | Geo-directory (July 2011)   | MS Access Database | An Post GeoDirectory    | 02/12/2011 | Fit For Purpose                         |
| Social        | Government Building under OPW                                     | Mapinfo, Excel     | OPW                     | 02/12/2011 | Fit For Purpose                         |
| Social        | Health Centres  | Mapinfo, Excel     | HSE                     | 02/12/2011 | Fit For Purpose                         |
| Social        | Hospitals   | Mapinfo, Excel     | HSE                     | 02/12/2011 | Fit For Purpose                         |
| Social        | Nursing Homes   | Mapinfo, Excel     | HSE                     | 02/12/2011 | Fit For Purpose                         |
| Social        | Post Primary Schools  | MapInfo            | Department of Education | 02/12/2011 | Fit For Purpose                         |
| Social        | Primary Schools   | MapInfo            | Department of Education | 02/12/2011 | Fit For Purpose                         |

| Category | Description                             | Format         | Owner                      | Date       | Fitness for purpose / Quality |
|----------|---|----------------|----------------------------|------------|-------------------------------|
| Social   | Public Residential Care for The Elderly | Mapinfo, Excel | HSE                        | 02/12/2011 | Fit For Purpose               |
| Social   | Third Level Institutions                | Mapinfo        | Higher Education Authority | 02/12/2011 | Fit For Purpose               |

## 2.8 Flood Event Data

A significant amount of flood event data has been identified and collected from a number of sources. These sources include the OPW Floodmaps website, Local Authorities and other stakeholders. All flood event data including maps, photographs and reports has been downloaded from floodmaps.ie and all available reports and studies from Local Authorities and stakeholders gathered. In addition to the above, flood event data and information was also gathered during the Flood Risk Review stage and following specific Flood Event Reviews. This information / data includes anecdotal evidence and testimonials from landowners, locals etc. A summary list of flood event data sources used is contained in Table 2.5 below.

Table 2.5: Flood Event Data

| Description                       | Format         | Owner | Date       | Fitness for purpose / Quality                               |
|-----------------------------------|----------------|-------|------------|---|
| Flood Data Collection             | Excel          | OPW   | 02/12/2011 | Professional judgement should be applied to the use of data |
| Historical Flood Data             | MapInfo, Excel | OPW   | 02/12/2011 | Professional judgement should be applied to the use of data |
| PFRA Groundwater Flooding Reports | pdf            | OPW   | 02/12/2011 | Professional judgement should be applied to the use of data |
| Cork – New PFRA data              | pdf            | OPW   | 08/02/2012 | Fit for purpose   |
| Waterford – New PFRA data         | pdf            | OPW   | 08/02/2012 | Fit for purpose   |
| Flood Risk Review Reports         | MS Word        | OPW   | 01/02/2012 | Fit for purpose   |
| Flood Event Review Reports        | Excel / pdf    | OPW   | Ongoing-   | Professional judgement should be applied to the use of data |

## 2.9 Flood Defence Asset Data

Data relevant to flood defence assets, which includes data used to identify and locate flood defence assets within AFAs, MPWs and HPWs, has been gathered. A list of the relevant flood defence asset data is contained in Table 2.6 below. This data does not represent the survey requirements for flood defence assets and as stated, contains data used only in identifying and locating defence assets.

Table 2.6: Relevant Flood Defence Asset Data

| Description  | Format    | Owner | Date       | Fitness for purpose / Quality |
|--|-----------|-------|------------|-------------------------------|
| Dredged Area                                       | GIS       | SWRBD | 09/05/2005 | Fit for purpose               |
| HDTM (20m resolution hydrologic correction to DTM) | GIS files | EPA   | 02/12/2011 | Fit for purpose               |

| Description                    | Format          | Owner     | Date       | Fitness for purpose / Quality     |
|--------------------------------|-----------------|-----------|------------|-----------------------------------|
| Lakes                          | MapInfo         | EPA       | 02/12/2011 | Fit for purpose                   |
| Marine Embankments             | GIS             | SWRBD     | 01/04/2008 | Fit for purpose                   |
| Marine Shoreline Reinforcement | GIS             | SWRBD     | 15/04/2008 | Fit for purpose                   |
| NDHM (5m resolution IFSAR)     | MapInfo         | OPW       | 02/12/2011 | Fit for purpose                   |
| Omitted Watercourses           | MapInfo         | JBA       | 02/12/2011 | Fit for purpose                   |
| OPW Benefiting Lands           | MapInfo         | OPW       | 02/12/2011 | Fit for purpose                   |
| OPW Channels                   | MapInfo         | OPW       | 02/12/2011 | Fit for purpose                   |
| OPW Embankments                | MapInfo         | OPW       | 02/12/2011 | Fit for purpose                   |
| OSi Maps                       | Mapinfo         | OPW       | 02/12/2011 | Fit for purpose                   |
| PFRA Breakdown                 | MapInfo         | OPW       | 02/12/2011 | Fit for purpose                   |
| PFRA Combined Point Receptors  | MapInfo         | Various   | 02/12/2011 | Fit for purpose                   |
| PFRA Final Database            | Access, MapInfo | OPW       | 02/12/2011 | Fit for purpose                   |
| PFRA Pluvial Screening         | pdf             | OPW       | 02/12/2011 | Fit for purpose                   |
| River Centrelines              | ESRI            | OPW (FSU) | 02/12/2011 | Generally OK. Some discrepancies. |
| Tidal Barrages                 | GIS             | SWRBD     | 09/05/2005 | Fit for purpose                   |

## 2.10 Outstanding Data

Table 2.7 lists the outstanding data that is required for the detailed hydrological and hydraulic assessments.

Table 2.7: Outstanding Data for UoM 22

| Type   | Location                       | Comments   | Source  | Required by | Impact of non provision of data  |
|--|--------------------------------|--|---|-------------|--|
| ICWWS Water Level and Wave Overtopping Data  | Dingle and Castlemaine Harbour | Stage 2 of ICWWS : Water level, $H_{m0}$ , $T_m$ and mean wave direction for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEP events | Irish Coastal Water Level and Wave Study, OPW | 08/02/2013  | Less accurate techniques will be used to predict extreme sea levels. This will have a cost implication |
| Glenflesk HEC RAS model Kerry County Council | Glenflesk                      | 100yr water level and peak flow results and underlying survey can be used for reference in the main stage                            | Kerry County Council                          | 15/03/2013  | No impact  |
| Killarney Area Source Meeting                | Killarney                      | Map to accompany minutes identifying locations subject to flooding   | www.floodmaps.ie                              | 10/07/2012  | Less accurate data will be used to calibrate model.  |

## 2.11 Unavailable Data

Table 2.8 lists the hydrometric data that is not available for the South West CFRAMs and how these data gaps will be overcome in the hydrological assessment.

Table 2.8: Unavailable Hydrometric Data for UoM 22

| Data Type  | Impact  | Proposed Mitigation  |
|--|---|--|
| Observed tidal curves  | Limits accuracy of tidal overtopping volume, duration of flooding and progression of tidal events up the River Blackwater | Derive astronomic tidal curves from Admiralty Tide Predictions   |
| Observed surge profiles/residuals  |   | Derive simple surge profile based on existing studies and local knowledge of surge duration  |
| Observed water level data in Portmagee Channel   | Overestimation of water level based on open water calculations  | Estimate water level variation between ICPSS calculated points in Dingle Bay and the predicted tidal levels at Knights Town in Portmagee Channel for the annual tidal flood. |
| Observed water level data within Castlemaine Harbour                                     | Underestimation of water levels as estuarine effects not considered   | Use ICWWS analysis of extreme water level, gauge data at Castlemaine and predicted tide points to develop a representative water level profile.                              |
| Long term river flow data in Milltown, lower reaches of the River Maine and River Laune. | Limits accuracy of design hydrology and potential pivotal sites within UoM 22   | Use hydrologically similar gauged site from beyond UoM 22 to extent gauge record and derivation of design peak flows at ungauged subject sites.                              |



## 3. Survey Requirements

### 3.1 River Channel Survey

The Survey Requirements for Unit of Management 22 are detailed in Table 3.1 below. These include the survey of a total of 605 river cross sections, approximately 226 linear kilometres of flood defence assets and approximately 134km of water courses. This total for flood defence assets includes channel drainage schemes. We will agree with OPW if Channel Schemes are considered as flood defences.

The required survey information will be gathered as part of Survey Contract Nr. 5 which is currently underway. However, final delivery dates are not yet clear due to issues with Fresh Water Pearl Mussels.

Table 3.1: Survey Requirements within Unit of Management 22

| Description                                    | Units      | UoM 22       |
|--|------------|--------------|
| <b>Total Nr. Cross Sections</b>                | <b>Nr.</b> | <b>605</b>   |
| upstream node at a junction                    | Nr.        | 1            |
| downstream node at a junction                  | Nr.        | 56           |
| conduit section                                | Nr.        | 0            |
| upstream node at a bridge                      | Nr.        | 70           |
| downstream node at a bridge                    | Nr.        | 46           |
| extended cross section                         | Nr.        | 0            |
| upstream node at a floodplain section          | Nr.        | 0            |
| downstream node at a floodplain section        | Nr.        | 3            |
| open channel                                   | Nr.        | 390          |
| upstream node at a culvert inlet\outlet unit   | Nr.        | 14           |
| downstream node at a culvert inlet\outlet unit | Nr.        | 9            |
| lateral spill on the left bank                 | Nr.        | 0            |
| upstream node at an orifice                    | Nr.        | 0            |
| downstream node at an orifice                  | Nr.        | 0            |
| lateral spill on the right bank                | Nr.        | 0            |
| upstream node at a spill                       | Nr.        | 2            |
| downstream node at a spill                     | Nr.        | 0            |
| upstream node at a weir                        | Nr.        | 10           |
| downstream node at a weir                      | Nr.        | 4            |
| <b>Total Linear Flood Defences</b>             | <b>km</b>  | <b>226.1</b> |
| Identified (including Channel Schemes)         | km         | 226.1        |
| Possible                                       | km         | 0.0          |
| <b>Total Length of Watercourse</b>             | <b>km</b>  | <b>134.7</b> |
| HPW  | km         | 32.0         |
| MPW  | km         | 102.7        |

### 3.2 Floodplain Survey

The floodplain survey includes level and location data for the floodplains of the relevant reaches of the channels in the study area. This survey is necessary for the construction of a hydraulic model adequate to meet the objectives of the study. The floodplain survey will be in the form of DTM and, or, DEM data derived from a survey using LIDAR or similar systems.

This data is to be provided by OPW. Following receipt of the data the survey will be reviewed and assessed to determine if the data is fit for purpose and compatible with the modelled schema.

### 3.3 Flood Defence Asset Condition Survey

The flood defence asset condition survey is a condition survey of all flood defences identified within AFA's and all defined flood defences along MPW's or in coastal areas. The survey includes the identification, inspection, photographing and assessment of flood defence assets and the entry of all relevant data into the Defence Asset Database. Details of the location and type of flood defence assets to be surveyed as part of the CFRAM Study are contained in a GIS database file entitled SWCFRAM\_Flood\_Defence\_Assets. This file will be made available to the Study team along with this report.

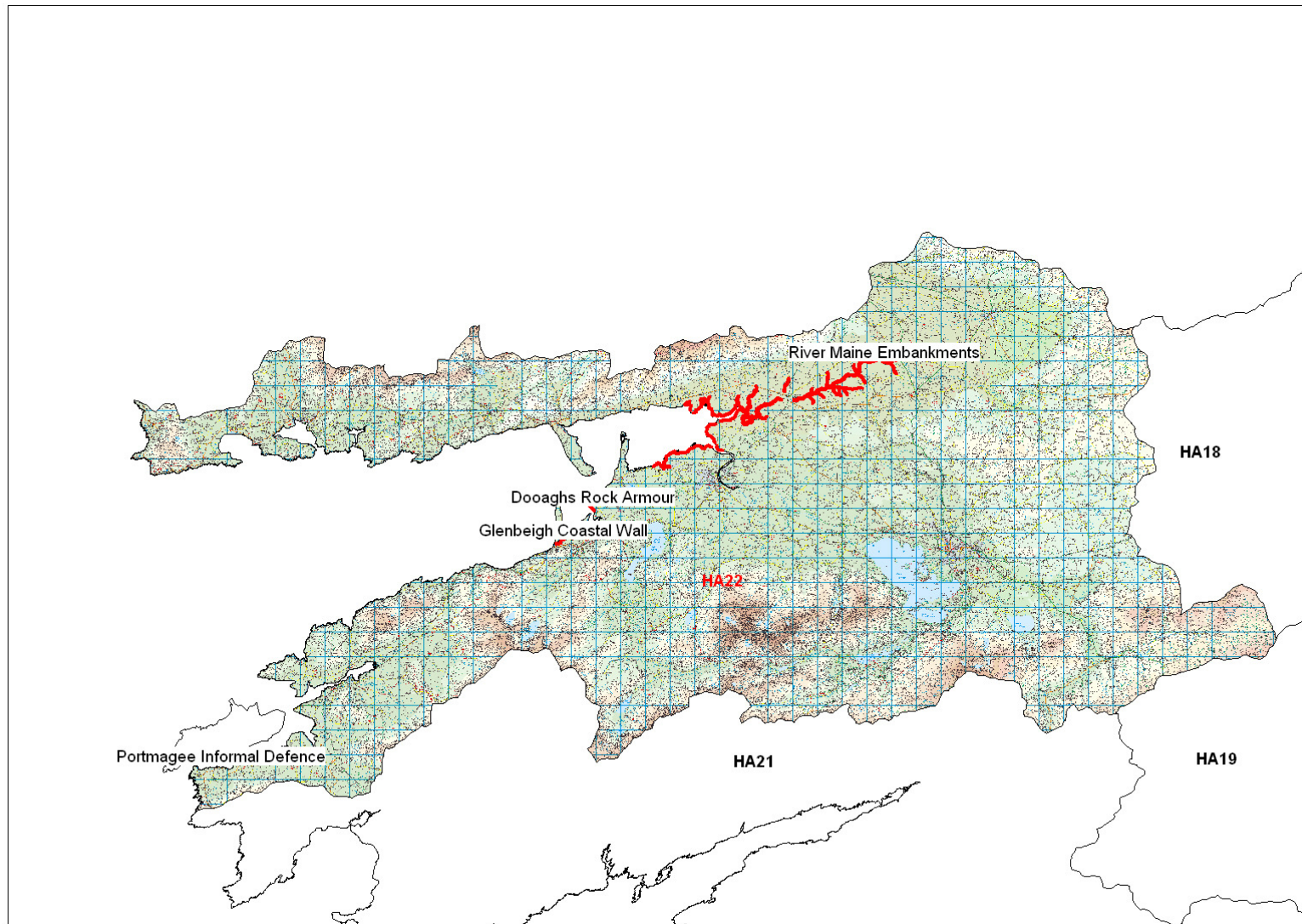
The flood defence asset condition survey has not yet been carried out. The survey will be undertaken following the completion of the river channel survey, which will identify undefined assets, and receipt of the flood plain survey (DTM / DEM data).

The flood defence assets to be surveyed as part of the Study are listed in Table 3.2 below. The location of these defences are shown in Figure 3.1.

**Table 3.2**

| Name                       | Type                                | Description   |
|----------------------------|-------------------------------------|---|
| Glenbeigh                  | Coastal - Wall                      |   |
| Dooaghs Rock Armour        | Rock Armour – Dooaghs – Black Point |   |
| River Maine Embankments    | Embankment                          |   |
| Portmagee informal defence | Wall                                | Block wall on the sea side of a commercial property |

Figure 3.1: Flood Defence Locations



### **3.4 Property Level Survey**

The property survey includes gathering information on property location, type, use, etc. for all properties potentially at risk from flooding. The primary purpose of the property survey is to inform the damage / benefit analysis required to meet the project objectives. OPW have provided a licensed copy of the An Post GeoDirectory. Property ground floor levels will be determined using the DTM data and a specific height that will be based on observations / measurements for each AFA along with spot checks.

The property level survey has not yet been carried out. The survey will be undertaken following the completion of the river channel survey and receipt of the floodplain survey (DTM / DEM data).

## 4. Preliminary Hydrological Assessment

This section details the analysis of river flow, rainfall and tidal level data as well as a preliminary review of historical flood events.

This section covers the following requirements of the CFRAM brief:

- Review and analyse recorded water levels, including tidal and surge levels, and estimated flows with a description of the quality, fitness-for-purpose and interpretation of such data.
- Review and analyse recorded rainfall data with a description of the quality, fitness-for-purpose and interpretation of such data.
- Review and analyse all available previous studies and reports and the historic flood data collected in terms of peak levels, flood extents, etc. and rank in terms of magnitude.

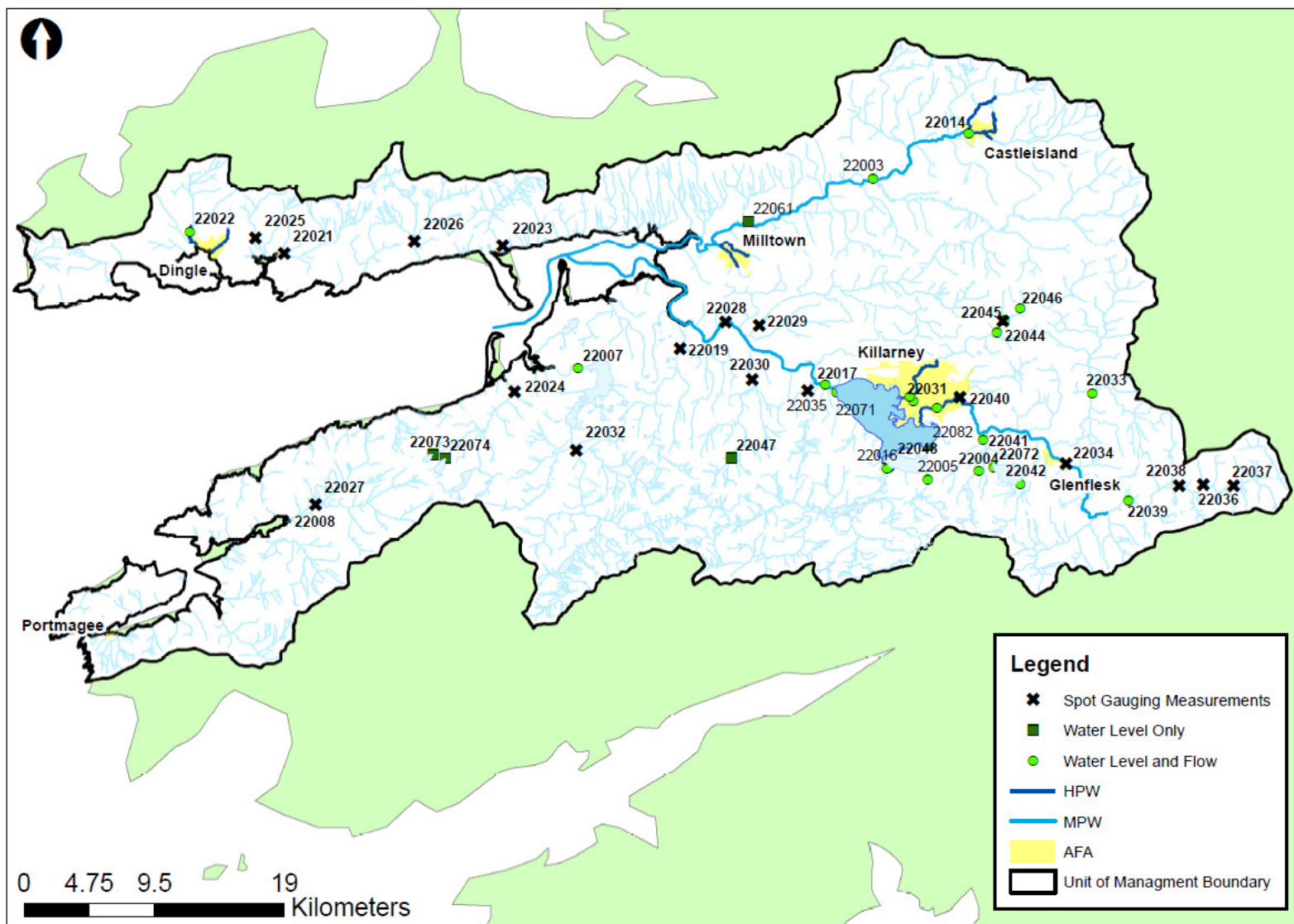
### 4.1 Hydrometric Data Review

Map 4.1 shows the locations of river gauges in the catchment with available water level and flow data.

The existing hydrometric data has been assessed for the following common issues:

- Anomalous spike or dips in water level and/or flow from the continuous data records;
- Capping of water level and/or flow, particularly for extreme events at fluvial gauges where extreme flows may be out-of-range;
- Trends in water level or flow over time that might be caused by systematic error of gauging equipment or erosion/sedimentation;
- Sudden shifts in level of the gauging datum;
- Comparison of AMAX flows and levels from digital gauged data with manually extracted AMAX series;
- Anomalously high or low AMAX flood event AMAX series at each gauge;
- Consistency of concurrent high flows downstream for AMAX events;
- Length of data record to enable hydrological analysis; and,
- Any significant data gaps.

Map 4.1: Available Hydrometric Data



Source: OPW and EPA



*Stations 22001, 22003 and 20014:* The Riverville and Castleisland provide long term records over 40 and 13 years for the River Maine at Currans and Castleisland respectively. The Castleisland gauge was relocated to its current site in 2002. Therefore, the records previous to 2002 cannot be used as a continuous series with data recorded after 2002. The high flow rating for the Castleisland gauge will be reviewed in the hydrological study when more detailed topographic data becomes available to assess the by-pass flows. Following this rating review and subject to the review being satisfactory, both of these gauges will be suitable for the assessment of design flows.

The Riverville bypass gauge (22001) will be used to inform total flow at Riverville, but is not suitable for statistical analysis on its own due to short record of less than 2 years. The tidal gauge at Castlemaine (22061) has anomalous spikes in early 2008 which have been corrected for the hydrological study so that the gauge can be used to inform water level profile up Castlemaine Harbour and typical tidal curve for this location.

*Stations 22006, 22009, 22039 and 22041:* The Flesk Bridge on the Flesk, White Bridge on the Deenagh, Clydagh Bridge on the Upper Flesk and Dromickbane on the Finow provide longer term records between 12 and 64 years for the River Flesk catchment. There were a number of data gaps found at Clydagh Bridge (22039) between 2001 and 2011 which led the rejection of 4 years in the statistical analysis. Data records prior to 1982 at Flesk Bridge were found to be of poor data quality with significant gaps and data recording issues at White Bridge which limits the quality of the data records. However, the annual maximum flood were found to be largely unaffected by these issues, so these gauges have been deemed fit for the assessment of design flows.

*Stations 22035, 22071 and 22082:* The Laune Bridge on the River Laune, Tomies Pier and BVM park gauges on Lough Leane provide water level data and in the case of Laune Bridge, flow data for Lough Leane and downstream reaches of the River Laune. There was a 3 m datum shift found in the water level records at Tomies Pier which was corrected to create a continuous 38 year record to assessment of extreme water level across the Lough. The flow records at Laune Bridge have been edited by Kerry County Council based on the existing rating curve which is deemed suitable for the derivation of extreme flows due to the constrained nature of the river valley at this location. Following the corrections to the data records, all these gauges were deemed suitable for the assessment of extreme Lough levels and in the case of Laune Bridge, extreme flow assessment downstream.

Appendix A contains a list of the selected gauges for the preliminary hydrological analysis

There is no hydrometric data for Portmagee. However, this AFA is only at coastal flood risk and does not require estimation of fluvial inflows as agreed with OPW at the flood risk review stage.

## 4.2 Meteorological Data Review

Available meteorological data from rain gauges and synoptic stations in and near to catchment are shown in Map 4.2.

The existing meteorological data has been assessed for the following common issues:

- Spatial distribution of intensity loggers and respective storage gauges (event based);
- Identification of gaps or erroneous data which have been cross-referenced with the Met Eireann climate stations to assess if significant events have been omitted;
- Identification of shifts in rainfall records using temporal and cumulative plots; and,
- Analysis of cumulative rainfall for key historic events.

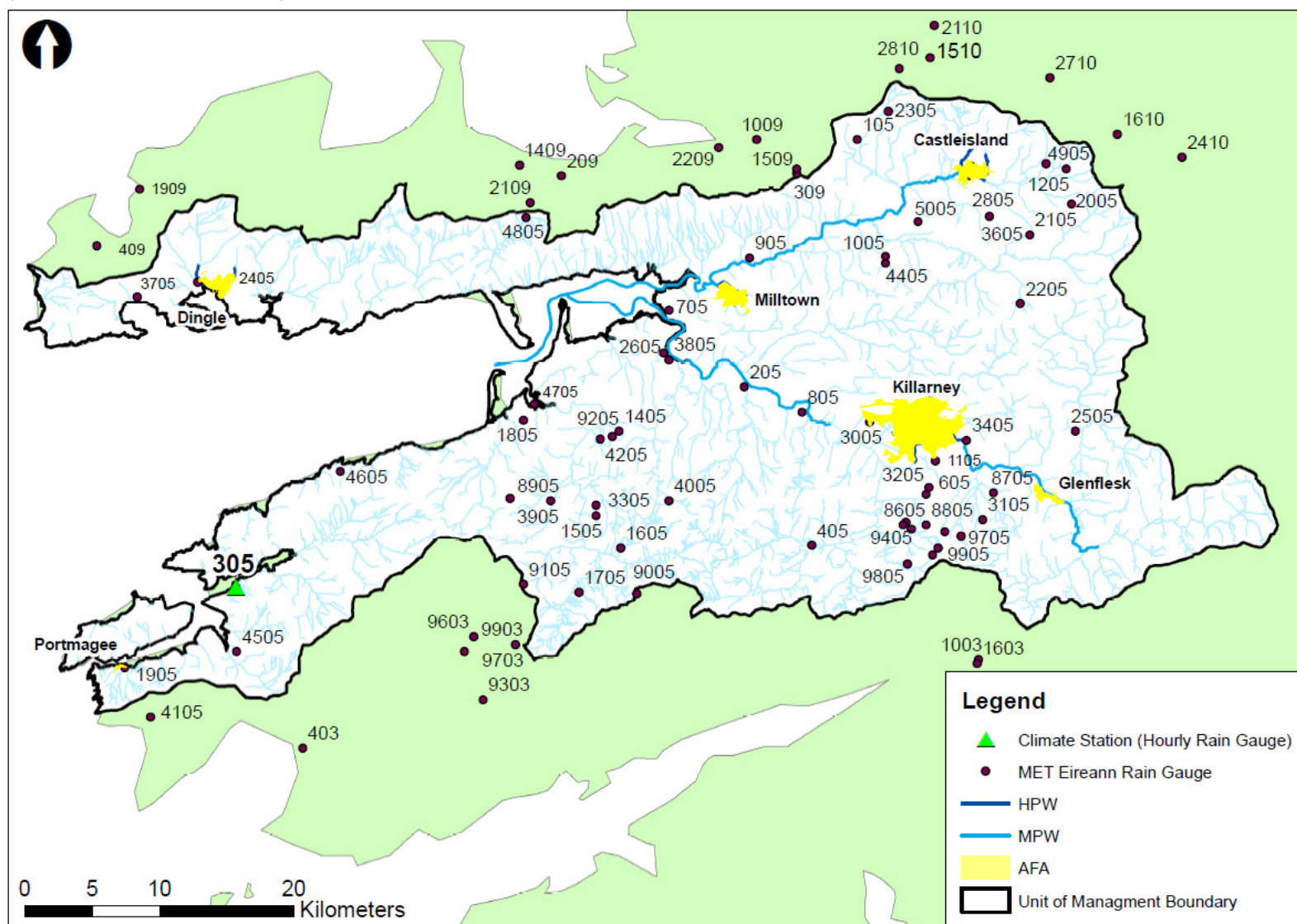
Appendix A contains a list of the selected gauges for the preliminary hydrological analysis.

Detailed hourly rainfall is limited to the Valentia synoptic station (305), which is located in the far west of the area.

Rainfall-runoff modelling is not necessary for the derivation of design flows given the relatively good geographical coverage of hydrometric data for the majority of the River Laune and Maine. However, the selected rain gauges will be used to derive catchment representative rainfall for historic events in Milltown, Dingle and for other AFAs when the hydrometric data is of poor quality.



Map 4.2: Available Meteorological Data

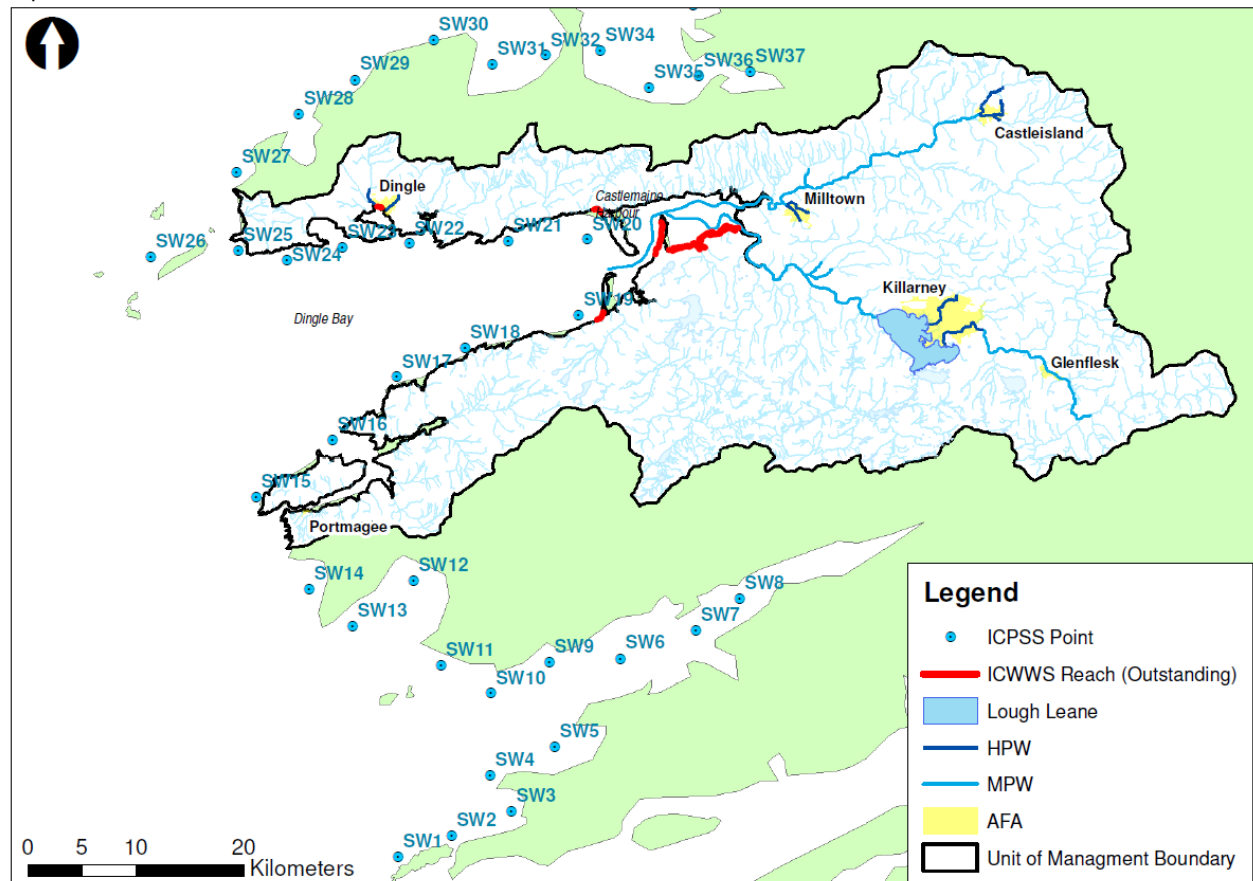


Source: Met Éireann

### 4.3 Coastal Data Review

Map 4.3 shows the extreme coastal water level points and locations of other available coastal data.

Map 4.3: Available Coastal Data



Source: ICPSS and OPW

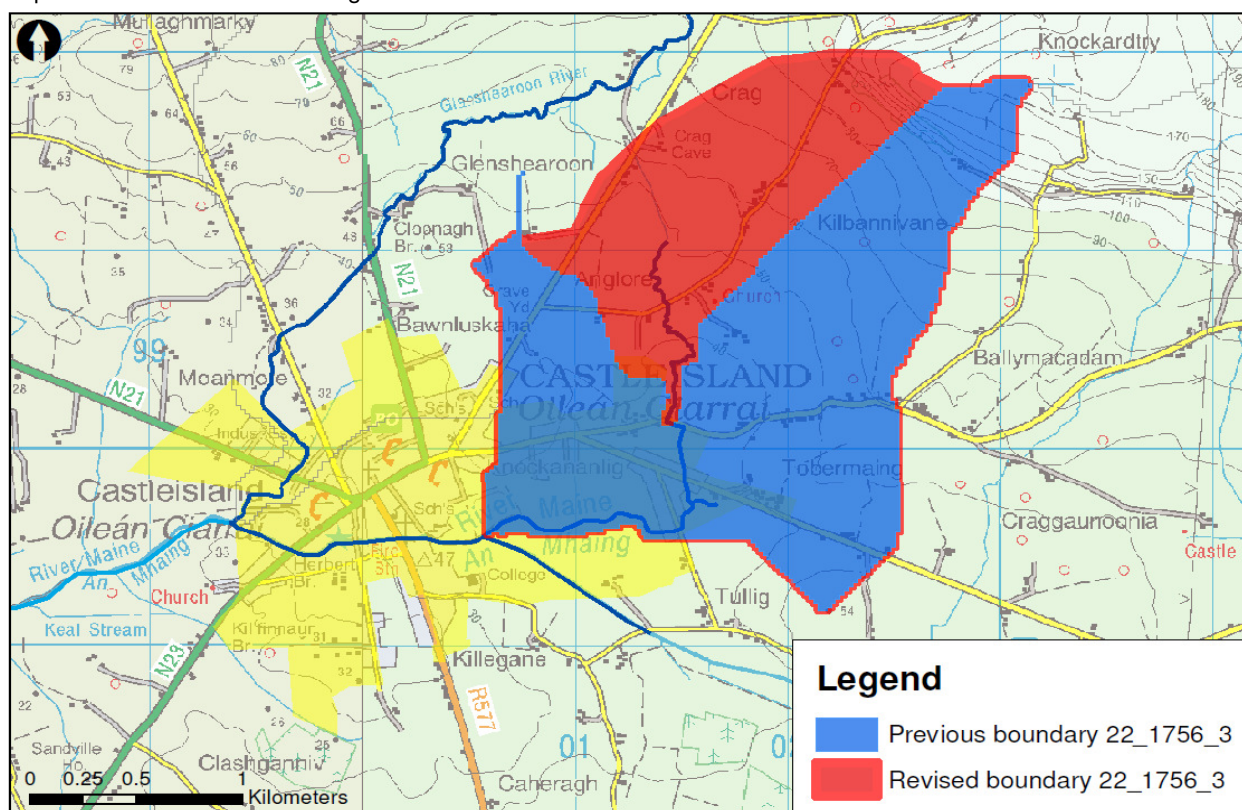
The Irish Coastal Protection Strategy Study (ICPSS) data has been approved by OPW for use directly as the coastal boundaries for the South Western CFRAM models. The extreme sea levels will be used to define the magnitude of the tidal events along the coast for all AFAs. The extreme sea levels are calculated for near shore points but do not necessarily consider variation in water level around islands such as in the Portmagee Channel. No paired water level gauges or buoys were available for this study in order to assess water level difference between Portmagee and Dingle. Therefore, it will be important to ascertain any water level variation between Portmagee Channel and Dingle Bay from the analysis of wider coastline and engineering knowledge of typical water level variation in similar locations in the UK and Europe.

The Irish Coastal Water Level and Wave Study (ICWWS) will also provide extreme wave heights, wave periods and mean wave direction for those areas highlighted red in Map 4.3. The ICWWS data will be available from late 2012 to early 2013 to assess the impact of wave overtopping at Dingle and along Castlemaine Harbour.

## 4.4 Physical Catchment Descriptor Review

GIS spatial analysis was undertaken on the national digital elevation model to determine slope aspect and subsequently used identify the watersheds for each catchment. The outputs from this GIS analysis was compared with the automated FSU catchment boundaries and verified against manual interpretation from ordnance survey mapping at 1:50,000 scale; previous hydrological reports; and, observations from site visits. Overall, the automated FSU catchment boundaries were found to match the ordnance survey mapping well in areas of steep relief. The catchment area for Anglore Stream in Castleisland has been significantly modified so that it now flows south into the River Maine instead of the Glenshearoon Stream. The baseflow of Anglore Stream is fed by groundwater from the Crag Cave complex based on a site visit to the AFA. The physical catchment descriptors have been adjusted accordingly (Map 4.4). The physical catchment descriptors for each of the catchments are provided in Appendix B.

Map 4.4: Modifications to Anglore Stream Catchment at Castleisland



However, where the terrain is flatter along the lower reaches of the River Maine the watershed is less distinctive. The analysis of the national digital elevation model indicated similar watersheds to the FSU catchments. Therefore, the local knowledge from the County Council and OPW will be essential to verify these low-lying catchments during the hydrological study.

The other physical catchment descriptors (PCDs) were also reviewed including; average slope (S1805); average rainfall (SAAR); runoff indicators (SPR); permeability indicators (BFI); and attenuation (FARL). Information from the Geological Survey of Ireland (GSI) was also used to assess the impact of underlying geology and aquifers on permeability and groundwater dominance as well as inform those catchments influenced by karstic systems.

Analysis of the catchment parameters for UoM 22 indicates that:

- The River Glen and River Maine through Castleisland are influenced by the underlying karstic system which not only controls baseflows but also provides subterranean flood routes during extreme events.
- The lower reaches of the River Maine have a higher proportion of artificial drainage in order to discharge agricultural drains during high tide on the River Maine.
- Flows along the River Laune downstream of the Lough Leane are heavily attenuated by the Lough and have correspondingly low FARL values.
- The highest standard average rainfall is in the southern areas of UoM 22 which flows into Lough Leane as this is the areas of highest elevation.
- The fastest responding catchments are associated with steep slopes in and around Milltown causing rapid response to rainfall as seen in the past flood events.

All the modifications made to the original FSU database are highlighted in Table B.1, Appendix B.

## **4.5 Historical Flood Events**

### **4.5.1 Review of Historical Flood Data**

Severe historic flood events in Laune, Maine and Dingle Bay catchments were identified from the historical flood database provided by OPW, from discussions with stakeholders during the Flood Risk Review, from reports carried out on behalf of the Local Authority as well as the observed water level, flow and meteorological records. Table 4.1 summarises and ranks the key flood events reported in UoM 22. The rank refers to peak flow / magnitude only, where flow data is available within the AFA or at a nearby gauge. The hydrographs and historic flood evidence will form the calibration and verification events for the hydraulic modelling process.

### **4.5.2 Historical Flood Event Summaries**

#### **Flood Event of 15<sup>th</sup> January 2011**

Intense rainfall caused the River Flesk levels to rise and flood the adjoining floodplain in Killarney and Killarney National Park. However no properties were affected.

Soure: OPW (2011) Flood Event Report 15<sup>th</sup>- 17<sup>th</sup> January 2011.

#### **Flood Event of 4<sup>th</sup> October 2008**

After a period of prolonged rainfall, flooding at Castlemaine occurred due to a complex river flooding via a subterranean flow path. Initially, river levels in the Glanshearoon River overtopped the left bank where upon the flood water entered the Crag Cave complex to flood areas downstream on the Anglore Stream. Several properties were flooded along Anglore Stream at Cordal Road. An additional commercial property was also affected by the flooding.

Source: OPW (2008) Flooding at Tullig 4 October 2008.

#### **Flood Event of 1<sup>st</sup> February 2002**

A combination of high tidal level on the River Maine and flood flows on the adjoining tributary downstream of Castlemaine caused river levels to overtop the raised embankments and flood the surrounding farmland



at Castlemaine. Fields were flooded for several days as flood waters were unable to return to the river because the floodplain is below the embankments.

Source: Floodmaps.ie (2002) Castlemaine Photographs of February 2002 Flood.

**Flood Event of 17<sup>th</sup> February 1997**

Similar to the 2011 event, intense rainfall caused the River Flesk levels to rise and flood the adjoining floodplain in Killarney and Killarney National Park. However no properties were affected.

Source: Extracted from gauged flows along the Flesk.

Table 4.1: Key Historic Flood Events

| AFA/<br>HPW                             | Nearest Gauging Station |              | Historic Flood Event |                                  |                                  |       |            |   |
|---|-------------------------|--------------|----------------------|----------------------------------|----------------------------------|-------|------------|---|
|   | Station No.             | Location     | Date                 | Peak Flow<br>(m <sup>3</sup> /s) | Estimated<br>Duration<br>(hours) | Rank  | AEP<br>(%) | Flood Mechanism   |
| Glenflesk/<br>Flesk                     |                         |              | 02/11/1980           | 277.1                            | +/-24                            | 2     | 1          | Fluvial: Intense, heavy rainfall, overtopping of the River Flesk.   |
| Killarney/<br>Flesk                     |                         |              | 06/08/1986           | 224.27                           | 12                               | 4     | 4.6        | Fluvial: Intense, heavy rainfall, overtopping of the River Flesk.   |
|   |                         |              | 17/02/1997           | 140.34                           | 6                                | c. 40 | >50        | Fluvial: Period of rainfall, followed by a high intensity storm, leading to the overtopping of the River Flesk.                                       |
|   |                         |              | 19/11/2009           | 224.27                           | 12                               | 4     | 4.6        | Fluvial: Prolonged period of rainfall, followed by a high intensity storm, leading to the overtopping of the River Flesk.                             |
|   | 22006                   | Flesk Bridge | 15/01/2011           | 194.47                           | Unknown                          | 12    | 18.8       | Fluvial: Intense, heavy rainfall, overtopping of the River Flesk.   |
| Castleisland/<br>Glanshearoon           | 22014                   | Castleisland | 04/10/2008           | 2.11                             | +/-24                            | 3     | 23         | Fluvial: Flooding due to period of localised rainfall, inadequate capacity of the Glanshearoon and subsequent rising of the Anglore stream.           |
| Castlemaine/<br>Maine                   | 22003                   | Riverville   | 01/02/2002           | 161.2*                           | Unknown                          | 13    | 33         | Fluvial combined with tidal: Overtopping of the River Maine and tributary in Castlemaine.   |
| Milltown/<br>Ashullish-<br>Ballyoutragh | N/A                     | N/A          | January 2008         | No Data†                         | Unknown                          | -     | -          | Fluvial: Overtopping at Ashullish and Ballyoutragh streams.   |
|   |                         |              | 01/01/1988           | No Data‡                         | Unknown                          | -     | -          | Tidal/fluvial: High tides cause backing up of the Dingle stream, historically affecting the sewer system. Fluvial flooding possible at Dingle Stream. |
| Dingle                                  | 22022                   | Milltown     | Recurring**          | No Data                          | N/A                              | -     | >50        | Fluvial: Culvert capacity exceeded.   |

\*Based on 22003 Riverville, the nearest gauging station located 20km from Castlemaine.

†No data due to lack of gauged data at or near Milltown, data gap in 22003 Riverville.

‡ No data due to lack of historical gauge records.

\*\* Recurring problem of flooding at The Wood on the coastal road, particularly at the culvert on Foildarrig Road at the Dentist Surgery.

Source: Mott MacDonald 2012

**Flood Event 1<sup>st</sup> January 1988**

Flooding in Dingle occurred due to the backing up of floodwater in the sewer system rather than the Dingle Stream that flows through the town. Silt build up at the Hudson Bridge is a possible cause for concern. This flood event led to the re-modelling of the stream outfall into Dingle Harbour.

Source: Floodmaps.ie (1988) Dingle Photographs of January 1988 Flood.

**Flood Event of 6<sup>th</sup> August 1986**

A large flood in the Killarney/Lough Leane area caused damage estimated to be over IR£78,000 with some flooded properties left uninhabitable for up to six weeks. The Cork to Killarney road was impassable with reports of damage to bridges.

Source: IEI paper Nov 1987 sourced on OPW Floodmaps website.

**Flood Event of 2<sup>nd</sup> November 1980**

In Glenflesk 23 homes flooded with 4 having to risk their lives to leave their home. 3009 acres of land (primarily grazing) were flooded and livestock perished. The harvest was also affected in the immediate area, at a cost. An estimated cost of IR£38,230 was estimated to residential damages, with a further IR£4,833 cost to business. Including cost to harvest, land and livestock, the estimated total was IR£127,641.

Source: Floodmaps.ie (1980) Local engineer notes, photographs and map of November 1980 Flood in Killarney and Tralee.

**4.5.3 Selection of Calibration/Verification Events**

The calibration and verification of the hydraulic models is important to ensure confidence in the flood modelling and mapping results. The calibration process aims to achieve the best match possible between the model predicted values against observed levels, flood extents and photographic evidence for the out of bank flooding by adjusting key model parameters. The historical events listed in Table 4.1 were assessed for quality and availability of gauge data and supporting historic flood evidence to calibrate water levels and flood extent from photos, reports and anecdotal evidence.

The following three historical events were selected for the Laune Catchment in UoM 22 based on the available historic flood evidence that will be used to calibrate the hydraulic models for the River Flesk, Glenflesk, Killarney and River Laune:

- 19<sup>th</sup> November 2009
- 23<sup>rd</sup> October 2008
- 2<sup>nd</sup> November 1980

The following three historical events were selected for the Maine Catchment in UoM 22 based on the available historic flood evidence that will be used to calibrate the hydraulic models for the River Maine, Castleisland, Milltown and Dingle:

- 19<sup>th</sup> November 2009
- 4<sup>th</sup> October 2008
- 4<sup>th</sup> January 2008

Milltown does not have flow data and only limited historic flood evidence with which to undertake model calibration. Therefore, the assessment of historic flood events in these AFAs will be based on the magnitude and duration observed at the other AFAs.

Extensive sensitivity testing will also be undertaken on the following key parameters to ensure confidence in the results for the hydraulic models:

- Channel and floodplain roughness (Manning's 'n' values)
- Bridge and culvert loss coefficients
- Pre-event catchment conditions/saturation (baseflow levels)

We will seek to verify these sensitivity tests with observed data should any further flood events occur during the hydrological stage of SWRBD CFRAM study (completion due in June 2013).

## 4.6 Flooding Mechanisms

Following the review of the historic reports and other data, the key flood mechanisms identified in UoM 22 include:

- **Fluvial or river flooding:** Fluvial flooding can occur when the capacity of the river channel is exceeded due to excess flow from heavy rainfall or releases from reservoirs upstream. Flood waters typically overtop river banks at low sections or where water is constricted by bridges or culverts forcing water levels to rise upstream and flood surrounding areas. Most of the flooding reported in UoM 22 is attributed to fluvial flooding mechanisms.
- **Pluvial or surface water flooding:** Pluvial flooding can occur when overland flow from intense rainfall or prolonged heavy rainfall is unable to enter the urban drainage network or river channel either because they are already full or there is a blockage. Pluvial flooding is exacerbated by the increase of impermeable areas (such as concrete or tarmac) associated with urbanisation which increases the amount of overland flow. Bantry has suffered from pluvial flash flooding in the past due to the steep topography around the town and exposed location to Atlantic Storms. It should be noted that the study of pluvial flooding is not included in the scope of the CFRAM Study.
- **Coastal or tidal flooding:** Extreme sea levels, waves and storm surges overtop coastal defences and river banks in tidally influenced reaches, particularly when combined with high river flows for tidal rivers. The risk to people can be very high from this form of flooding as the flood waters can be fast-flowing water. Dingle has been identified as at risk from coastal flooding although no flood reports are available to provide evidence.
- **Groundwater flooding:** Ground water flooding can occur when waters levels rise above the ground to flood low-lying fields and property basements, or where there are significant cave systems, can form an alternative flow path. Properties to the east of Castleisland have been identified as at risk from this second form of groundwater flooding as experienced in 2008 when river flood water entered the Crag Cave complex which then added to flooding along Anglore Stream. It should be noted that the study of groundwater flooding is not included in the scope of the CFRAM Study.

Based on the historical flood evidence, the key mechanisms for each of the AFAs are as follows:

- **Glenflesk:** Flooding occurs from the overtopping of the River Flesk banks. The bank cannot sustain the high flows of water and as a result houses, land and roads become flooded once every two years.
- **Killarney:** The N71 floods annually due to Lough Leane after high rainfall causing a rise in water level. Transport routes frequently affected.
- **Castleisland:** Flooding occurs from the overtopping of the River Maine banks to surrounding properties. However, recent flood events have highlighted that river flooding along the Glenshearoon Stream can



also contribute to flooding along Anglore Stream and the River Maine downstream via subterranean flow routes. Flood waters from the upper reaches of Glenshearoon Stream can enter underground cave complexes which transport the flood water to the Anglore Stream resulting in flooding to riverside properties near Tullig.<sup>1</sup>

- **Dingle:** Flooding occurs during high flows on Dingle Stream due to under capacity at key structures resulting from the accretion silt, such as at Hudson's Bridge. Dingle is also identified as at risk from coastal flooding, occasionally flooding only coastal roads.
- **Portmagee:** This AFA has been identified as at risk from tidal flooding however there are no historic reports of flooding at this location.
- **Milltown:** Flooding occurs at both the Ballyoughtragh and Ashullish stream. Both of these streams overtop their banks to cause localised flooding to properties downstream of the N70.

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<sup>1</sup> It is important to note that this is fluvial flooding in origin and not groundwater flooding which is not considered under the scope of CFRAMS.

## 5. Detailed Method Statement

### 5.1 Flood Risk Review Approach

The overall flood risk review process ensured that the final definition of the AFA's, which are taken forward for the more detailed aspects of the CFRAM methodology, takes full account of local data. During this process regular feedback was provided to OPW. The Risk Review Report included details on the following aspects:

- The new data received, in addition to the information available during the PFRA stage.
- Details of how the data impacts on the existing AFA's definition.

#### 5.1.1 Site Visits

We carried out walkover surveys of the Communities at Risk and the Areas for Flood Risk Review. We reviewed and updated key aspects of the AFA designation, with particular attention to the preliminary flood hazard and receptor data from the PFRA in each case. This involved the completion of proforma documents during the site visits, for example, to ensure consistency between the reviews of the different areas.

#### 5.1.2 Flooding History

Flooding history taken from anecdotal information from OPW, Local Authorities, previous reports and from the historical analysis for the PFRA was examined as part for the flood risk review. All data on flooding history was given a level of confidence based on the data source and detail. Areas identified as being at flood risk from the flooding history information, but not highlighted within the PFRA, were examined further to see if local characteristics would adversely impact results from the normal depth method. Depending on the level of confidence attached to the data sources the AFA regions were altered to incorporate historical evidence.

#### 5.1.3 Flood Risk Review Report

A Flood Risk Review Report was prepared and submitted to OPW. The report included the following:

- Flood Risk Review methodology (including datasets, information and knowledge used, and details from preliminary risk assessments);
- Outcomes of the Review in areas of significant risk.

### 5.2 Survey Approach

#### 5.2.1 Channel and Structure Survey

The surveys have been specified and procured. We are currently managing the execution, delivery and quality control of the geometric and geo-referenced survey of channel cross-sections required for the river modelling.

#### 5.2.2 Defence Asset Condition Survey

Once the channel and structure survey is complete (Section 3.3), we shall undertake a condition survey of the flood defence assets as required. This shall include a geometric survey, visual inspection and condition survey of flood defences and their component assets, structures and elements. All data will be inputted to

the Defence Asset Database, including location, photography, flow level and assessment details as well as areas benefiting from protection and the economic value of defended risk receptors.

## 5.3 Hydrology Approach

### 5.3.1 Overview

In UoM 22, we will derive peak flood flows and typical hydrographs for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEP fluvial flood events for the River Flesk, River Laune, River Maine and Milltown Streams and all the associated tributaries combined with suitable tidal conditions in Dingle Bay, Portmagee Channel and within Castlemaine Harbour to be agreed with OPW during the hydrological study.

The hydrological approach draws on the data review described in Chapter 4 of this report and the latest Flood Studies Update (FSU) guidance. The following sections state the approach for remaining steps to derive design fluvial hydrographs for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEP events as boundary conditions for the hydraulic modelling, including:

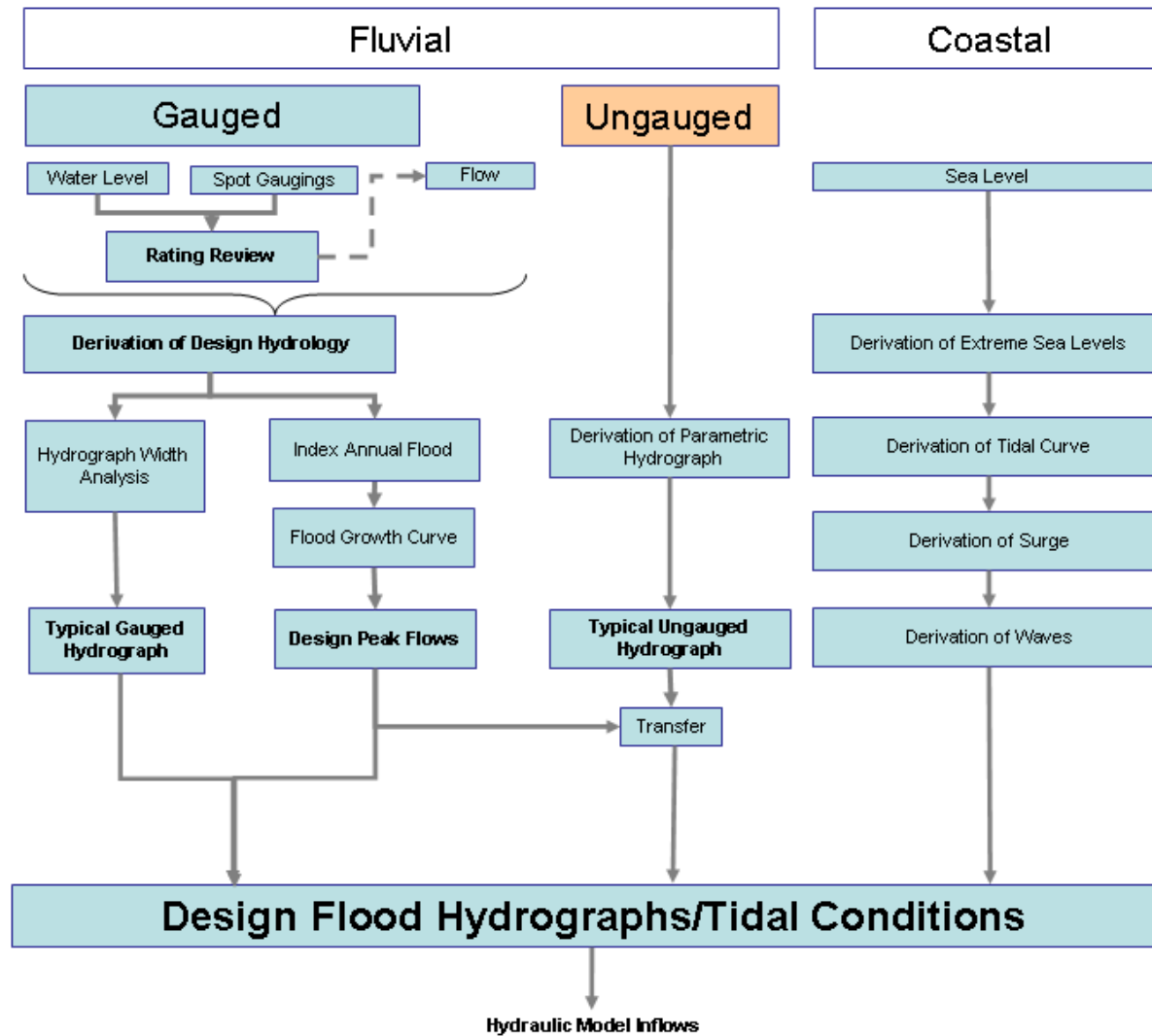
- Hydrological Estimation Point (HEP) Conceptualisation;
- Gauging Stations Rating Reviews;
- Derivation of the Index Flood Flow;
- Derivation of the Flood Growth Curves;
- Derivation of the Typical Flood Hydrograph;
- Phasing of inflows; and
- Consideration of Climate Change.

The design tidal conditions for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEP events will follow a similar process, including:

- Derivation of the index extreme sea level;
- Derivation of the tidal flood growth curves;
- Derivation of the typical tidal flood hydrograph;
- Phasing of the tidal, surge and fluvial components; and
- Consideration of Climate Change.

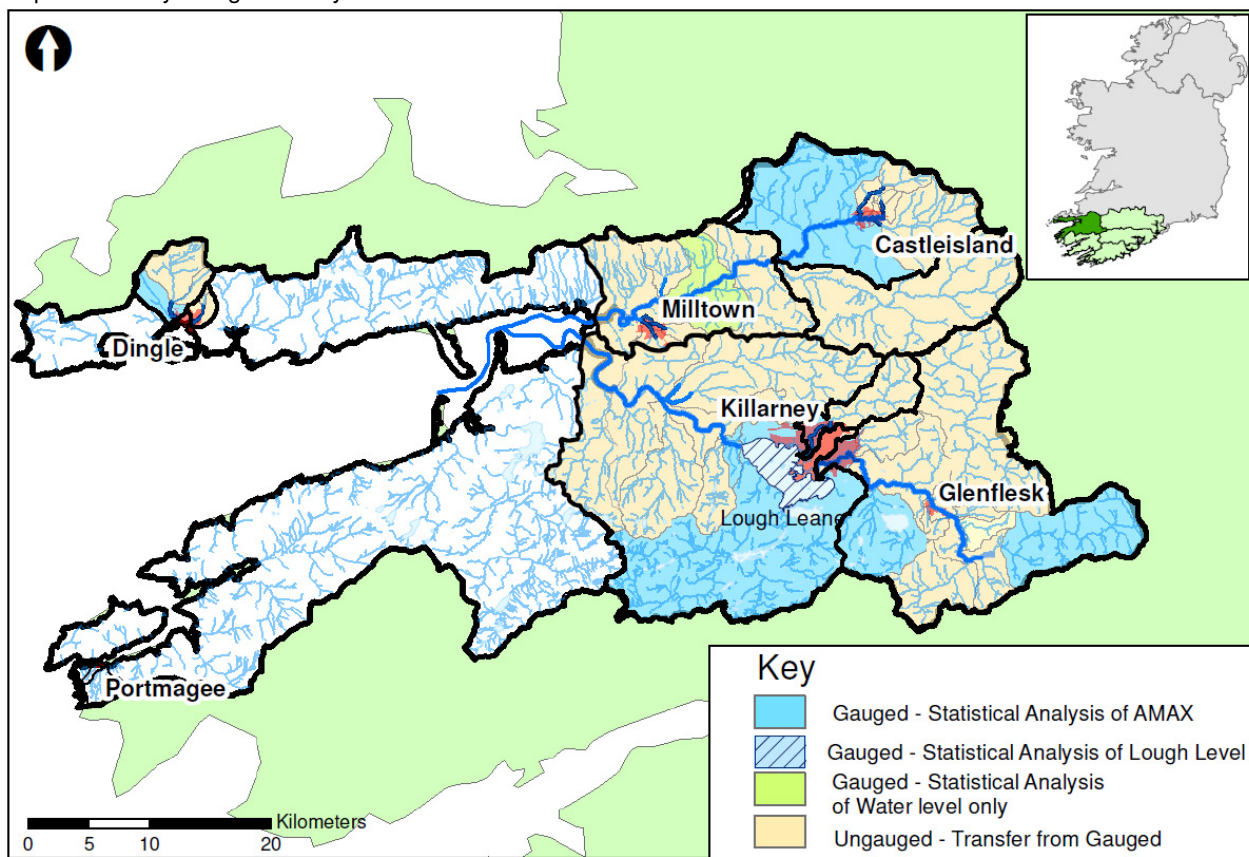
Figure 5.1 outlines the key steps that will be undertaken for each HEP in the hydrological analysis phases as a simplified flow chart.

Figure 5.1: Flowchart of Hydrological Approach for UoM 22



Map 5.1 details where these different hydrological approaches will be applied to UoM 22. Each approach is discussed in greater detail in the following sections and how it will be applied to derive the design flood hydrographs for UoM 22.

Map 5.1: Hydrological Analysis



### 5.3.2 HEP Conceptualisation

Following this review of catchment descriptors in Section 4.4, hydrological estimation points (HEPs) were selected along each modelled watercourse to represent the inflows to the hydraulic models, intermediate target points to check the models and the downstream boundaries for the hydraulic models. The HEPs were identified through a GIS analysis using the criteria set out in section 6.5.3 of the Project Brief which include;

- Central points within AFAs;
- Flow gauging stations used in the hydrological analysis;
- Upstream and downstream limits of each hydraulic model reach;
- Major confluences which contribute significant flow to the modelled reach\*;
- Locations where the physical catchment descriptors significantly change from the upstream catchment i.e. catchment centroid more than 25km away,  $\pm 0.15$  change in BFI and  $\pm 0.07$  change in FARL; and,
- At 5km intervals along each watercourse.

The conceptualisation of the HEPs carefully considered the balance between having too many inflows, thus complicating the model, or too few inflows, so misrepresenting the catchment response at key locations such as the AFAs and major tributaries.

The FSU guidelines define a major confluence as any tributary that contributes more than 10% flow to the model reach downstream. This approach can lead to an over representation of HEPs in the upper reaches of the River Maine and River Flesk and an under-representation in the lower River Maine and River Laune. Other CFRAM studies have used a different approach to overcome this imbalance by applying a 5km<sup>2</sup> catchment area threshold to define a major confluence. However, this results in excessive HEPs to calculate model inflows in large catchments such as the River Maine and Laune. Therefore we have applied a threshold of more than 10% flow contribution and reviewed these to limit the number of HEPs upstream reaches and increased the HEPs for the downstream reaches especially downstream of the tidal limit on the River Maine.

Reaches of the Laune downstream of Lough Leane are sufficiently covered by HEPs identified by the previous three guidelines to cover the variation in catchment response along the Flesk/Laune.

Table 5.1 summarises the HEPs identified for the MPW and HPW modelled reaches in UoM 22. Appendix B.1 details the location of these HEPs and sets out the proposed physical catchment descriptors for each of these HEPs considering the modifications described in Section 4.4.

Table 5.1: Summary of Hydrological Estimation Points (HEPs)

| Type   | Number of HEPs |
|--|----------------|
| Gauged HEP   | 9              |
| Upstream or downstream limit of model HEP          | 16             |
| Intermediate and confluence inflow HEP             | 20             |
| Significant variation in catchment descriptors HEP | 0              |
| <b>TOTAL</b>                                       | <b>45</b>      |

### 5.3.3 Rating Review

Rating reviews will be undertaken for the specified gauge in

The stage-discharge relationship up to bankfull will be developed from the spot gaugings and used to calibrate the hydraulic model at the gauge. The model calibration will only use those spot gaugings that were captured during the period for the stage- discharge relationship that was applicable at the time of survey to ensure the spot gaugings are representative of the latest hydraulic conditions. It may be difficult or impossible to genuinely represent hydraulic conditions during other periods unless the physical change that caused the change in rating is known and can be simulated (e.g. trim model to extrapolate rating, where known change was gravel extraction). Therefore, the hydraulic models will only be calibrated for the latest period where spot gaugings are available.

The calibrated hydraulic model will then be used to simulate the extreme flow conditions during the 0.1%AEP and the results used extend the rating for out-of-bank flows.

Table 5.2 based on the spot gaugings combined with the high flow results from the hydraulic model developed for Castleisland.

A desktop review will be undertaken of each location combined with the information from the flood risk review site visits and survey details. The review will focus on the following aspects:

- Consistency in the use of the datum (e.g. compare datum to difference between water level and stage records) and link findings back to assessment of the water level records,
- Assess limitation of ratings (bypassing, floodplain flow, backwater from downstream structures),
- Check rating curves against spot gaugings recorded during the period that rating curve applies;
- Check spot gauging for anomalously high or low flows
- Check spot gaugings for seasonality of vegetation effects
- Check spot gaugings for hysteresis effects i.e. where the rising limb and falling limb of a flood event differ due to floodplain attenuation.

The stage-discharge relationship up to bankfull will be developed from the spot gaugings and used to calibrate the hydraulic model at the gauge. The model calibration will only use those spot gaugings that were captured during the period for the stage-discharge relationship that was applicable at the time of survey to ensure the spot gaugings are representative of the latest hydraulic conditions. It may be difficult or impossible to genuinely represent hydraulic conditions during other periods unless the physical change that caused the change in rating is known and can be simulated (e.g. trim model to extrapolate rating, where known change was gravel extraction). Therefore, the hydraulic models will only be calibrated for the latest period where spot gaugings are available.

The calibrated hydraulic model will then be used to simulate the extreme flow conditions during the 0.1%AEP and the results used extend the rating for out-of-bank flows.

Table 5.2: Gauges Requiring Rating Reviews

| Gauge Name   | Gauge Number | Watercourse | AFA         | Approach    |
|--------------|--------------|-------------|-------------|-------------|
| Castleisland | 22014        | River Maine | Castlemaine | 1D-2D model |

Water levels and flows at Castleisland gauge are controlled by a low-crested weir which is anticipated to quickly become submerged under extreme flows. Therefore, the gauge location is anticipated to be sensitive to the inflows from the Glenshearoon River a short distance downstream. In extreme flood events, additional flows are transferred from the Glenshearoon River via the cave system and Anglore Stream (see Section 5.2). Therefore a 1D-2D ISIS-TUFLOW hydraulic model will be developed for Castleisland to model these complex flow paths. The model results will be used to revise the rating curve for high flows.

The revised rating curve will be used to convert the water level series. This converted flow series will be assessed to determine the index flood in the design hydrology and fit the flood growth curve for more extreme flows as discussed in section 5.3.3 below.

### 5.3.4 Approach for Gauged Fluvial Locations

Gauged catchments are shown in Map 5.1 as blue and green sub-catchments for records greater than and less than ten years respectively. Table 5.3 summarises the approach for each gauge selected for further assessment.

Table 5.3: Gauged Location Hydrological Approach

| Number | Name         | Watercourse     | AFA or Model Reach | Usable Record Length (Years) | Approach  |
|--------|--------------|-----------------|--------------------|------------------------------|---|
| 22003  | Riverville   | Maine           | Maine Reach 1      | 40                           | <ul style="list-style-type: none"> <li>■ QMED<sub>amax</sub></li> <li>■ Single site growth curve</li> </ul> |
| 22006  | Flesk Bridge | Flesk (Laune)   | Killarney          | 64                           |   |
| 22009  | White Bridge | Deenagh         | Killarney          | 29                           |   |
| 22035  | Laune Bridge | Laune           | Laune Reach 1      | 20                           |   |
| 22071  | Tomies Pier  | L. Leane        | Lough Leane        | 38                           | <ul style="list-style-type: none"> <li>■ Statistical hydrograph</li> <li>■ POT QMED</li> </ul>              |
| 22014  | Castleisland | Maine           | Castlemaine        | 10                           |   |
| 22022  | Milltown     | Milltown Stream | Dingle             | 10                           |   |



| Number | Name           | Watercourse | AFA or Model Reach | Usable Record Length (Years) | Approach  |
|--------|----------------|-------------|--------------------|------------------------------|---|
| 22039  | Clydagh Bridge | Flesk       | Flesk Reach 1      | 12                           | <ul style="list-style-type: none"> <li>■ Pooled growth curve</li> <li>■ FSU hydrograph or transferred statistical hydrograph</li> </ul> |
| 22041  | Dromickbane    | Finow       | Flesk Reach 2      | 13                           |   |
| 22082  | Bvm Park       | L. Leane    | Lough Leane        | 7                            |   |

### Index Flood

The shorter the gauge record the greater the influence of extreme low or high flows on the statistical analysis of the index flood. Therefore we will use the median descriptor (QMED) from the Annual Maximum Series (AMAX) to minimise outlier skew instead of the average ( $Q_{BAR}$ ) used in the previous Floods Studies Report. The majority of flood events occur in the winter months (October to March) in Northern Europe, therefore the AMAX series is based on the annual maximum flood that occurs in each water year, i.e. from October to October, to avoid counting two consecutive flood events in December and January if the calendar year was applied.

For gauges with records over ten years in length, such as Flesk Bridge, the recorded annual maximum flood series will be used to estimate the index flood and compared with the  $QMED_{adj}$  from the FSU catchment descriptors methodology (FSU WP 2.3).

The estimates of QMED will be checked across the catchment to ensure flows increase consistently with area and contributing inflows.

### Flood Growth Curve

The flood index value and observed AMAX series will then be used to generate a single site flood growth curve using the FSU methodology for AEP events twice the record length at the site. For instance, the 64 year AMAX series at Flesk Bridge will be used to derive peak flow estimates up to the 0.8% AEP.

In accordance with WP 2.2 of the FSU, the single site analysis at gauges will be combined with the recommended pooled analysis with at least five times the target 100 year or 1%AEP event i.e. 500 years of Amax data, to derive a pooled flood growth curve for larger magnitude events up to the 100 year or 0.1%AEP event. The L-moment statistics from the at-sites single site analysis and pooled analysis will then be weighted to interpolate the final flood growth curve for the 1%AEP event up to the 0.1% AEP event.

The joint probability of flows at each confluence where the tributary contributes more than 10% of downstream flow will be guided by Table 13.1 of the FSU WP3.4 to produce the required design AEP downstream. Observed data of AMAX event will be used to validate the estimated joint probability where there is sufficient gauged data on both the tributary and main river. The selection of the AEP flows on the main river and tributary will be based on the relationship between catchment centroids, area and attenuation descriptors as specified by FSU WP 3.4.

### Typical Flow Hydrograph Shape and Phasing

The design hydrograph shape is important in determining the volume of flood water routed down the river systems as well as the duration of flooding for the AFAs once out-of-bank. Therefore, the characteristic flow



hydrograph for gauged sites will be derived empirically using the hydrograph width analysis approach as specified in the FSU WP 3.1 based on AMAX flood events for gauges with over 10 years' record and all flood events exceeding 80% of QMED for sites with less than 10 years' records.

It may be beneficial to include analysis of level-only gauges to verify the routing of the flood hydrographs for calibration events to inform the shape of the design hydrograph, such as Castlemaine (Maine) and Milltown gauges (Dingle).

An appropriate parametric curve will be fitted to the empirically derived median hydrographs for the whole sample and split samples for 1%, 10% and 50% AEP equivalent magnitude events. These characteristic hydrographs will be compared with the symmetrical hydrograph produced from previous FSR/FEH methods for flows above 50% of the peak flow and discussed with OPW to agree the most appropriate design hydrograph. The statistical analysis of flood durations will be informed by Mott MacDonald's development of a similar approach for the South West England Region for flood incident management, Evans et al (2006)<sup>2</sup>.

The phasing of inflows will be determined by the statistical analysis of time lag in observed peak flows or levels for AMAX events where there is concurrent gauge data available such as between Flesk Bridge and White Bridge in Killarney. The typical observed phasing will be used to inform the timing of hydrographs at each confluence across the catchment in combination with the FSU time difference equation (WP 3.4).

## Lough Leane

The assessment of design hydrology for Lough Leane is a special case. Our strategic approach to produce flood extent mapping for the Lough will be based on the projection of design peak water levels at the three gauges across the Lough, i.e. Laune Bridge, Tomies Pier and BVM Park. The three gauges have been selected to represent the variation in water level across the Lough, particularly for the smaller magnitude AEP flood events.

The median annual maximum water level will be derived from the AMAX series or POT series as discussed above. Single site analysis will then be undertaken at each gauge to establish flood growth curve fitted to observed AMAX events and produce a single consistent flood growth curve in order to derive design peak water levels up to twice the length of the records, e.g. the 38 years record will be used to derive peak flows up to the 1.25% AEP event. The preferred distribution will be discussed and agreed with OPW before extrapolating to estimate the 1% and 0.1% AEP levels. Sensitivity tests on peak levels for these AEP events will be vital for Lough Leane as there is little or no data to verify the extreme peak water level. Pooling analysis is not applicable to extent water level records. Those design water levels will then be used to generate water surfaces in GIS and intersected with the digital terrain model to determine the flood extent for each scenario as discussed in Chapter 2 of this report.

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<sup>2</sup> Evans et al. (2006) Paper 10.5.1-11; A new approach to flood estimation using flood peak and duration: a case study informing incident management plans for Exeter. Flood and Coastal Management Conference, 41st, DEFRA, The University of York, Tuesday 4th July to Thursday 6 July 2006 , 2006.

### 5.3.5 Approach for Ungauged Fluvial Locations

Ungauged inflows are shown as yellow or green in Map 5.1.

#### Index Flood and Flood Growth Curve

The index flood values for the ungauged fluvial sub-catchments will be transferred from the gauged locations identified in Section 5.3.4. The QMED at the target ungauged site will be adjusted by the ratio between the observed  $QMED_{amax}$  and calculated  $QMED_{rural}$  at the pivotal site. The selected flood growth curve from the pivotal site will then be used to derive the design peak flows for the ungauged site based on the adjusted QMED.

The design peak flows will be compared with to historic flood evidence for the AFAs as a 'reality' check.

Alternative methodologies for estimating the design hydrology for small ungauged catchments have been considered and discounted for the following reasons in UoM 22:

- **Rational Method:** The rational and modified rational method estimates greenfield (undeveloped) runoff rates from runoff coefficients, rainfall intensity measures and catchment area principally for sewer design. Previous research has shown that the rational methods tend to overestimate peak flood flows compared to observed data in test small lowland catchments. Therefore, the rational and modified rational methods have been discounted for SWRBD CFRAMs.
- **IH124 Method:** The Institute of Hydrology Report 124 Method (IH124) estimates peak flood flows from time to peak ( $T_p$ ) and index flood (QBAR) equations. The equations were derived from 71 catchments in England and Wales based on data up to 1990. As such, the coefficients may not represent Irish catchments and more recent storm events which can differ from those in England. Therefore, the IH124 method has been discounted for SWRBD CFRAMs.
- **ADAS 345 Method:** The ADAS Report 345 method estimates peak flood flows from land use, soil type and rainfall parameters related to the rational method equations for the purpose of design field drainage systems. Previous research has shown this method tends to underestimate the index flood flow compared to observed data in test catchments and has a higher mean error than other methods possibly due to a smaller database from which the ADAS345 equations were derived. Therefore, the ADAS345 method has been discounted for SW RBD CFRAMs.
- **Gebre Small Catchment Method:** Research by OPW in 2012 developed a revised regression equation for  $QMED_{rural}$  based on 38 small gauged catchments (Area between  $5km^2$  and  $30km^2$ ). However, this revised small catchment QMED equation requires further verification before widespread use. Therefore, it was not recommended to replace the original FSU 7 variable  $QMED_{rural}$  equation for small catchment.

The approach differs for the artificially drained ungauged catchments along lower reaches of the River Maine. In accordance with GN21, the lowland FSR method will be used to derive the design peak flows as described in SC090006 (Flikweert and Worth, 2012). However, the five year-42 hour and five year – two day (M5-42hr/M5-2D) will be derived from the latest rainfall depth duration information from Met Eireann.

#### Characteristic Flow Hydrograph and Phasing

Given the lack of suitable flow or level records at the ungauged locations, the 3 parameter regression-based equations from WP3.1 will be used to derive a representative design hydrograph based on the baseflow index (BFI), floodplain attenuation factor (FARL), alluvial soil percentage (ALLUVIAL), artificial drainage (ARTDRAIN) and catchment average slope (S1085).

Local catchment knowledge from anecdotal sources and OPW will be used to modify the derived hydrograph where the catchment response is known to be atypical such as rapid responding urban catchments in Milltown.

The derived hydrograph will then be compared with the symmetrical hydrograph produced from previous FSR/FEH methods for flows above 50% of the peak flow to select the most appropriate design hydrograph. The phasing of inflows will be based on the FSU time difference equation (13.5.4 from WP 3.4) and time difference adjusted so that the peak occurs at the time predicted at the gauged location downstream and in the modelled reach.

The characteristic hydrograph for the artificially drained catchments will be derived using the tailored FSR approach trapezoidal unit hydrograph to cap peak flow between 0.5Tp to 1.5 Tp as described in SC090006 (Flikweert and Worth, 2012).

### **5.3.6 Approach for Tidal Locations**

Dingle Bay and Castlemaine Harbour are vulnerable to coastal flooding from extreme sea levels overtopping coastal defences and the residual risk of wave overtopping of defence. The downstream tidal conditions will be derived as follows.

#### **Design Extreme Sea Levels**

The design extreme sea levels will be linearly interpolated from the nearest ICPSS calculated points and the ICWWS reaches within Castlemaine Harbour for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEP events as specified. The ICWWS water level will be used to define extreme sea level in Dingle itself. The water level at Portmagee will be derived based on difference between the calculated ICPSS points in Dingle Bay and the predicted tidal levels at Knights Town in Portmagee Channel to ensure the coastal risk is not overestimated.

#### **Design Combined Tidal and Surge Hydrograph**

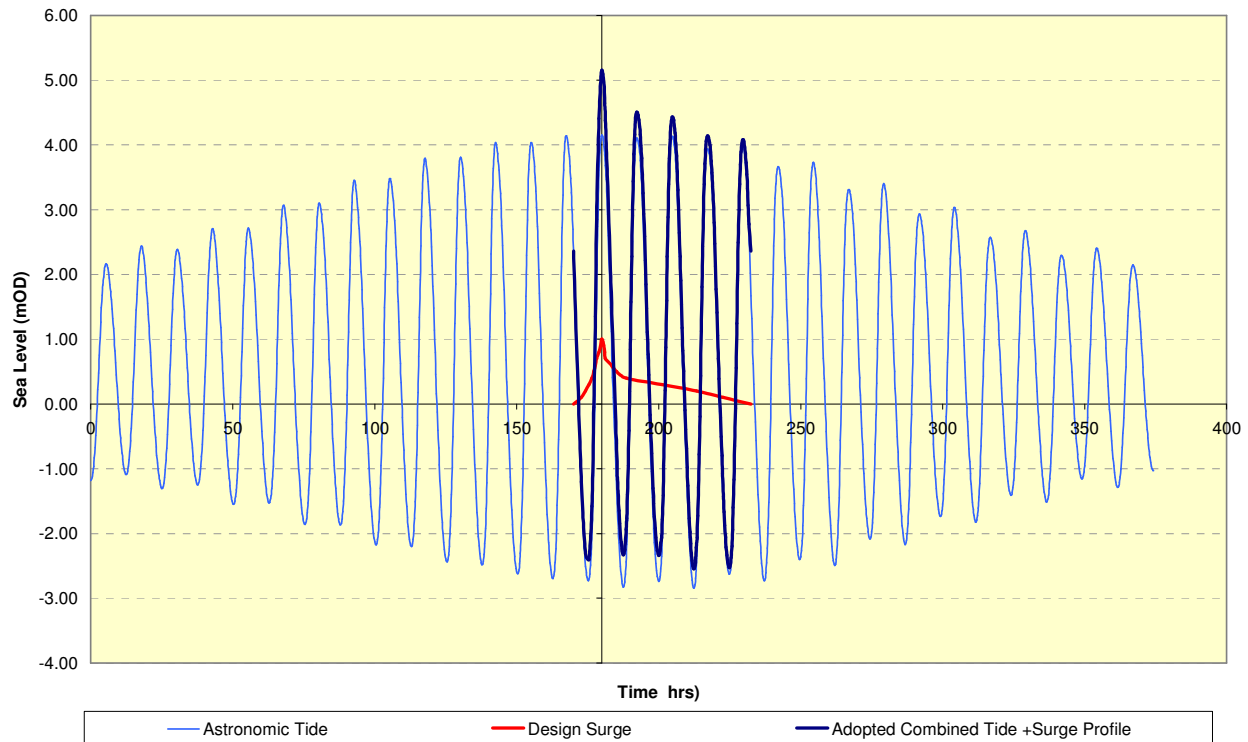
In addition to the peak water levels, the tidal hydrograph shape is key in determining the volume and duration of tidal flooding and tide-locking various rivers flowing into the bays. The astronomic tidal curve will be derived initially from the mean high water spring and mean low water spring nearby port predictions. This astronomic curve will then be adjusted based on the local knowledge from OPW, the Local Council, the local communities in Dingle Bay and Castlemaine Harbour. The tidal river gauge at Castlemaine will be used to verify the transformation of the tide up the River Maine.

The design surge profile will be derived from analysis in existing reports for Dingle Bay. Where there is no existing analysis, such as Portmagee, the surge profile will be a simplistic triangular shape based on our experience of surges in locations such as Cornwall and the local knowledge of surge durations by OPW. The preferred surge profile will then be agreed with OPW before being standardised and scaled on top of the astronomic curve to meet the design extreme sea levels (Figure 5.2). We will discuss and agree with OPW the appropriate phasing of the surge such as matching the peak surge with the peak coastal water level as a conservative estimate.

Recent research (DEFRA FD2308) indicates that the phasing of extreme tides does not necessarily correspond to rainfall and fluvial flood events. There is a gauge at Castlemaine near the River Maine outfall which can inform the observed phasing between tidal and fluvial events. However, the gauge length is of

insufficient length (4 years) to statistically analyse the joint probability at this location. Therefore, the joint probability between the extreme tidal conditions and fluvial flooding will take a practical approach where appropriate, such as applying the 1% AEP fluvial flood with the annual tidal flood conditions.

Figure 5.2: Example of Design Tidal Hydrograph for a Coastal Flood Event



## Wave Conditions

Dingle and Castlemaine Harbour have been identified as a Coastal Area Potentially vulnerable to wave Overtopping (CAPO) by the ICWWS. This study suggests there remains a residual risk from wave overtopping of defences/banks even when the extreme water level is below the defence/ bank crest level due to wave run-up. The joint probability of extreme sea level and extreme wave conditions will be discussed and agreed with OPW drawing on recent research such as the DEFRA FD2308 report.

In order to simulate the flood hazard resulting from wave overtopping, the wave height, wave period and mean wave direction will be extracted from the ICWWS at the Dingle and Inch shorelines. These wave conditions will be used to derive discharge-time hydrographs externally to the hydraulic model. The wave overtopping discharges will be calculated using the methodology Mott MacDonald has successfully developed for the East Coast of England based on Besley (1999) and hydraulic principles. This approach assesses both current and future risk with climate change which is often extends beyond the design life of the existing defences. The resulting discharges will be compared with the EurOtop methodology within the valid range of the equations and validated by local experiences of the council and other relevant local marine communities.

### 5.3.7 Future Scenarios

The design hydrology described in Sections 5.2.4 to 5.2.6 will be based on present day climate conditions (2012). However, climate change is predicted to change the hydrological conditions over the next 100 years. The predicted impacts of climate change over the next 100 years are likely to include:

- Increase in rainfall depth,
- Increase in flow,
- Sea level rise (including land movement),

For the SWRBD CFRAMs, Table 5.4 sets out the predicted changes in the key catchment parameters over the next 100 years. The range of potential impacts of climate change may vary AFA to AFA as there are significant uncertainties associated with global climate predictions and local variation in urbanisation and forestation beyond 20 years. Therefore, two scenarios will be assessed to quantify the sensitivity of flood risk to these uncertainties, namely; the Mid-Range future scenario (MRFS) and the High-Range future scenario (HRFS) as detailed in Table 5.4.

Table 5.4: Allowance for Change in Catchment Parameters Over 100 Years

| Catchment Parameter              | MRFS                                      | HRFS                                      |
|----------------------------------|---|---|
| Extreme Rainfall Depth           | +20%                                      | +30%                                      |
| Flood Flows <sup>1</sup>         | +20%                                      | +30%                                      |
| Mean Sea Level Rise <sup>1</sup> | +0.5m                                     | +1.0m                                     |
| Land Movement <sup>2</sup>       | -0.5mm/year<br>i.e. -0.05m over 100 years | -0.5mm/year<br>i.e. -0.05m over 100 years |
| Urbanisation                     | Specific to each Town                     | Specific to each Town                     |
| Forestation <sup>3</sup>         | Tp reduced by factor of 6                 | Tp reduced by factor of 3<br>+10% SPR     |

**Note 1:** Applies to entire range of flows or tidal levels, not just the peak.

**Note 2:** Land movements as a result of postglacial rebound since the last ice age. Applies to all locations south of Dublin to Galway which includes the entire SWRBD CFRAM study area.

**Note 3:** Reduction in time to peak (Tp) and increase in standard percentage runoff (SPR) allows for potential accelerated runoff that may arise as a result of drainage of afforested land.

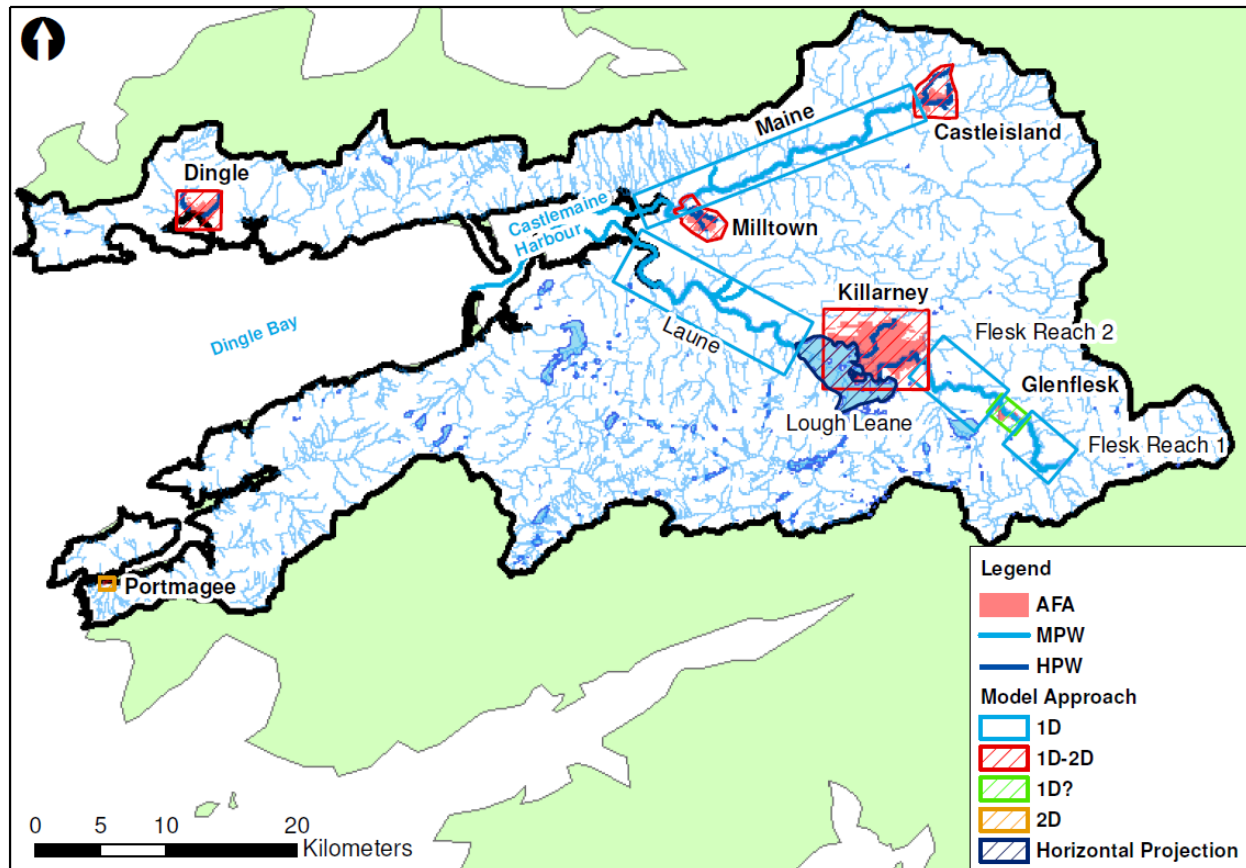
Source: Reproduced from Appendix F of National Flood Risk Assessment and Management Programme, Catchment-Based Flood Risk Assessment and Management (CFRAM) Studies, Stage I Tender Documents: Project Brief.

The urbanisation rates will be based on future development plans from the local councils combined with OPW's local knowledge for each AFA to derive a mid and high annual rate of growth. This will consider a long-term assessment of urbanisation since 1960 (or earlier where records permit) to reduce the influence of the rapid increase from 2000 to 2008 and stagnation in since 2008 in some areas. This will then be extrapolated over 100 years to adjust the extent of urban land cover (URBEXT) for each HEP, adjust the representation of urban extent in the hydraulic models of the floodplain and economical appraisal of flood damages.

## 5.4 Hydraulic Analysis Approach

The Laune, Maine and Dingle Bay catchment has been divided into ten separate reaches to produce flood extent mapping for all Medium Priority Watercourses (MPW) and flood hazard mapping for all High Priority Watercourses (HPW). Map 5.2 summarises our approach to the assessment of flood risk in the Laune-Maine-Dingle Bay UoM 22.

Map 5.2: Approach to UoM 22 River Laune-Main-Dingle Bay



Independent hydraulic models will be developed for each reach to simulate the flood extent for the design flood as follows:

- **1D Hydraulic Models for MPWs and Glenflesk:** A 1D ISIS hydraulic modelling approach will be sufficient to simulate peak water levels and flows for intervening MPWs and downstream reaches of the River Flesk, River Laune and River Main.
- **1D/2D Hydraulic Models for HPWs:** A 1D/2D ISIS/TUFLOW hydraulic modelling approach will be taken for all the AFAs listed in Table 1.2 with the exception of Glenflesk to enable a detailed assessment of depth, velocity and hazard across urban areas and complex interaction with tidal flows and wave overtopping in the case of Dingle.
- **2D Hydraulic Model for Portmagee:** A 2D TUFLOW modelling approach will be sufficient to model the progression of tidal flood water at Portmagee assuming the coastal boundary between land and the Portmagee Channel are suitably represented in the available LiDAR data.
- **Horizontal Projection for Lough Leane MPW:** A horizontal projection of calculated extreme water levels across the Lough will be sufficient to map flood extent as required by OPW, avoiding timely and costly bathymetric surveys and complex lacustrine modelling.

In each case the 1D, 1D/2D and 2D HPW and MPW hydraulic models will be developed in seven steps as follows:

**1. Model Conceptualisation and Configuration:** We will review available maps, existing HECRAS model for Glenflesk, previous hydraulic analysis for Milltown, historic flood evidence and other information from



OPW and the Local Authorities to understand and schematise the river network. This will focus on changes in slope and channel morphology based on review of the river channel survey; any hydraulic structures and linking watercourses (such as drains); flow routes and barriers such as roads, railways and embankments; major areas of attenuation such as floodplain depressions; and, any areas of noted concern.

**2. Representation of Channels, Structures and Floodplain Interface:** River channels will typically be represented by a series of nodes (cross-sections) and reaches. We will make informed use of channel roughness guides, such as by Chow 1959, in conjunction with engineering judgement, and the river channel survey and surveyors observations/photos to assign Manning's 'n' roughness values for each reach to best represent changes in channel slope, morphology and flooding mechanisms without compromising the stability and robustness of the hydraulic models.

It is important to incorporate all significant online bridges, weirs and culverts in the channel within the 1D modelling for both MPWs and HPWs, considering losses around and through structures. Only those structures that significantly influence flow for the MPW or HPW reach during flood events will be incorporated as specified for the survey. Parameters such as afflux, weir discharge coefficients and structure losses will initially be set to industry standard values using catchment knowledge from site visit, industry guides and drawing on expertise of senior hydraulic modellers/engineers.

For both the HPWs and MPWs, the river bank elevations will be based on the river bank surveys collected as part of this CFRAM study ensuring any known low points are fully represented in the 1D/2D river/floodplain interface. In the case of the HPWs 1D/2D modelling this will usually form the interface between the 1D river channel and the 2D floodplain model, therefore it is vital to have confidence in the surveyed bank elevations which will be verified by spot checks as part of the survey.

**3. Representation of the Floodplain and Floodplain Features:** A digital terrain model (DTM) will be created using the extended topographic survey from Castleisland, the latest LiDAR surveys of the AFAs and the national digital elevation model (IFSAR data) for the more rural areas. The DTM will be used to inform the geometry and formulation of the floodplain model. All topographic data will be cross-checked in areas of overlap to ensure consistency on receipt of data.

For the 1D/2D models of HPWs, a preliminary grid size of 5m will be applied to accurately represent the urban floodplain without compromising the simulation time and efficiency. Any further revisions to the grid size will be determined by the complexity of the floodplain. Key features less than 5m in size, will be explicitly enforced in the 2D domain using 3D breaklines, regions or flow constrictions to modify the underlying grid. On the floodplain, we propose to use a combination of the following to classify land use: topographic survey data; photographs captured at the time of the survey; OSi Mapping and the EU Environment Agency's latest CORINE dataset. The photographs captured at the time of survey and available aerial photography will then be used to assign the appropriate Manning's 'n' roughness value to each land use classification. We will incorporate relevant barriers and potential flow routes as identified in the schematisation using 3D breaklines to represent the effective crest of floodplain features such as roads, railways and embankments.

The urban environment can significantly modify flow paths, depth and velocities; to model this satisfactorily requires, in our experience, paying particular attention to how the buildings are incorporated. Buildings can be represented in the 2D models in variety of ways depending on data availability and output requirements. Buildings will be considered using a combination of building footprints raised to a uniform threshold value of 300mm and assigned with depth variable roughness values to enable simple extraction of results of

economic, social and environment assessment at a property level. The buildings footprints have been extracted from the detailed 1:5000 OSi mapping at a national scale for use in the CFRAM studies

**4. Upstream Boundary Conditions** We will develop appropriate boundary conditions for fluvial inflows, lateral inflows for intermediate catchments, and any important surface water run-off. Upstream boundary conditions will typically be located at the upstream limits of the model and key inflow points/locations. The orientation and immediate topography at upstream boundary will be considered in the creation of the 2D domain and are important in influencing flow routes and flow distribution. It is also important to carefully consider the location of lateral inflows along the 2D boundary to represent inflows from intermediate catchments and/or drainage catchments, distributing and transferring flows between the various drains where appropriate as identified by the Hydrological Estimation Points.

**5. Downstream Boundary Conditions** The downstream boundaries will be located at a known gauged sites or control structures (e.g. weir, gates etc.) where possible, or sufficiently away from the area of interest in order to minimise the uncertainty associated on backwater effects or any assumptions made with the downstream boundary conditions. For fluvial reaches, the downstream boundary will typically be represented using water-time series for calibration/verification which will inform the design stage-discharge relationship downstream boundary for design events. For tidally influenced reaches, water level-time boundaries will be used. The phasing and timing between river flows and the tidal boundary will be such that the peaks coincide in accordance with the joint probability guidance note (due late 2012).

**6. Initial Conditions:** Where required, appropriate initial hydraulic conditions will be established prior to model simulation.

**7. Calibration:** A proportionate approach will be taken to the representation of floodplain features. All the hydraulic models will be calibrated for historic flood events where there is sufficient data, as outlined in Section 4.5. For a widespread event, the model predicted flows will be calibrated across catchment where there are several gauges along a river. This will mean iterative calibration across several models for larger catchments.

Reality checks will be undertaken instead of model calibration where there is insufficient gauge data or only anecdotal historic flood evidence as set out in Guidance Note 23. The design flood outlines and water level profiles will be checked against anecdotal flood evidence and estimated frequency of historic events as an indicative measure of what might be considered reasonable.

This calibration will focus on the structure coefficients and head losses at bridges and weirs as well as Manning's 'n' roughness values for the river channel and floodplain. Section 4.5 summarises the historic events and available calibration data in UoM 22 for each AFA. The limited availability of flow data at Castleisland, Milltown and Dingle means that a full event calibration is unlikely to be feasible. Therefore, sensitivity tests will be carried out for relevant hydrological assumptions and hydraulic parameters including sensitivity tests on roughness values and on key structures for urban HPWs.

The models will be used to simulate and map the current and future flood extents and flood hazard for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEP fluvial flood events considering scenarios with existing defences in place and without defences in place to assess the protection afforded by the existing defences.

We will use the resultant modelled maximum water levels and flows for the HPWs and MPWs in addition to the depth, velocity and hazard results for the HPWs to produce flood extent and flood hazard maps as follows:



- **1D Model Flood Mapping for MPWs:** We will use our in-house tool, developed in ArcGIS, to generate flood maps from one-dimensional model cross-sections, intersecting the maximum water level with the digital terrain model to produce flood extent and flood depth grids. The resultant GIS files will be converted into the appropriate MapINFO GIS format to produce the specified flood maps.
- **1D/2D and 2D Model Flood Mapping for HPWs:** Water level, depth, velocity and flood hazard can be directly extracted from the model and then post-processed into the appropriate MapINFO GIS format to produce flood maps. Flood hazard will not consider the impact of debris as specified by OPW. If information is required for the one-dimensional channel, water level lines will be incorporated into the model so that water level, depth, velocity and hazard function can be mapped for the channel.
- **Horizontal Projection Flood Mapping for Lough Leane:** A DTM will be created for the Lough and surrounding area from the latest LiDAR and national digital elevation model. The derived extreme water level profiles will be used to create water level surface across the Lough which will then be intersected with the DTM to create the maximum flood extent. The hydraulic modelling results for Killarney and the Laune Reach 1 will take precedent where this flood extent overlaps with horizontal projected extent for Lough Leane.

The flood extent for Dingle, the lower reaches of the River Laune and the lower reaches of the River Maine are subject to both fluvial and tidal influence. Joint probability analysis of fluvial and tidal events will be undertaken as set out in Section 5.2 of this report to determine the fluvially-dominated and tidally-dominated scenarios. The resultant flood extents from each scenario will be merged to show the maximum extent of flooding from either source thus meeting the CFRAM requirements for flood mapping.

This will be an automated process carried out using the 'union overlay' function in ArcMap. The merged map will then be converted to the appropriate MapINFO GIS format to produce the flood extent map. It will not be produced for the other map formats.

## 5.5 Flood Risk Assessment (FRA)

Flood risk is a combination of the probability and degree of flooding (the 'hazard') and the damage caused by the flood (the 'consequences'). What constitutes hazard and consequences are described below.

Flood hazard can arise from a range of sources of flooding, the SW CFRAM Study addresses the following sources:

- Rivers (fluvial)
- Sea (coastal and tidal)

The following four risk receptor groups are vulnerable to the potential adverse consequences of flooding:

- Society
- Environment
- Cultural
- Economy

We will assess and map the potential adverse consequences associated with flood hazard in each of the AFAs.

### 5.5.1 Social Risk

The social flood risk shall be assessed, mapped and reported upon using four methods and indicator sets:

- the location and number of residential properties
- the location, type, and an indicator of vulnerability and number of potentially high vulnerability sites, such as residential homes for children, the elderly or disabled, etc.
- the location, type, and an indicator of vulnerability and number of valuable social infrastructural assets, such as fire stations, Garda stations, ambulance stations, hospitals, government and council buildings, etc.
- the location, type, and an indicator of vulnerability and number of social amenity sites, such as parks, leisure facilities, etc.

### **5.5.2 Risk to the Environment**

The flood risk to the environment shall be assessed and mapped and reported upon using three methods and indicator sets:

- The location, type, an indicator of vulnerability and number of installations referred to in Annex I to EU Directive 96/61/EC (1996) concerning integrated pollution prevention and control and other significant potential sources of pollution.
- The location, extent, nature and an indicator of vulnerability of areas identified in Annex IV (1) (i), (iii) and (v) to the Water Framework Directive (EU Directive 2000/60/EC)
- The nature, location, an indicator of vulnerability and areas of other environmentally valuable sites, such as SACs.

### **5.5.3 Risk to Cultural Heritage**

The flood risk to cultural heritage shall be assessed and mapped and reported upon using one method and indicator set:

- The location, type, an indicator of vulnerability and number of sites or assets of cultural value

### **5.5.4 Risk to the Economy**

The flood risk to the economy shall be assessed and mapped and reported upon using four methods and indicator sets:

- The location, type (residential and classifications of non-residential) and numbers of properties, with associated frequency-depth-damage information based on property type
- The density of economic risk expressed as annual average damage (euro / year) per unit area (e.g., per 100m or 500m square)
- The location, type, an indicator of vulnerability and number (and / or lengths) of transport infrastructural assets, such as airports, ports, motorways, national and regional roads, rail, etc.
- The location, type, an indicator of vulnerability and number of utility infrastructural assets, such as electricity generation and sub-stations, water supply and treatment works, natural gas and oil facilities, important telecom interchanges, data repositories, etc.

### **5.5.5 Indicators of Vulnerability**

Indicators of vulnerability are typically a categorisation of vulnerability (e.g., very high to very low) or, a numerical or economic consequence or depth-consequence curve in the event of flooding. The indicators of vulnerability are to be provided by OPW for each type of social, environmental, cultural and economic risk receptor.

The definition of the indicators of vulnerability shall be reviewed and, if necessary and agreed, refinement of the NTCG, subject to approval of the OPW.

#### **5.5.6 Risk Assessments**

We will undertake the risk assessments using relevant information for all of the design flood event probabilities for existing conditions and for the MRFS. We will prepare the Preliminary Options Report where the results of the flood risk assessments under the four risk receptor groups shall be described. For each AFA, we will prepare a range of flood risk maps that present the flood risk in a clear manner.

### **5.6 Strategic Environmental Assessment (SEA)**

We will prepare the SEA to have due regard to best practise guidance in the context of its application to CFRAMS which will include the EPA SEA Pack 2010, the Strategic Environmental Assessment (SEA) And Climate Change: Guidance For Practitioners, 2004, the 'Draft GISEA Manual' updated in 2010 and DEHLG guidance on the Implementation of SEA Directive (2001/42/EC): Assessment of the Effects of Certain Plans and Programmes on the Environment Guidelines for Regional Authorities and Planning Authorities November 2004.

#### **5.6.1 Phase I Screening Assessment**

A Screening Assessment has been completed by others for this project. Our first task will be to confirm the basis for and conclusions of the Screening Assessment to ensure that all parties are moving from the same starting position in relation to the basis for the requirement for the SEA. This is an important legal consideration which will need to be clearly documented and tracked in later deliverables as the legal process is completed.

#### **5.6.2 Phase II Constraint and SEA Scoping Study**

This phase essentially sets the goalposts for the assessment process to ensure that it remains relevant, focussed and coherent. We will assess other plans and programmes relevant to the South Western District and will determine the aspects of such plans / programmes that should be considered as part of the South Western CFRAM Study in order to ensure consistency across the board.

There are clear interrelationships between the mitigation and monitoring measures committed to the SEA for the South Western River Basin District Management Plan and the CFRAM Study SEA which need to be carefully integrated, particularly where requirements for Appropriate Assessment and other such commitments have been identified as being necessary. Similarly, Freshwater Pearl Mussel Plans and Shellfish Pollution Reduction Programmes in the SWRBD prescribe measures that will be considered in the CFRAM SEA. The Lee CFRAMS SEA will also be considered.

We will complete the necessary desk studies and preliminary site visits to identify any significant constraints which would have a significant influence on the design and / or implementation of any flood risk management measure. We intend to do this by identifying the key environmental sensitivities in the study area, the basis for these sensitivities and how they can be managed such that options are presented to the Steering Group / Progress Group rather than constraints.

In order to assess the vulnerability of sites and areas to flooding it will be necessary to characterise the sites in terms of their sensitivity. Vulnerability of the designated areas / environmentally valuable sites to pollution loading from licensed discharges will be spatially evaluated against 'flood hazard' areas.

### **5.6.3 Phase III Option Appraisal Study**

We will assess and report on the possible environmental benefits and impacts associated with each measure and option. The evaluation of the 'Do Nothing' or 'Do-Minimum' scenarios will be very important to set the context of the FRMP.

We will assess and rank the options (with and without impact mitigation measures) against the environment objectives, indicators and targets identified at the Scoping Stage.

In assessing the options there is a necessity to ensure that the alternatives are evaluated using clear multi-criteria analysis developed in consultation with the OPW. The selection of the evaluation mechanism, weighting and scoring will need to be carefully analysed and subjected to sensitivity analysis to underpin the robustness of the outputs. We will also have due regard to the experience gained by the OPW in the Lee CFRAMS SEA as the statutory consultees (e.g. EPA) will have reviewed the methodology presented therein. It will be important to demonstrate cross-comparability in the logic applied across individual CFRMPs. We will set out clearly the justification for choosing each of the preferred options.

The environmental benefits / impacts of each measure / option may be ex situ or in situ and may be direct or indirect. The relationship between each measure / option and environmental receptor(s) will be considered and a source-pathway-receptor evaluation made. The impacts / benefits will be evaluated with respect to their duration, scale, extent and nature. Cumulative impacts / benefits will also be assessed. Where negative effects are predicted we will set out recommendations for environmental mitigation. Mitigation will follow the 'mitigation hierarchy' i.e. Avoid at source; Reduce at source; Abate on site; Abate at receptor. We will ensure that all mitigation measures pass the SMART test, i.e. specific, measurable, achievable, with responsibility for their implementation clearly assigned and time limited (i.e. when they are required to be implemented). Mitigation measures will be reflective of any prescribed in the Habitats Directive Assessment and will also incorporate relevant mitigation from protected area/species plans.

Having due regard to the proposed monitoring programme, it is very important that third parties to the process understand the legal interpretation of what is meant by monitoring. Certain parties will consider this to be field investigations, etc. however due to the nature of SEA it is more typical to consist of strategic level datasets and monitoring have they are being effected, in this case, the CFRMP.

In specifying the content of the Monitoring Programme we will ensure that validity, accessibility, frequency of update and ownership of the datasets to determine the applicability and the extent to which they are meaningful or 'fit for purpose'.

### **5.6.4 Phase IV SEA Report**

In parallel and close co-ordination with the identification and development of the preferred flood risk management strategy and the preparation of the Flood Risk Management Plan, we will prepare an SEA Report covering the preferred options and Plan. Very importantly it will also contain a history of the SEA process and how it was conducted particularly emphasising stakeholder and public involvement.

### **5.6.5 Phase V Update of SEA Report**

We will undertake any necessary revisions to the SEA arising from submissions on the draft Final Report of the CFRAM Study, including speedy, yet robust SEA on significant changes to the plan.

### **5.6.6 Production of the SEA Statement**

From a legal and process perspective the production of the SEA Statement is the most important phase in the process. The function of the SEA Statement is to identify how the SEA process has influenced the plan. This requires careful scripting, particularly in the context of how differing opinions from consultees have been managed throughout the process.

## **5.7 Appropriate Assessment**

We shall carry Appropriate Assessments in accordance with the requirements of Articles 6(3) and 6(4) of Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive) to inform the Competent Authority of whether the plan will have adverse impacts on the conservation objectives of the relevant Natura 2000 sites within the zone of influence. The Appropriate Assessment shall be conducted in accordance with all relevant guidance and legislation including:

- European Communities (Birds and Natural Habitats) Regulations 2011
- NPWS (2012) Marine Natura Impact Statements in Irish Special Areas of Conservation, A working Document.
- DEHLG (2009) Appropriate Assessment of Plans and Projects in Ireland Guidance for Planning Authorities;
- EC (2000) Managing Natura 2000 Sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC.
- EC (2001) Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC.
- EC (2007) Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC: Clarification of the concepts of alternative solutions and imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the Commission.

## **5.8 Development of Flood Risk Management Options**

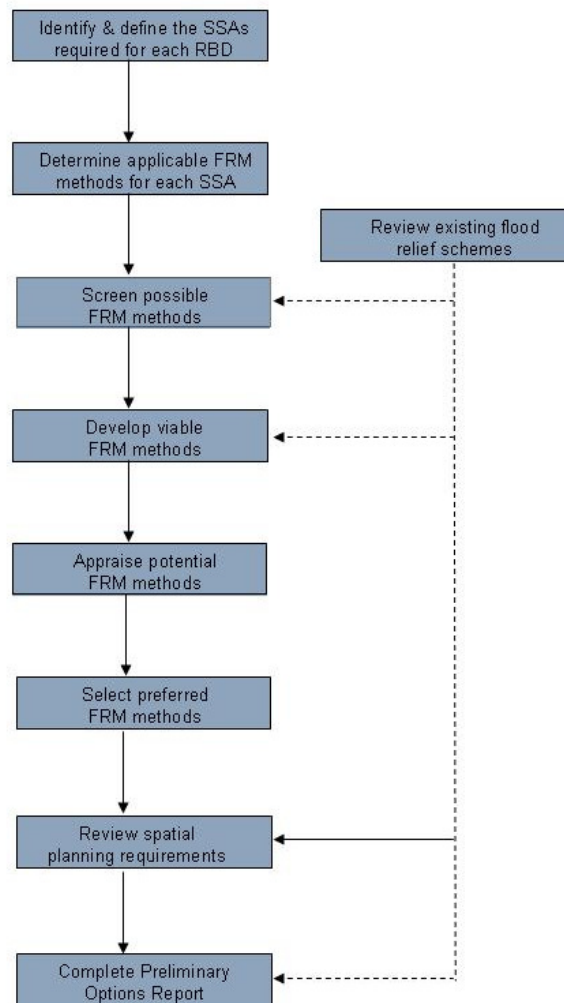
### **5.8.1 Summary**

Each FRMP will set out a list of actions required for various spatial scales. Each action will be supported by a description of the objectives and need for that action, an indicative cost, a timescale for implementing the action, and identification of responsibility.

We will derive these actions from a detailed option appraisal, described in the following Section (and summarised in Figure 5.3). This appraisal will not only identify the recommended way forward, but will also

provide robust and clear opinion on why other options were deemed to be inappropriate. This clear and auditable process will provide the requisite sound foundation for future full development of measures to be taken to planning and subsequent implementation.

Figure 5.3: The Flood Risk Management Process



### 5.8.2 Preferred Design Standards

The preferred design standards that we will adopt for the development of flood risk management options will be the 1% AEP for fluvial flooding and the 0.5% AEP for tidal flooding.

Notwithstanding the above, there may be instances where higher design standards can be accommodated for at little or no additional cost. For example, closure of a low spot, or saddle, within a natural embankment could provide a standard of protection significantly in excess of the required standard for limited additional cost. Where this is the case we will use a benefit:cost analysis to determine appropriate defence levels.

Likewise there may be instances where it is unviable to provide the preferred design standard for every property within an AFA. For example the infilling of gaps in a quay wall may provide a cost effective means of protecting properties from frequent flooding where a 2m high river wall necessary to protect an area from the 1% AEP flood may not be acceptable. In this case we will assess viable options using a benefit:cost model and determine an appropriate way forward.

### **5.8.3 Flood Risk Management Methods**

#### **5.8.3.1 Flood Forecasting Systems**

Flood forecasting is one of the commonly used methods of managing flood risk. Although it does not reduce the extent of flooding, it provides a means of reducing the socio-economic impacts of flooding if combined with an efficient action plan.

For each AFA we will investigate the potential for the development of a flood forecasting system. Although envisaged for individual AFAs we consider it important to assess how individual components can be linked. We will use the modelling results from the hydraulic models to initially assess key information such as the travelling time of flow peaks and the relation between flood levels in the AFA and levels recorded at gauges further upstream.

We will develop a conceptual design of rainfall and flow gauges, existing and new, required to provide reliable forecasts. We will gather information as to the availability and accuracy of RADAR rainfall forecasts in the study area which will be pivotal to the accuracy of any water level forecasts. The use of gauge corrected rainfall radar datasets is also being studied by OPW. The output of their study may be of benefit to this study. We will also refer to ongoing studies relating to Storm Surge forecasting to address tidal flood risk forecasting.

As the rainfall – runoff modelling applied for the purpose of flood forecasting requires the consideration of the actual status of the catchment in terms of storages, generally event based approaches such as FSR and FEH techniques are inadequate. We will propose suitable software for the rainfall – runoff modelling based on our and other consultants' experience.

Equally, the hydraulic modelling techniques used for the modelling of flood risk are not necessarily applicable for the purpose of flood forecasting. This is particularly the case where 1D-2D models have been chosen as their run-time renders them unsuitable for flood forecasting. We will propose suitable software and approaches for the routing of flows from catchments to the AFAs.

We will also investigate operational systems which have the ability to link the input data, the rainfall runoff model and routing model together and provide the level predictions in an appropriate format. We will also investigate the drainage network in the context of flooding and its prediction for the Lower Maine. Where important we will propose methods of linking the drainage network to the surface water modelling.

Upon agreement of draft conceptual designs we will provide a comprehensive cost estimate for the installation and the operation of the flood forecasting systems

#### **5.8.3.2 Strategic Sustainable Urban Drainage Systems**

The use of SUDS to attenuate discharges and intercept pollution flowing into river and other watercourses, and thus reduce flooding, is a key issue. We would analyse existing information in flood mapping reports on



soil types, infiltration drainage capacity, topography, watertable depths and watercourse capacities held by the OPW and other authorities. This baseline information would be used to develop a map showing potential areas in which SUDS might be used.

#### 5.8.3.3 Dams, Reservoirs and Operable Control Structures

It will be required to review the operational and regulatory controls at dams and other hydraulic structures on HPW's and MPW's to determine the potential for a general reduction in flood risk.

When doing this work it is vital to understand that dams and other storage facilities provide value to the community in a number of different ways, including:

- Reduction in flood risk
- Provision of a robust water supply system
- Supply of irrigation water
- Hydropower
- Amenity (i.e. sailing, fishing, visual improvement)

Usually a single structure will provide more than one of the above benefits meaning that it is a multi-functional asset. Where this is the case, we must take into account the fact that while altering the operational strategy at the structure may, for example, mitigate flood risk, a by-product could be reduced long term average reservoir water levels which would impact on amenity and storage potential. In simple terms a greater reduction in flood risk can be gained by keeping the storage reservoir as empty as possible. Clearly this strategy could be at odds with other stakeholder beneficiaries.

The above are common issues. In these situations it is relatively easy to compare the different types of benefit afforded by the reservoir through a traditional financial analysis, however, we have found that this represents only a small percentage of the work required to develop an acceptable operational plan. The "owners" of water supply, flood risk, power and amenity facilities tend to be different private and public bodies, all of which have their own requirements and objectives. An effective operating plan will require a comprehensive understanding of the needs of all these project stakeholders. We have found that this is best achieved through a co-ordinated stakeholder engagement strategy which facilitates catchment wide discussions and solutions.

#### 5.8.3.4 Structural Measures

**Storage:** In certain circumstances the upstream storage of flood water will be an effective measure to reduce the potential damage that could result from flooding. This is achieved by reducing the peak flow that would be experienced in a watercourse and thereby reducing the depth of flooding experienced for a certain AEP. Flood storage will be effective where the magnitudes of peak flows are relatively small and there are suitable sites upstream of the at risk area to hold the flood water in either a single site or a number of smaller sites. This methodology may be suitable for use in the areas at risk in UoM 20 and 21 which are located on relatively short watercourses. For larger, flatter catchments storage is not always a viable option as the volume of storage required to dampen the peak flow can be very large giving rise to large areas of land that have to be set aside for flood storage. This in turn may lead to the cost of providing storage being prohibitively expensive.

**Flow diversion:** In certain areas at risk it may be possible to divert peak flows away from areas at risk thus reducing flood depth in those areas during extreme events. Important considerations in deciding whether a flood channel such as this is viable or not include; the topography of the area, the length of by-pass



required, the infrastructure that would require diversion (bridges, services, etc.) and the possible backwater effect from where the flood flow rejoins the existing channel.

**Flood Defences:** In areas where receptors are grouped together it may be feasible to protect them from flooding by the construction of solid flood defences. Earthen embankments can be very effective flood defences as long as the seepage under the defences is not excessive. Embankments require a large footprint and are generally suitable for use in open areas only. Where space for the construction of defences is restricted flood defence walls are required. These can be expensive to construct when compared to embankments as the materials are more expensive and for given ground conditions the depth of groundwater cut-off required for walls is considerably deeper than for embankments. In many AFAs there may be existing flood defences which could be repaired to a useful state. Generally the height of existing defences are much lower than would be required by modern design standards and the level of defence offered by repairing existing defences can be difficult to justify in terms of AEP.

In addition to the above mentioned methodologies we would consider other options for flood risk management including but not limited to works that would lead to improvements in channel conveyance characteristics by the widening and or deepening of river channels, the relocation of properties at risk and the provision of temporary flood barriers where long lead flood forecasting is possible.

#### 5.8.4 Screening of Possible FRM Methods

We will develop flood risk management options for three Spatial Scales of Assessment (SSAs). These are at the Unit of Management Scale, The Sub Catchment or Coastal area scale and the AFA scale. We will develop these options using a defined process which will include:

- An initial high level screening of FRM options
- Development of the screened options to identify tentative scheme solutions
- Appraisal of scheme solutions using a multi-criterion analysis
- Selection of the preferred scheme

The high level screening will look at individual solutions to determine their viability based on a set of criteria, namely: applicability to the relevant area and, economic, environmental, social and cultural aspects. This screening will usually be based upon an assessment of issues and benefits using experience and professional judgement except in specific cases where quantitative data is available. A brief example of an initial screening exercise is provided in Figure 5.4.

Figure 5.4: Example of an Initial Screening Exercise

|                         |  |
|-------------------------|--|
| <b>Identified Risk:</b> | Significant fluvial flooding of 3 residential properties at a calculated rate of occurrence of 2% (on average once in fifty years).  |
| <b>Objective:</b>       | Remove flooding to the 3 properties for the 1% AEP   |
| <b>FRM Method:</b>      | Construct a Flood Storage Area (FSA) upstream of the properties  |
| <b>Applicability:</b>   | Satisfactory. Rural area with geotechnical and geological conditions commensurate with the construction of an impounding embankment. Local construction materials available. Access to construct and maintain the FSA is reasonable. |

|                       |   |
|-----------------------|---|
| <b>Economic:</b>      | Questionable. The economics of building a FSA to protect only 3 properties are likely to be unviable. There are no realistic opportunities for micro-hydro or amenity benefits. |
| <b>Environmental:</b> | Slightly positive. Likely to enhance marginal flora and fauna as existing land is used for grazing only.  |
| <b>Social:</b>        | Significantly negative. Likely to be extensive land ownership issues with local farmer known to be unwilling to sell. Landowner is an influential local politician.             |
| <b>Cultural:</b>      | No known issues   |
| <b>Outcome:</b>       | Given the questionable economic outcome of the method and the known issues with land ownership, our recommendation is not to pursue this option.                                |

We recognise the importance at this stage of only ruling out those methods which are clearly inappropriate. For this reason we recommend carrying out an initial review of each method (as above). Where the outcome recommends abandoning the option we will then briefly revisit the screening to expand and confirm those criteria which are deemed to be critical – in the above example, economics and land acquisition.

### 5.8.5 Development of Potential Options

When developing options we will utilise those methods which the screening analysis confirmed as being appropriate and develop / combine them into a scheme solution. In most cases we expect that a single solution (e.g. enhancement of flood defences within the urban area) will be unlikely to fully mitigate the identified risk. We will therefore need to combine this with other approved methods, such as implementation of a sustainable urban drainage system, provision of upstream storage, construction of a flood bypass channel or implementation of a catchment wide flood forecasting and warning system.

The intent will be to develop a series of schemes which each satisfy the identified flood risk objective. The number of schemes identified in this development phase will vary according to the particular issues observed at the locale; however, we would endeavour to provide at least three to enable a realistic comparison and appraisal to take place.

Some of the schemes may have sub-options associated with them (i.e. provide a flood bypass channel in open cut or using a culvert) and some may look at alternative flood design standards (2%, 1% and 0.5% AEP). However, our extensive understanding of flood risk engineering will be used to identify sustainable and innovative solutions while rigorously assessing each scheme to ensure that we do not go down the path of “option overload”.

### 5.8.6 Appraisal of Potential Options

We will discuss and agree with OPW the detailed methodology to be adopted for the appraisal of the different schemes.

We currently see the appraisal as being a two phased approach involving a multi-criteria analysis set against a series of minimum and aspirational targets for each objective, and a detailed benefit:cost analysis. As with all appraisals of this type, we will endeavour to use quantitative evidence where it is

available but recognise that in some cases this will not be possible and in these instances a quantitative approach will be developed.

There are two traditional approaches to a multi-criteria appraisal:

- An un-weighted analysis
- A weighted analysis

The un-weighted approach does not attempt to directly compare say, infrastructure benefits with environmental benefits. It merely assigns a score for each objective. Schemes can then be compared at an objective level, but not at an overall scheme level.

A weighted analysis attempts to allow comparison across objectives by, for example, assigning a factor which allows protection of a cultural asset to be directly compared with an environmental asset. This allows a scoring system to be developed for an entire scheme with the objective being that the scheme that scores most highly is deemed the preferred option. This approach has clear advantages over the un-weighted analysis in terms of affording much better comparability, but it suffers from the inevitable qualitative assumptions made when setting the weighting criteria.

The weighted multi-criteria analysis will be followed by a standard benefit:cost analysis for each scheme. We do not anticipate incorporating amenity, environmental or similar potential indirect scheme benefits in the economic benefit:cost appraisal, as the results of doing this are highly qualitative; instead we will consider these issues in the multi-criteria analysis.

We will develop scheme costs to the required level of detail. For this we will utilise our extensive internal cost database of similar construction activities, allied to external sources where required. These will include SPONS, WESSEX and the EA's cost database for river based engineering works. We are fully aware that scheme cost assessments carried out at feasibility and outline design phases traditionally underestimate final outturn costs by up to 60%. We will therefore discuss with OPW a rationale for using an optimisation bias in all cost determinations to offset this.

### **5.8.7 Selection of Preferred Options**

The preferred option shall be identified using the above option appraisal methodology. In addition we are required to confirm that the preferred scheme is:

- Viable against all criteria
- The most beneficial option relative to cost
- Spatially coherent
- Temporally coherent

In terms of spatial coherence we will consider whether the scheme provides advantages or disadvantages to other SSAs in the vicinity and in terms of temporal coherence we recognise the need to consider the timing of additional options required as a result of future variation, such as climate change.

For each preferred option we will identify a series of actions and measures which need to be undertaken to implement the scheme. These will then form the basis of the Flood Risk Management Plan. In addition, and in consultation with OPW and the steering and stakeholder groups, we will prioritise the actions, taking account of potential budgets and time constraints.

### **5.8.8 Spatial Planning and Impacts of Development**

We will review the Development Plans, Local Area Plans and any other spatial planning documents relevant to each AFA and each Unit of Management as a whole, including Plans or documents in force or in draft form at the time of the review.

We will discuss potential land use, spatial planning and development management policies, objectives, zoning and issues with the planning departments of Local Authorities whose jurisdiction falls in part or in whole within the AFAs and / or Units of Management.

On the basis of the review and discussions and with reference to all other work undertaken under the Project, and to the Guidelines on the Planning System and Flood Risk Management, we will develop and discuss the high-level draft recommendations. We note that such recommendations shall, where appropriate, form actions or measures to be included in the FRMP.

### **5.8.9 Preliminary Options Report**

We will prepare and submit the Preliminary Options Reports. In particular we note the requirements to potentially provide copies of the Spatial Planning and Strategic SUDS sections of the report in isolation and the need to prepare separate reports for each Unit of Management within the study area.

## **5.9 Flood Risk Management Plan (FRMP)**

We will prepare a separate Flood Risk Management Plan (FRMP) for each Unit of Management, including a 10-15 page executive summary that can be read in isolation.

The FRMP will briefly outline the Project and the flood risk assessment and analysis, and then clearly set out the flood risk management policies, strategies, actions and measures (proposed) to be implemented by the OPW, Local Authorities and other relevant bodies.

The flood extents generated will be used to assess the flood risk in the study area in terms of the economy, society, the environment and cultural heritage. This will be done using the methodologies outlined in our tender submission in conjunction with the receptor data listed in Section 3.1.6. This data will be supplemented with property occupancy data gathered from each AFA.

Following the completion of the analysis of the potential damage that could be caused by flooding we will investigate the available options to mitigate that damage in each of the AFAs as described in our submission.

We will carry out environmental assessments as described in our tender methodology. The Appropriate Assessments carried out will determine the environmental impacts of each of the various potential flood risk management options identified. These assessments will form an integral part of the selection of preferred options.

Throughout the study we will seek to engage with stakeholder as set out in the Communication Plan.

We understand that the FRMP will be publicly available, and should be non-technical and suitable for use by politicians, stakeholders and the public. The main text of the FRMP will typically be in the order of 100 pages in length (excluding the executive summary and appendices).

The hydraulic models developed for the assessment of current and future flood risk will be used to develop and appraise the potential strategic flood risk management options developed in the flood risk management plan. The modelling results will be compared to the existing risk and used to inform the economic, social and environmental impacts for each proposed option.

Subsequently, the model results will be used to develop and assess sustainable flood management options as part of the FRMPs.

## 5.10 Constraints and Opportunities

The key hydrological constraints for the Laune, Maine and Dingle Bay catchments are associated with water level, flow and rainfall gauge data availability both in terms of spatial and temporal coverage. The data availability and quality has been assessed as part of the data review (Chapter 3).

The key hydraulic constraints for the Laune, Maine and Dingle Bay catchments are as follows:

- The spatial coverage and quality of the river channel survey (see Chapter 4 in this report)
- The spatial coverage of coastal water level data for Dingle Bay and Castlemaine Harbour (See Chapter 5)
- The spatial coverage and quality of topographical data for the floodplain (see Chapter 4 in this report)
- The spatial coverage of hydrometric gauges for Dingle, Milltown and lower reaches of the River Maine and the River Laune (see Chapter 3 in this report)
- The spatial and temporal coverage of river flow and level data which could limit calibration of the hydraulic models. In such data poor locations, the design flood outlines and water level profiles will be compared with anecdotal flood evidence and estimated frequency of historic events as an indicative measure of what might be considered reasonable in place of full calibration.
- The limited timescale to develop the draft flood risk maps ready for the EU Floods Directive 01 January 2014 deadline constrains the detail in the hydraulic modelling approach for MPWs. Therefore, a strategic approach using 1D modelling has been applied to ensure the EU Flood Directives deadline can be met.

Therefore, the level of assessment outlined in Map 2.1 is proportionate to the level of risk and availability of data so that the EU Floods Directive deadline can be met.

The key opportunities for UoM 22 arising from the SWRBD CFRAMs are as follows:

- Opportunity to improve understanding on flood risk from fluvial and coastal sources and key flood mechanisms for key AFAs;
- Opportunity to improve underlying topographic data and hydrometric data at Castleisland through new surveys and rating reviews.
- Opportunity to communicate with and build relationship with other stakeholders and local communities to improve knowledge and understanding of the risk and viable options to mitigate any existing risk.
- Opportunity to improve management of flooding whether through development of flood alleviation schemes, property level protection measures or improve flood forecasting and warning services to better prepare local communities

## 6. Summary

### 6.1 Progress to Date

#### 6.1.1 Flood Risk Review

The Flood Risk Review has been completed and the final AFA definitions agreed. This process included a review of the PFRA outputs, data collection on historical events and consultation with Local Authorities and Stakeholders. Following this, site inspections were carried out which informed the final AFA definitions. These AFA's are listed in Table 1.1.

#### 6.1.2 Hydrological Analysis

Chapter 4 of this report assess the hydrometric, meteorological and historic flood data for UoM 22. The key findings include:

- There are 14 suitable existing river flow gauges for the derivation of design flows in UoM 22;
- There are 2 additional water level gauges suitable for the analysis of hydrograph shape and timing in UoM 22;
- Castleisland gauge will also be suitable for the derivation of design flows following the rating curve development in the main hydrological stage;
- The Milltown catchments do not have any river flow or water level gauges but it is anticipated that suitable gauges in nearby catchments or rainfall-runoff methods will provide appropriate design flows;
- There are no active tidal gauges within UoM 22 which limits the verification of tidal analysis in Dingle Bay.
- Preliminary flows and return periods were estimated for 9 historic flood events since reliable records began in 1980.
- The November 2009 flood event is the largest magnitude event which principally affected Killarney, Lough Leane and the River Laune downstream, although no property flooding was reported.
- Three separate calibration events were selected for the hydrological and hydraulic calibration in the Laune catchment namely;
  - 19<sup>th</sup> November 2009
  - 23<sup>rd</sup> October 2008
  - 2<sup>nd</sup> November 1980.
- Three separate calibration events were selected for the hydrological and hydraulic calibration in the Maine catchment namely:
  - 19<sup>th</sup> November 2009
  - 4<sup>th</sup> October 2008
  - 4<sup>th</sup> January 2008.
- Typical flooding mechanisms were identified for each of the AFAs based on historic flood evidence and the flood risk review reports.

Section 5.2 of this report expands on the proposed hydrological methodology as applied to UoM 22. The hydrological method statement incorporates the latest Flood Studies Update approach and sets out the methodology for the assessment of design flows including:

- Rating reviews at 3 gauging stations to update the extreme flows and subsequently the Annual Maximum Flood Series (AMAX);
- Conceptualisation of 3 MPW and 4 HPW hydraulic model reaches (7 in total);
- Conceptualisation of 45 HEPs to form the inflows, intermediate targets and downstream conditions to those hydraulics models;

- Estimation of the design index flood value, flood growth curve and typical hydrograph shape at gauged and ungauged fluvial locations;
- Estimation of tidal boundary conditions at Dingle, Portmagee and within Castlemaine Harbour; and,
- Assessment of climate change impacts on design hydrology over the next 50 and 100 years.

## 6.2 Upcoming Works

Following this inception report, the following tasks will be undertaken for UoM 22 to meet the deadlines set out by the EU Flood Directive:

- River Channel Survey – completion date unknown due to FPM issues
- Hydrological Analysis – to be completed by June 2013
- Draft Flood Maps and Hydraulic Report – to be completed by June 2013
- Public Consultation and Engagement on Draft Flood Maps – September to October 2013
- Final Flood Maps and Hydraulics Report – to be completed by January 2014
- Flood Risk and Strategic Environmental Assessment – to be completed by July 2015
- Development of Draft Flood Risk Management Plans (FRMPs) – to be completed by April 2014
- Public Consultation and Engagement on Draft FRMPs – January to June 2015
- Final Flood Risk Management Plans (FRMPs) – to be completed by November 2015



# Appendices

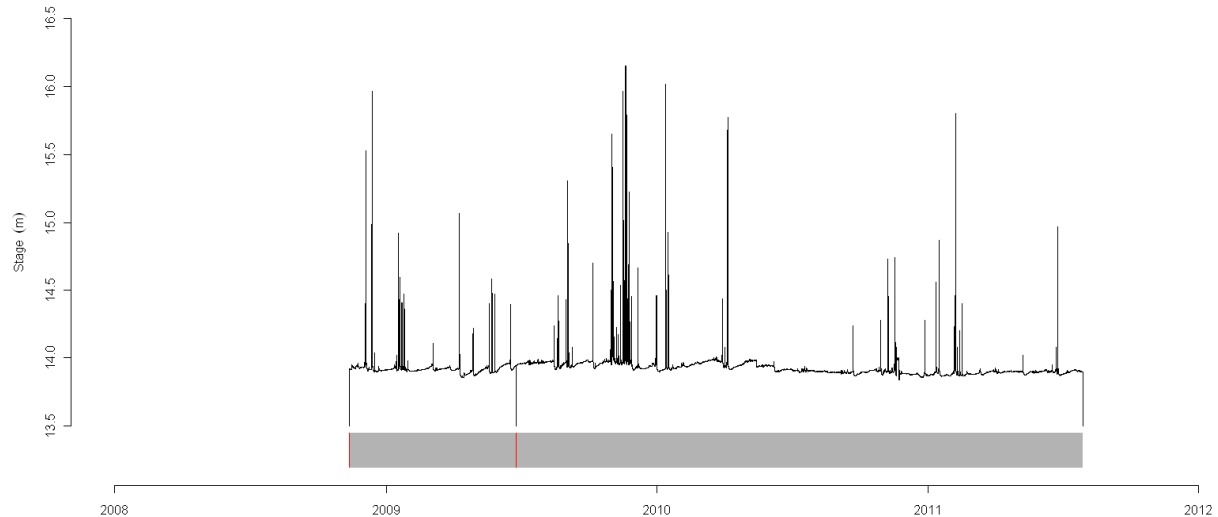
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# Appendix A. Hydrometric Data Review

Table A.1: Selected Hydrometric Gauge Data

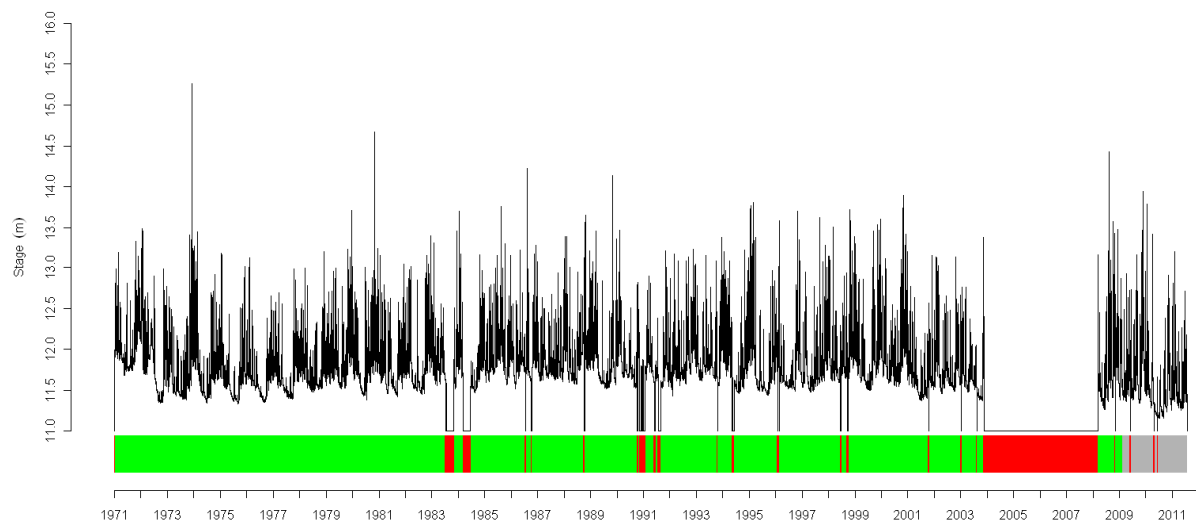
| Stn_No. | Station_Name      | River_Name     | Model         | Easting | Northing | Record_Start | Years Data | Owner | Rating_Curve | Comments   | Fit for Calibration Purposes? | Fit for Statistical Analysis?                  |
|---------|-------------------|----------------|---------------|---------|----------|--------------|------------|-------|--------------|--|-------------------------------|--|
| 22001   | Riverville Bypass | Bypass channel | Maine reach 1 | 92950   | 105725   | 12/11/2008   | 3          | OPW   | No           | Short record, no flow available  | Yes post 2009                 | No   |
| 22003   | Riverville        | Maine          | Maine Reach 1 | 92650   | 106201   | 01/01/1971   | 40         | OPW   | Yes          | Majority of flows have been edited to be suitable for use, significant data gap from 2004 to 2007. Water levels recorded above 14 m pre-2004 have suspect high flows to be verified by model. Statistical analysis should consider the removal of 1974, 1984 and 1987 AMAX flows | Yes                           | Yes, use with caution                          |
| 22005   | Torc Weir         | Owengarrieff   | N/A           | 96604   | 84219    | 01/08/1942   | 70         | OPW   | Yes          | Long record, but with significant data gaps. Potential pivotal site.   | No                            | Yes, post 2000 data                            |
| 22006   | Flesk Br.         | Flesk (Laune)  | Killarney     | 97283   | 89452    | 08/01/1947   | 64         | OPW   | Yes          | Numerous data gaps or poor data quality periods. Significant data gaps in the 1970's, 1980's and in 2006   | Yes                           | Yes, use with caution                          |
| 22009   | White Br.         | Deenagh/Laune  | Killarney     | 95291   | 90260    | 11/01/1982   | 29         | OPW   | Yes          | Numerous data gaps particularly in 1989, and post 2000   | Yes for events post-1982      | Yes, use with caution                          |
| 22014   | Castleisland      | Maine          | Castlemaine   | 99609   | 109506   | 04/02/2002   | 10         | EPA   | Yes          | Data gaps in 15 min data during 2006, 2007 and 2010. Peak flows available from 1985 to 1988 but data not at regular intervals. Rating curve will be reviewed during hydrological study.  | Yes, following rating review  | Yes, following rating review                   |
| 22022   | Milltown          | Milltown       | Dingle        | 93769   | 106440   | 24/01/2002   | 10         | EPA   | Yes          | Data gaps in 2006, 2007 and 2010.  | Yes                           | Yes, use with caution                          |
| 22033   | Kilquane          | Quagmire       | N/A           | 108628  | 90490    | 02/12/1999   | 13         | EPA   | Yes          | Potential pivotal site, data requested for further analysis.   | No                            | No   |
| 22035   | Laune Br.         | Laune          | Laune Reach 1 | 89143   | 91131    | 22/07/1991   | 20         | OPW   | Yes          | Data gap in 2010. Some flows have been edited to make suitable for use. However water level of good quality for assessment of Lough Leane  | Yes                           | Yes, use with caution                          |
| 22039   | Clydagh Br.       | Flesk          | Flesk Reach 1 | 93769   | 106440   | 26/01/2000   | 12         | EPA   | Yes          | Reasonable water level and flow but significant data gaps in 2001, 2004, 2007 and 2011   | Yes                           | Yes, use with caution                          |
| 22041   | Dromickbane       | Finow          | Flesk reach 2 | 93769   | 106440   | 02/12/1999   | 13         | EPA   | Yes          | Good quality and complete data record  | Yes                           | Yes  |
| 22044   | Rahanane Weir     | Stream         | N/A           | 101646  | 94969    | 23/10/1999   | 11         | EPA   | Yes          | Potential pivotal site, data requested for further analysis.   | No                            | Awaiting data                                  |
| 22061   | Castlemaine       | Maine          | Maine Reach 1 | 83544   | 103064   | 04/10/1989   | 23         | OPW   | No           | Reasonable AMAX series but digital records of 15 min water level data only available since 2007. Anomalous spike in early 2008 to be removed from data series and several months' data gap in late 2008.   | Yes                           | Yes, tidal and hydrograph shape analysis only. |
| 22071   | Tomies Pier       | L. Leane       | Lough Leane   | 89959   | 90589    | 01/10/1973   | 38         | OPW   | Yes          | 3 metre datum shift in 1990. Data series adjusted by - 3 m prior to 1990 to match similar levels across the Lough. Significant data gaps in 1988, 2000 and post-2007   | Yes (after processing)        | Yes (after processing)                         |
| 22082   | Bvm Park          | L. Leane       | Lough Leane   | 96640   | 86719    | 25/11/2004   | 7          | OPW   | No           | Short record with significant data gaps in 2007, 2008 and 2011   | Yes                           | Yes, use with caution                          |

Figure A.1: Water Level Data Quality Plot for Bypass Channel @ Riverville Bypass Gauge (OPW - 22001)



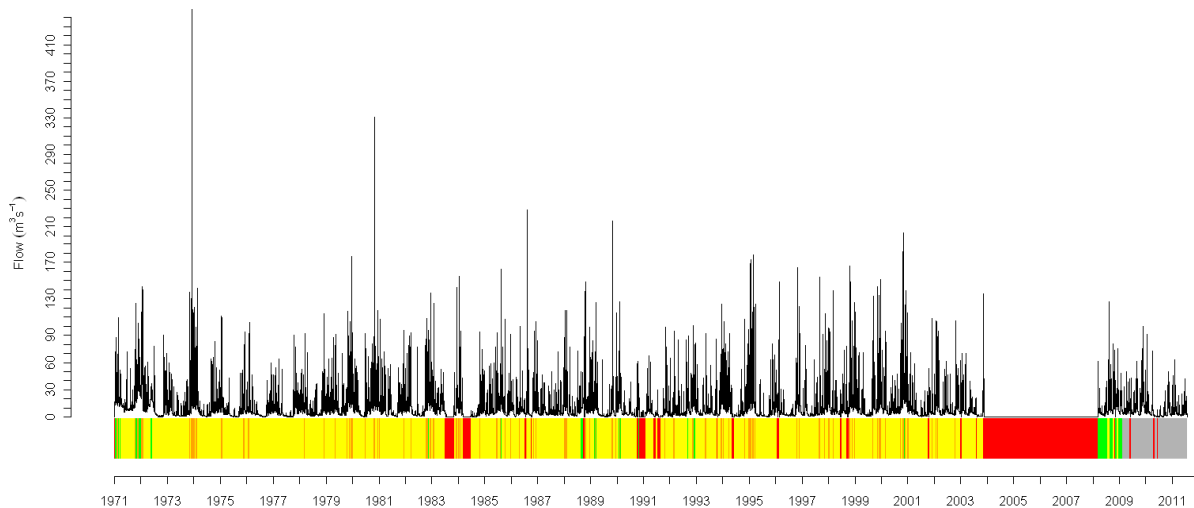
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.2: Water Level Data Quality Plot for Maine @ Riverville Gauge (OPW - 22003)



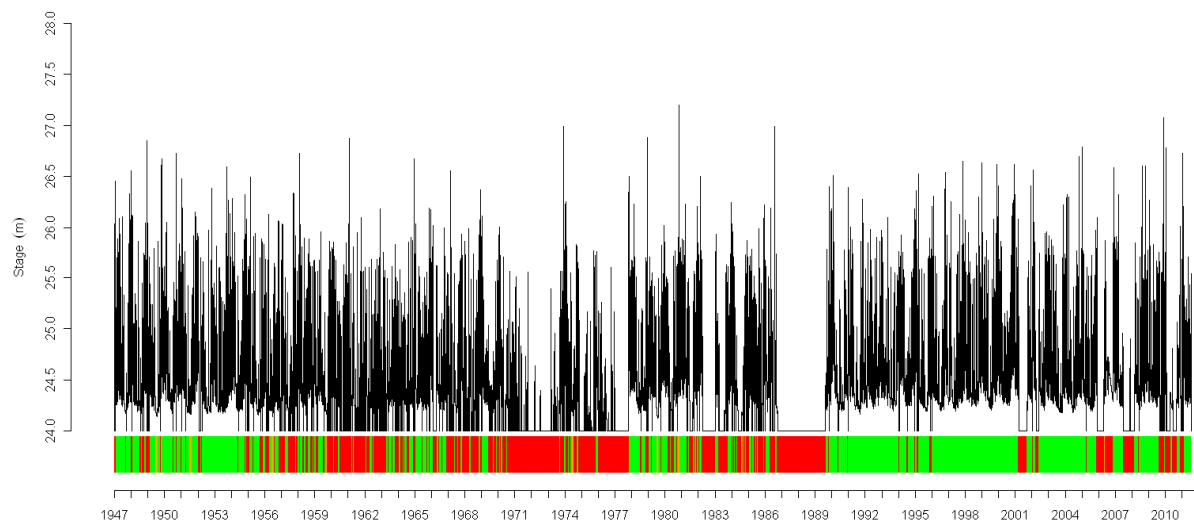
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.3: Flow Data Quality Plot for Maine @ Riverville Gauge (OPW - 22003)



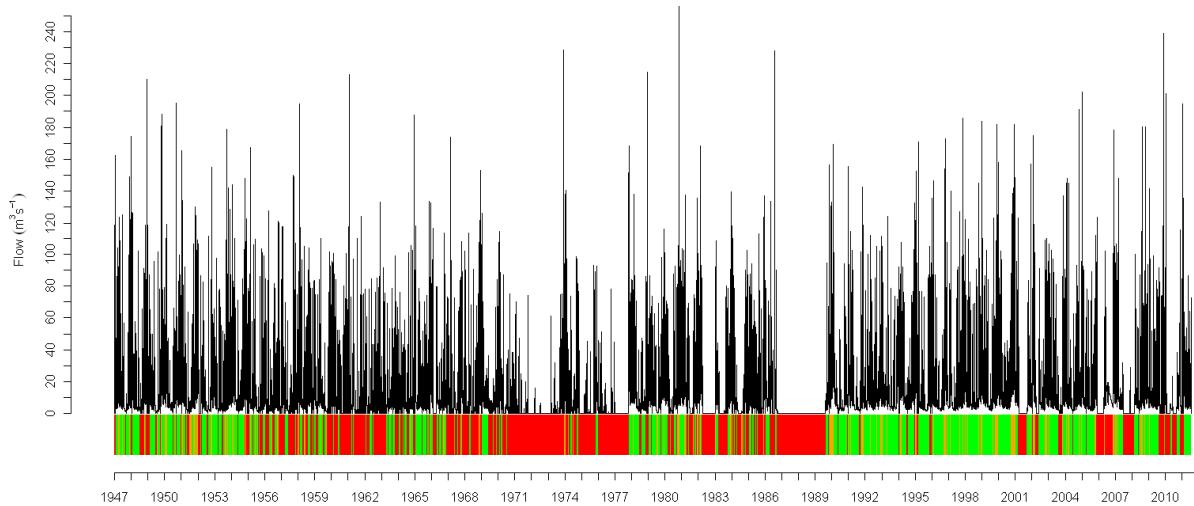
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.4: Water Level Data Quality Plot for Flesk @ Flesk Bridge Gauge (OPW - 22006)



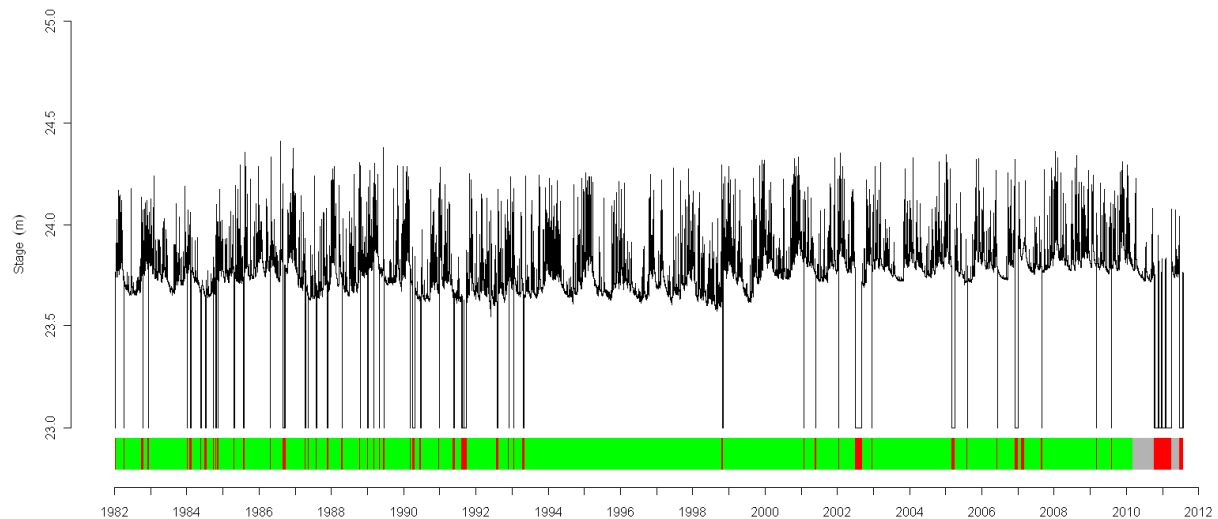
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.5: Flow Data Quality Plot for Flesk @ Flesk Bridge Gauge (OPW - 22006)



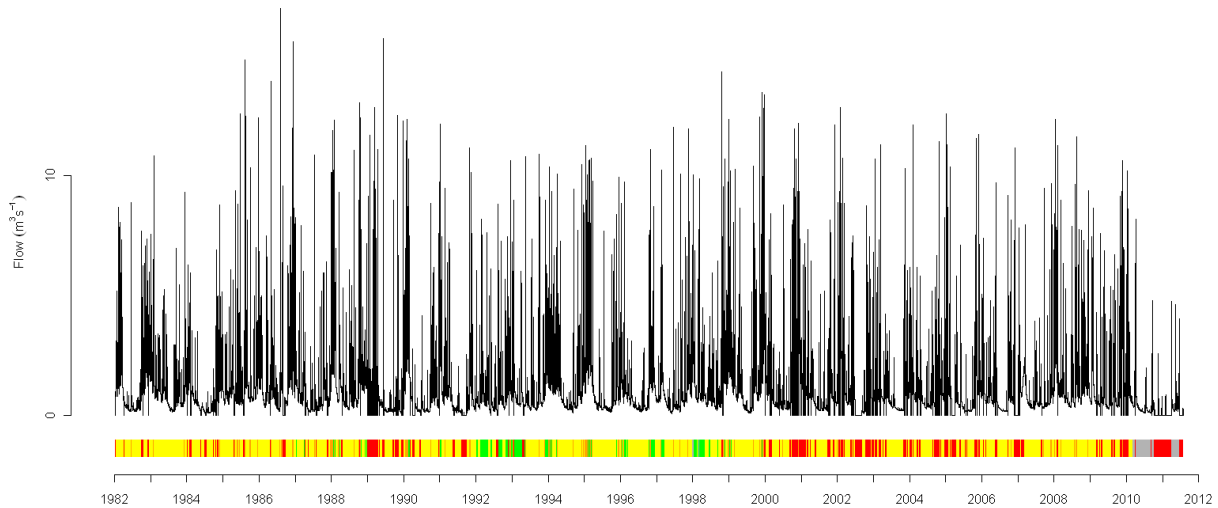
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.6: Water Level Data Quality Plot for Deenagh @ White Bridge Gauge (OPW - 22009)



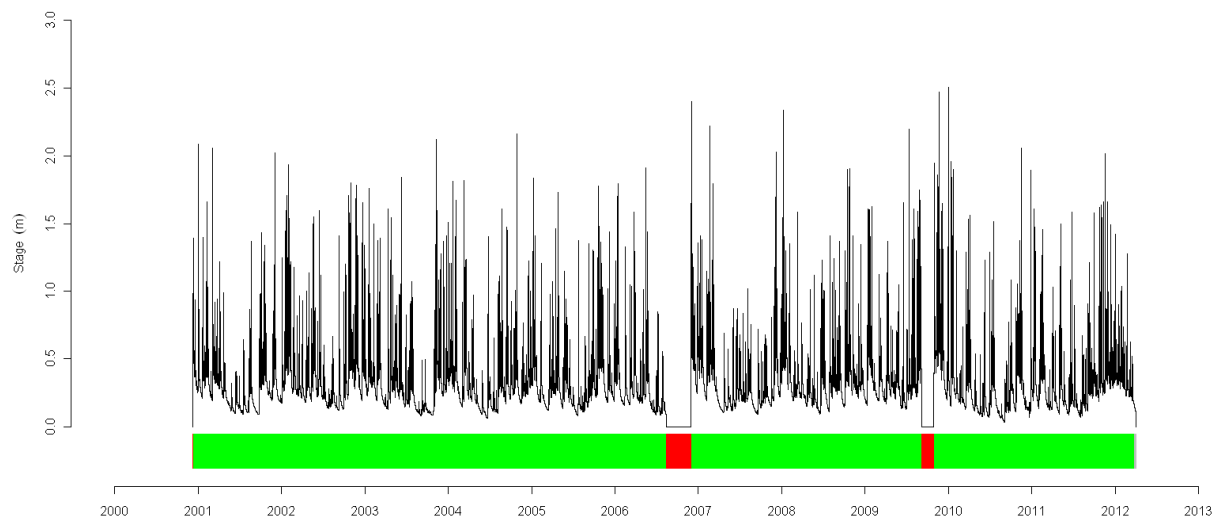
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.7: Flow Data Quality Plot for Deenagh @ White Bridge Gauge (OPW - 22009)



Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

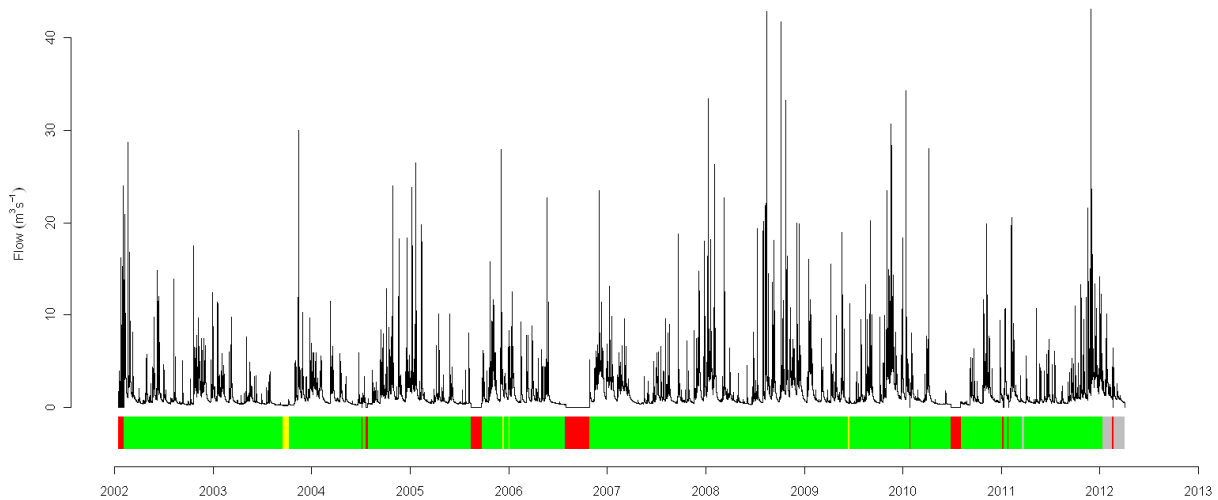
Figure A.8: Water Level Data Quality Plot for Maine @ Castleisland Gauge (EPA - 22014)



Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

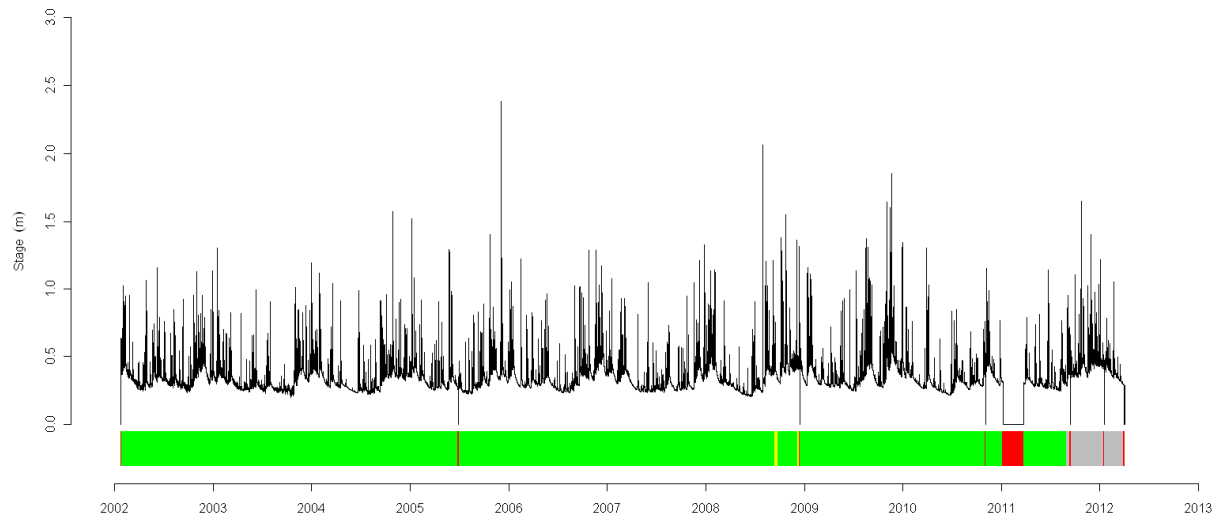


Figure A.9: Flow Data Quality Plot for Maine @ Castleisland Gauge (EPA - 22014)



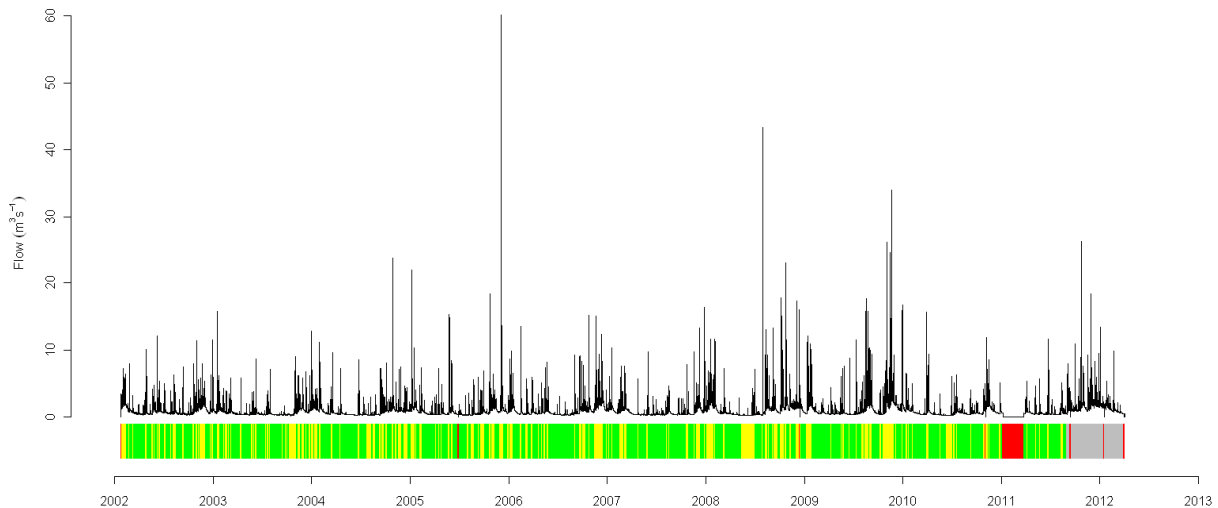
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.10: Water Level Data Quality Plot for Milltown @ Milltown (Dingle) Gauge (EPA - 22022)



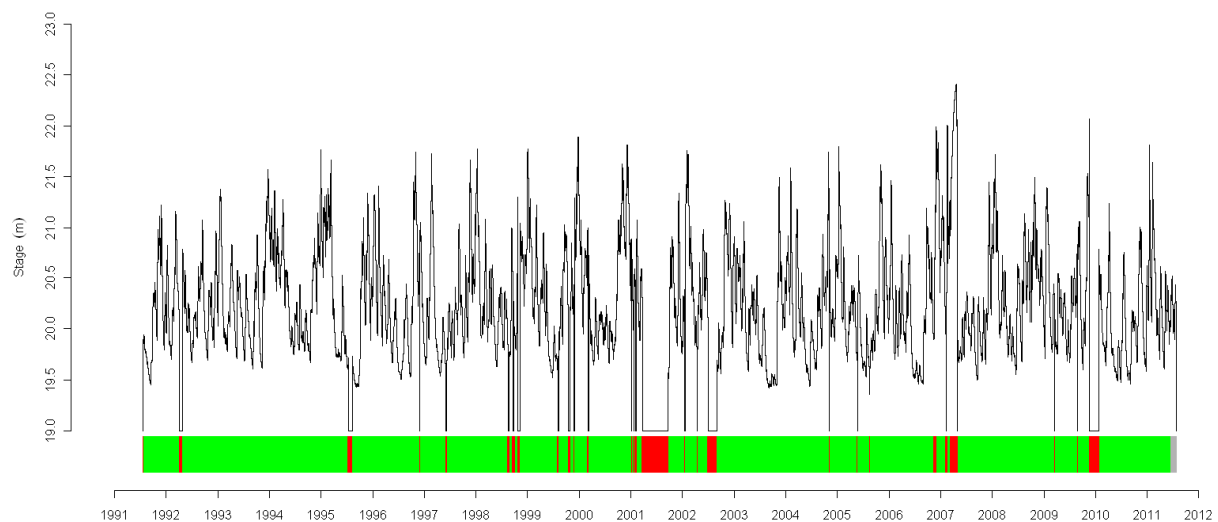
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.11: Flow Data Quality Plot for Milltown @ Milltown (Dingle) Gauge (EPA - 22022)



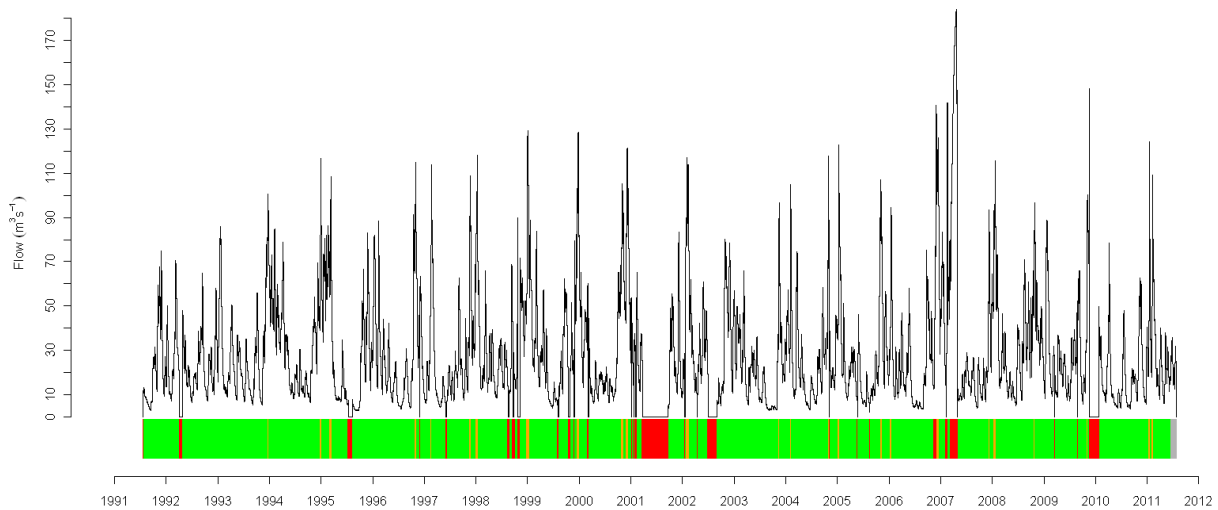
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.12: Water Level Data Quality Plot for Laune @ Laune Bridge Gauge (OPW - 22035)



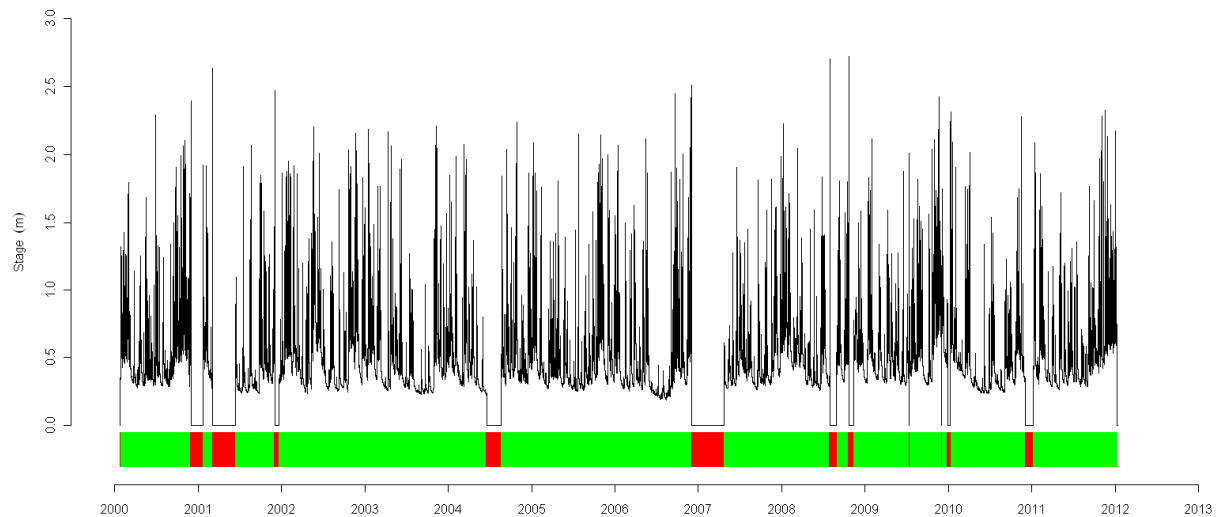
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.13: Flow Data Quality Plot for Laune @ Laune Bridge Gauge (OPW - 22035)



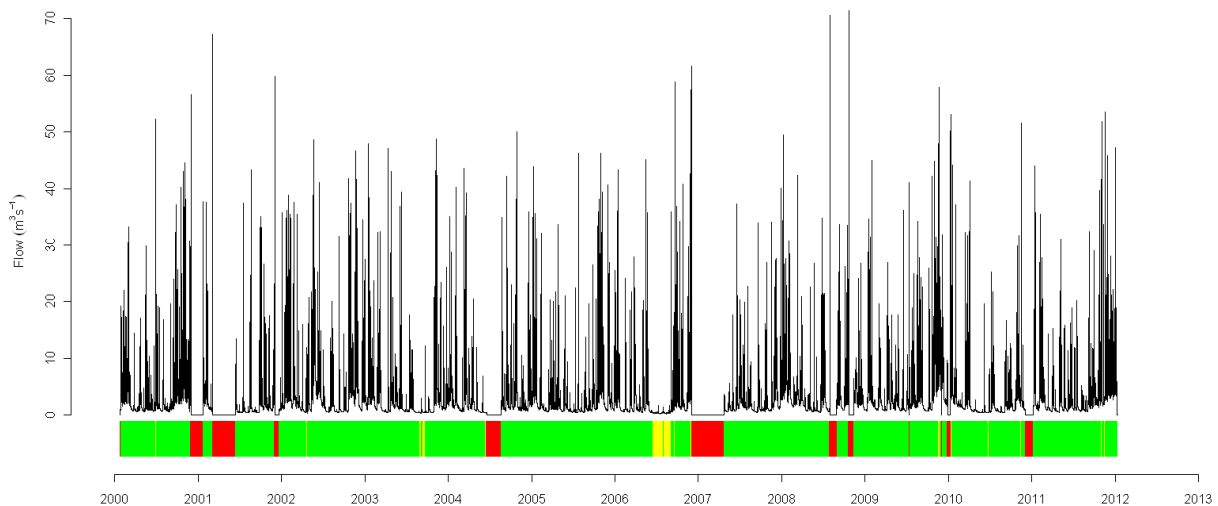
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.14: Water Level Data Quality Plot for Flesk @ Clydach Bridge Gauge (EPA - 22039)



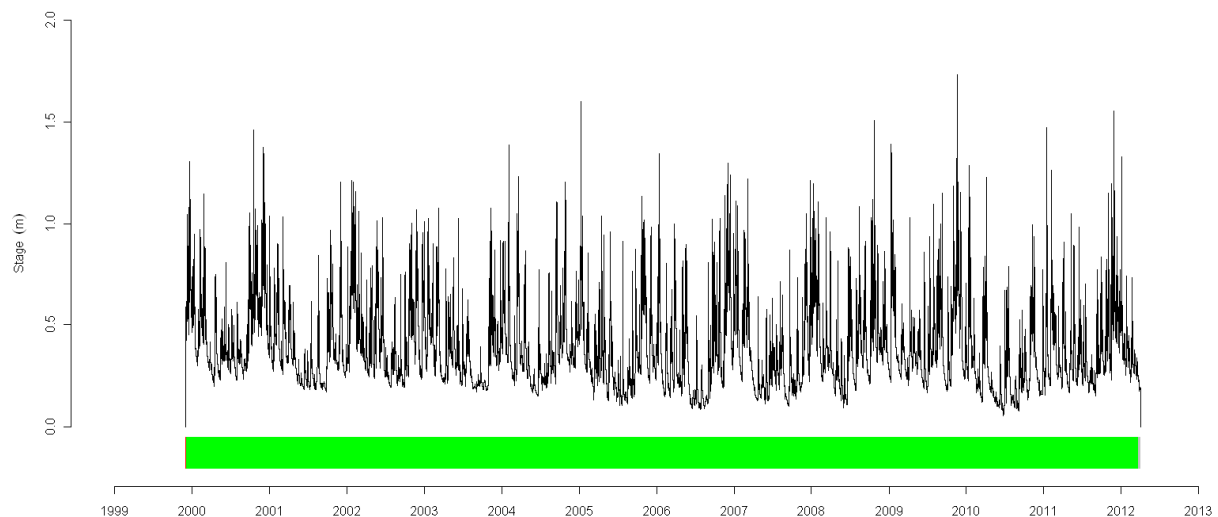
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.15: Flow Data Quality Plot for Flesk @ Clydagh Bridge Gauge (22039)



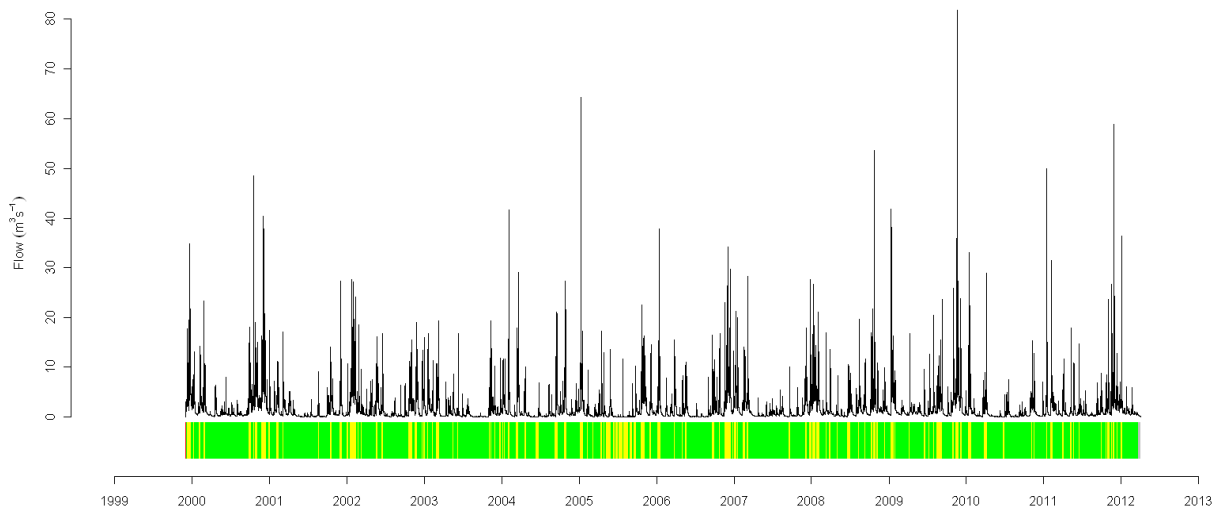
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.16: Water Level Data Quality Plot for Finow @ Dromickbane Gauge (EPA - 22041)



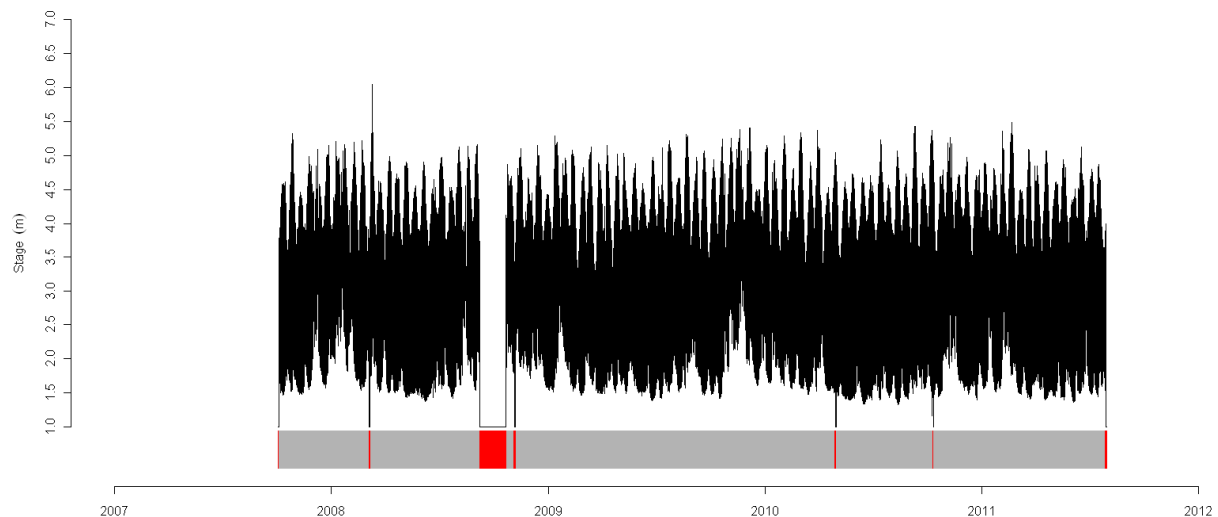
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.17: Flow Data Quality Plot for Finow @ Dromickbane Gauge (EPA - 22041)



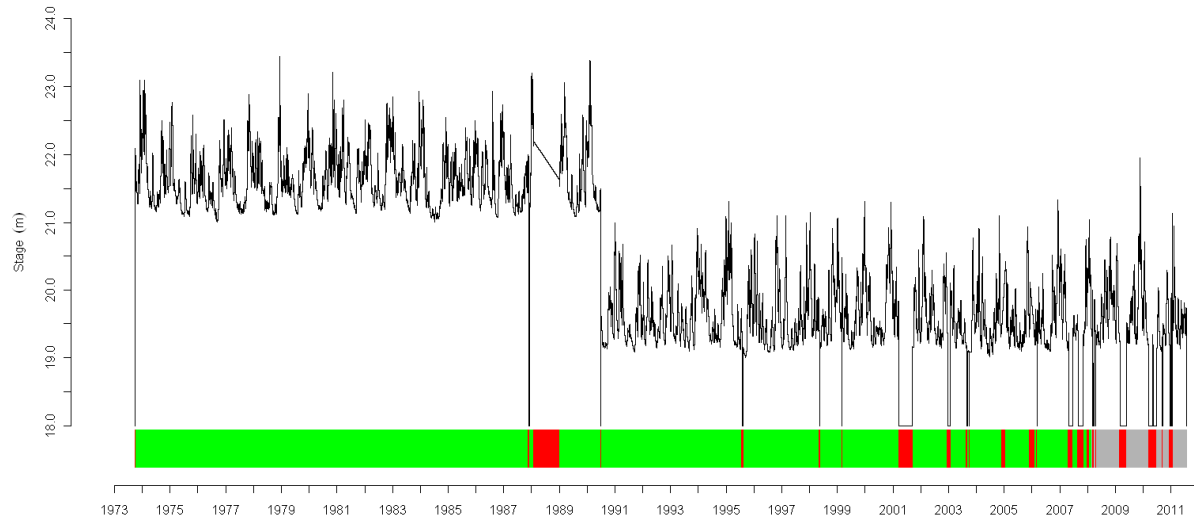
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.18: Water Level Data Quality Plot for Maine Estuary @ Castlemaine Gauge (OPW - 22061)



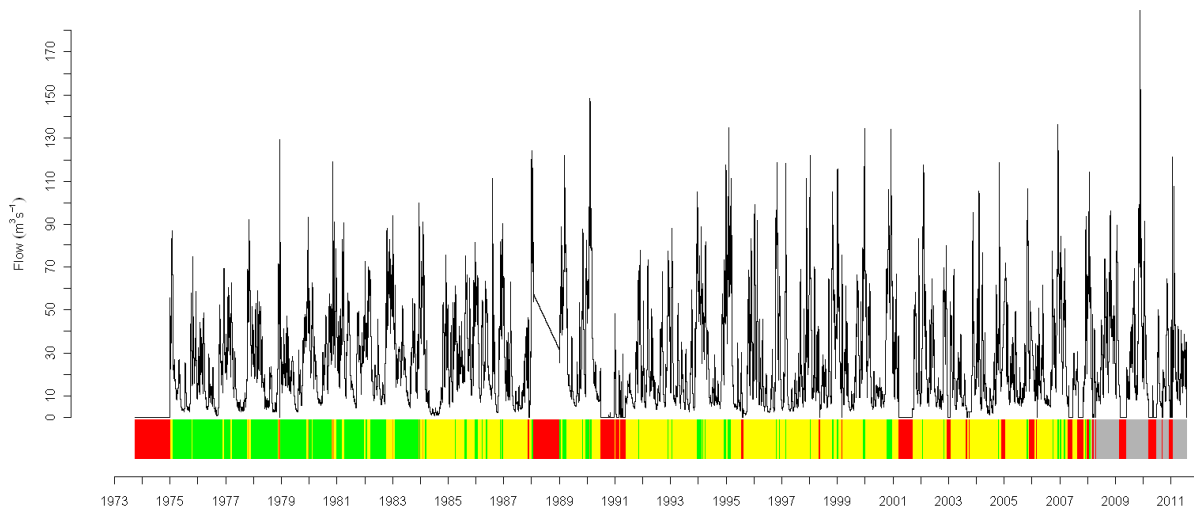
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.19: Water Level Data Quality Plot for Lough Leane @ Tomies Pier Gauge (OPW - 22071)



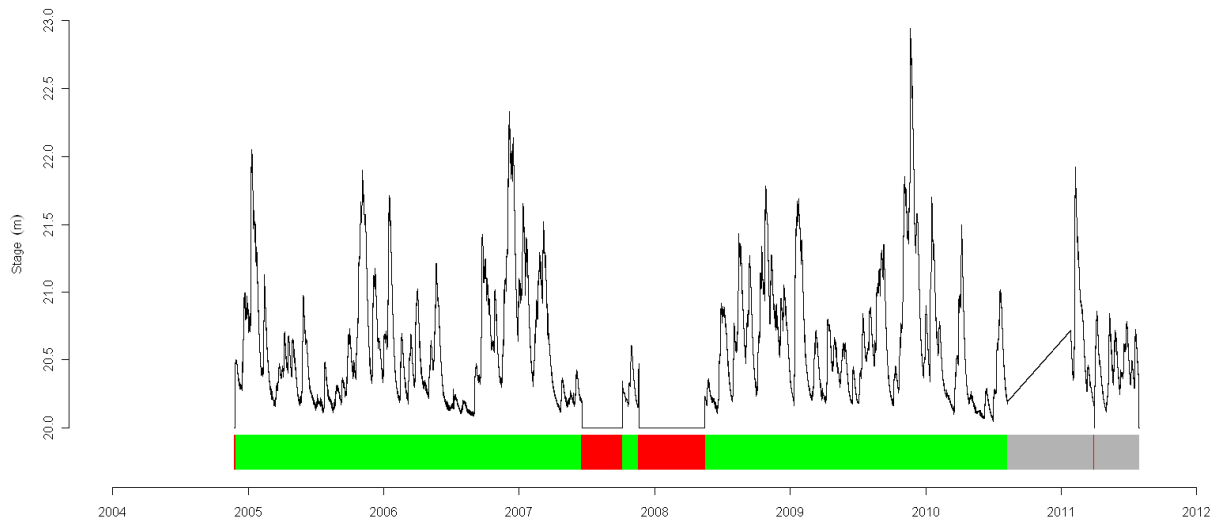
Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.20: Flow Data Quality Plot for Lough Leane @ Tomies Pier Gauge (OPW - 22071)



Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.

Figure A.21: Water Level Data Quality Plot for Lough Leane @ Bvm Park Gauge (OPW - 22082)



Where: Red is missing, Orange is suspect, Yellow is Edited, Green is good and Grey is unchecked based on OPW and EPA data quality flags.



Table A.2: Selected Meteorological Gauge Data

| Station Number | Name                           | Catchment             | Easting | Northing | ELEVATION (mAOD) | OPENED | YEARS DATA | DATA INTERVAL | Average Annual Rainfall | Comments  | Fit for Calibration? | Fit for Statistical Analysis? |
|----------------|--------------------------------|-----------------------|---------|----------|------------------|--------|------------|---------------|-------------------------|---|----------------------|-------------------------------|
| 805            | Beaufort G.S.                  | Laune                 | 87800   | 91800    | 35               | 1941   | 54         | Daily         | 1230                    |   | Yes                  | Yes                           |
| 1305           | Castleisland (Voc.Sch.)        | Shanowen – Maine      | 100400  | 110100   | 41               | 1944   | 44         | Daily         | 1241                    |   | Yes                  | Yes                           |
| 2805           | Castleisland O.P.W.            | Maine                 | 100200  | 109400   | 30               | 1959   | 3          | Daily         | Not enough data         | Short record does not cover calibration events, average annual based on 2 water years | No                   | No                            |
| 905            | Castlemaine G.S.               | Maine                 | 83900   | 103300   | 8                | 1941   | 45         | Daily         | 1132                    |   | Yes                  | Yes                           |
| 4505           | Dereen                         | Dereen                | 45800   | 74000    | 23               | 1995   | 17         | Daily         | 617                     |   | Yes                  | Yes                           |
| 4305           | Dingle (Milltown)              | Milltown              | 42900   | 101500   | 9                | 1989   | 6          | Daily         | Not enough data         | Short record does not cover calibration events  | No                   | No                            |
| 2405           | Dingle G.S.                    | On Coast              | 44600   | 100800   | 6                | 1950   | 38         | Daily         | 1331                    |   | Yes                  | Yes                           |
| 2905           | Killarney (Drom Aulinn)        | Lough Leane-Laune     | 97100   | 90200    | 32               | 1966   | 6          | Daily         | 1285                    | Short record does not cover calibration events, average annual based on 2 water years | No                   | No                            |
| 3505           | Killarney (Farm Centre)        | Deenagh – Lough Leane | 96000   | 92100    | 49               | 1976   | 16         | Daily         | 1128                    |   | Yes                  | Yes                           |
| 3005           | Killarney (Golf Club)          | Lough Leane – Laune   | 92800   | 91100    | 9                | 1967   | 5          | Daily         | Not enough data         | Short record does not cover calibration events  | No                   | No                            |
| 2705           | Killarney (Gt. Southern Hotel) | Lough Leane – Flesk   | 97500   | 90800    | 43               | 1958   | 10         | Daily         | 1265                    |   | Yes                  | Yes                           |
| 3405           | Killarney (Lissivigeen N.S.)   | Flesk - Laune         | 100000  | 89700    | 69               | 1969   | 15         | Daily         | 913                     |   | Yes                  | Yes                           |
| 1105           | Killarney (Muckcross For.Stn.) | Lough Leane - Laune   | 97700   | 88200    | 32               | 1941   | 35         | Daily         | 1341                    |   | Yes                  | Yes                           |
| 505            | Killarney (St.Finan's Hosp.)   | Lough Leane - Laune   | 96400   | 91600    | 55               | 1889   | 99         | Daily         | 1160                    |   | Yes                  | Yes                           |
| 705            | Killorglin (Callinafercy)      | Laune                 | 77900   | 99400    | 14               | 1921   | 91         | Daily         | 1260                    |   | Yes                  | Yes                           |
| 2605           | Killorglin (Voc.Sch.)          | Laune                 | 77500   | 96200    | 28               | 1952   | 30         | Daily         | 1232                    |   | Yes                  | Yes                           |
| 3805           | Killorglin V.S. II             | Laune                 | 77900   | 95700    | 34               | 1982   | 6          | Daily         | 1265                    | Short record does not cover calibration events  | No                   | No                            |
| 1905           | Portmagee g.s.                 | On Coast              | 37500   | 72800    | 6                | 1949   | 34         | Daily         | 1375                    |   | Yes                  | Yes                           |
| 305            | Valentia Observatory           | On Coast              | 45700   | 78800    | 11               | 1866   | 146        | Hourly        | 1460                    |   | Yes                  | Yes                           |

## Appendix B. Preliminary Hydrological Parameters

Table B.1: Catchment Descriptors at HEPs for Laune-Maine-Dingle Bay Unit of Management (UoM 22)

| NODE_ID    | WATERCOURSE                | PRELIMINARY HYDROLOGICAL APPROACH                     | EASTING | NORTHING | DTM_AREA | MSL    | NETLEN   | DRAIN2 | S1085   | TAYSLO  | ARTDRAIN2 | FARL  | SAAR | URBEXT | BFISOILS |
|------------|----------------------------|---|---------|----------|----------|--------|----------|--------|---------|---------|-----------|-------|------|--------|----------|
| 22003      | River Maine                | Riverville Gauged - Statistical                       | 92466   | 106120   | 271.2896 | 35.914 | 310.873  | 1.146  | 5.00201 | 1.2186  | 0.1885    | 1     | 1349 | 1.72   | 0.464    |
| 22006      | River Flesk                | Flesk Bridge Killarney Gauged - Statistical           | 97043   | 89432    | 328.8148 | 45.138 | 415.886  | 1.265  | 9.42058 | 0.69661 | 0         | 0.961 | 1819 | 0.54   | 0.388    |
| 22009      | Deenagh River              | White Bridge Killarney Gauged - Statistical           | 95226   | 90247    | 35.397   | 16.489 | 38.341   | 1.083  | 10.5456 | 2.76234 | 0         | 0.995 | 1172 | 5.75   | 0.601    |
| 22035      | River Laune                | Laune Bridge Gauged - Statistical                     | 89188   | 91126    | 559.6552 | 56.299 | 762.977  | 1.363  | 7.57974 | 0.43193 | 0         | 0.731 | 2010 | 0.97   | 0.636    |
| 22071      | Lough Leane                | Tomies Pier Lough Leane Gauged - Water Level Analysis | 89901   | 91011    | 557.6956 | 55.116 | 760.335  | 1.363  | 7.75701 | 0.4409  | 0         | 0.73  | 2011 | 0.97   | 0.644    |
| 22039      | Clydagh River/ River Flesk | Clydagh Bridge Gauged - Statistical                   | 111259  | 82658    | 57       | 21.859 | 73.42    | 1.287  | 14.288  | 9.417   | 0         | 0.998 | 1886 | 0      | 0.349    |
| 22041      | River Finnow               | Dromickbane Gauged - Statistical                      | 100913  | 87681    | 39       | 12.726 | 60.081   | 1.541  | 43.359  | 1.248   | 0         | 0.736 | 2242 | 0      | 0.622    |
| 22022      | Milltown River             | Milltown Bridge (R559) Gauged - POT/Shorter Series    | 43417   | 101307   | 28.9     | 9.91   | 34.338   | 1.19   | 25.36   | 3.213   | 0         | 1     | 1562 | 0.36   | 0.532    |
| 22014      | River Maine                | Castleisland Gauged -Rating Review & Statistical      | 99611   | 109505   | 47       | 11.434 | 56.567   | 1.241  | 15.935  | 6.746   | 0.174     | 1     | 1329 | 2.43   | 0.463    |
| 22_191_1   | Glanshearoon               | Ungaaged Transfer from Gauged                         | 101537  | 112224   | 7.827    | 4.369  | 10.036   | 1.282  | 39.212  | 32.19   | 0         | 1     | 1411 | 0      | 0.462    |
| 22_245_2   | Annagh Beg Stream          | Ungaaged Transfer from Gauged                         | 107431  | 85073    | 5.2      | 3.804  | 8.403    | 1.615  | 77.076  | 4.062   | 0         | 1     | 1783 | 0      | 0.377    |
| 22_360_2   | Glanshearoon               | Ungaaged Transfer from Gauged                         | 99368   | 109624   | 14.066   | 8.723  | 18.826   | 1.338  | 19.5516 | 12.6117 | 0.0777    | 1     | 1411 | 1.22   | 0.424    |
| 22_557_2   | Maine                      | Ungaaged Transfer from Gauged                         | 95629   | 108772   | 98.588   | 15.985 | 118.426  | 1.201  | 9.72883 | 2.46049 | 0.2524    | 1     | 1357 | 1.78   | 0.465    |
| 22_582_7   | Maine                      | Ungaaged Transfer from Gauged                         | 98065   | 109284   | 15.466   | 7.384  | 9.736    | 0.63   | 6.69643 | 1.72125 | 0.7       | 1     | 1301 | 0      | 0.488    |
| 22_583_2   | Maine                      | Ungaaged Transfer from Gauged                         | 98065   | 109284   | 75.273   | 13.176 | 101.114  | 1.343  | 13.2157 | 5.32714 | 0.1752    | 1     | 1361 | 2.33   | 0.466    |
| 22_957_4   | Maine                      | Ungaaged Transfer from Gauged                         | 98644   | 109344   | 11.624   | 8.159  | 21.733   | 1.87   | 23.7738 | 12.419  | 0.1263    | 1     | 1422 | 0.02   | 0.458    |
| 22_1223_5  | Maine                      | Ungaaged Transfer from Gauged                         | 95572   | 108778   | 7.953    | 6.383  | 10.626   | 1.336  | 20.2381 | 0.68369 | 0.4211    | 1     | 1408 | 0      | 0.458    |
| 22_1228_4  | Rusheenmore Stream         | Ungaaged Transfer from Gauged                         | 106860  | 85209    | 2.1      | 2.424  | 2.936    | 1.375  | 103.719 | 0.804   | 0         | 0.938 | 2322 | 0      | 0.458    |
| 22_1331_1  | Anglore Stream             | Ungaaged Transfer from Gauged                         | 101402  | 111165   | 1.091    | 1.249  | 1.25     | 1.146  | 0.1     | 0.1     | 0.1436    | 1     | 1385 | 0      | 0.335    |
| 22_1553_4  | Loo                        | Ungaaged Transfer from Gauged                         | 108478  | 81439    | 31.722   | 8.861  | 43.313   | 1.365  | 8.3268  | 0.2793  | 0         | 0.985 | 2757 | 0      | 0.406    |
| 22_1560_3  | Flesk                      | Ungaaged Transfer from Gauged                         | 105379  | 86807    | 130.973  | 33.255 | 175.018  | 1.336  | 12.9997 | 1.01747 | 0         | 0.994 | 2174 | 0      | 0.368    |
| 22_1562_6  | Flesk                      | Ungaaged Transfer from Gauged                         | 107700  | 84645    | 110.665  | 29.604 | 146.791  | 1.326  | 14.8788 | 2.0601  | 0         | 0.994 | 2214 | 0      | 0.367    |
| 22_1589_1  | Shanowen                   | Ungaaged Transfer from Gauged                         | 101410  | 109033   | 40.609   | 9.43   | 53.227   | 1.311  | 20.9401 | 13.6651 | 0.1231    | 1     | 1326 | 0.25   | 0.463    |
| 22_1721_2  | Isla                       | Ungaaged Transfer from Gauged                         | 107700  | 84645    | 7.37     | 5.933  | 10.69    | 1.45   | 74.0788 | 6.56248 | 0         | 1     | 2075 | 0      | 0.368    |
| 22_1756_3  | Maine                      | Ungaaged Transfer from Gauged                         | 100562  | 109555   | 3.072    | 1.338  | 1.338    | 0.436  | 3.30284 | 1.97515 | 1         | 1     | 1355 | 17.35  | 0.458    |
| 22_1927_3  | Finow                      | Ungaaged Transfer from Gauged                         | 100913  | 87681    | 38.985   | 12.726 | 60.081   | 1.541  | 43.359  | 1.24808 | 0         | 0.736 | 2242 | 0      | 0.622    |
| 22_1946_1  | Laune                      | Ungaaged Transfer from Gauged                         | 86626   | 92180    | 596.67   | 60.448 | 819.546  | 1.374  | 6.98039 | 0.38578 | 0         | 0.742 | 1997 | 0.91   | 0.652    |
| 22_1946_8  | Laune                      | Ungaaged Transfer from Gauged                         | 83944   | 93768    | 601.543  | 64.01  | 823.109  | 1.368  | 6.51954 | 0.36278 | 0         | 0.744 | 1992 | 0.9    | 0.654    |
| 22_2090_3  | Maine                      | Ungaaged Transfer from Gauged                         | 95204   | 108292   | 111.886  | 16.724 | 133.67   | 1.195  | 8.2872  | 2.14301 | 0.2766    | 1     | 1363 | 1.57   | 0.465    |
| 22_2091_3  | Maine Little               | Ungaaged Transfer from Gauged                         | 95204   | 108292   | 38.323   | 12.856 | 45.452   | 1.186  | 14.2682 | 3.59584 | 0.3528    | 1     | 1379 | 1.27   | 0.405    |
| 22_2197_3  | Woodford                   | Ungaaged Transfer from Gauged                         | 98945   | 90211    | 15.716   | 8.489  | 20.742   | 1.32   | 16.3255 | 5.19857 | 0         | 1     | 1260 | 0.34   | 0.588    |
| 22_2207_3  | Gweestin                   | Ungaaged Transfer from Gauged                         | 83150   | 94814    | 84.245   | 25.712 | 109.366  | 1.298  | 6.13802 | 0.96058 | 0         | 1     | 1261 | 0      | 0.608    |
| 22_2208_4  | Laune                      | Ungaaged Transfer from Gauged                         | 83150   | 94814    | 646.709  | 65.341 | 896.031  | 1.386  | 6.34886 | 0.36471 | 0         | 0.758 | 1984 | 0.84   | 0.660    |
| 22_2705_5  | Flesk                      | Ungaaged Transfer from Gauged                         | 100913  | 87681    | 264.463  | 38.746 | 326.154  | 1.233  | 10.7028 | 0.78921 | 0         | 0.995 | 1805 | 0      | 0.383    |
| 22_2717_2  | Laune                      | Ungaaged Transfer from Gauged                         | 79867   | 95210    | 777.336  | 70.47  | 1061.338 | 1.365  | 5.78799 | 0.33731 | 0         | 0.794 | 1877 | 0.7    | 0.614    |
| 22_2753_4  | Gaddagh                    | Ungaaged Transfer from Gauged                         | 83944   | 93768    | 42.309   | 14.585 | 71.591   | 1.692  | 27.8526 | 2.68708 | 0         | 0.964 | 1903 | 0      | 0.429    |
| 22_2754_7  | Gweestin                   | Ungaaged Transfer from Gauged                         | 85162   | 96337    | 64.908   | 22.481 | 90.009   | 1.387  | 7.35251 | 1.51741 | 0         | 1     | 1237 | 0      | 0.610    |
| 22_2860_1  | Flesk                      | Ungaaged Transfer from Gauged                         | 104522  | 87155    | 239.629  | 34.32  | 302.799  | 1.264  | 12.4462 | 0.8995  | 0         | 0.995 | 1843 | 0      | 0.381    |
| 22_2883_9  | Owneyskeagh                | Ungaaged Transfer from Gauged                         | 105379  | 86807    | 105.858  | 23.924 | 124.021  | 1.172  | 5.57441 | 0.52482 | 0         | 0.996 | 1437 | 0      | 0.384    |
| 22_2899_4  | Loe                        | Ungaaged Transfer from Gauged                         | 88317   | 91631    | 16.254   | 10.636 | 31.458   | 1.935  | 18.7189 | 1.77103 | 0         | 0.86  | 2254 | 0      | 0.477    |
| 22_3057_2  | Laune                      | Ungaaged Transfer from Gauged                         | 88317   | 91631    | 563.217  | 57.508 | 772.112  | 1.371  | 7.42058 | 0.41484 | 0         | 0.733 | 2008 | 0.96   | 0.642    |
| 22_3093_3  |                            | Ungaaged Transfer from Gauged                         | 82756   | 99906    | 2.276    | 1.644  | 1.643    | 0.722  | 15.0426 | 1.83264 | 0         | 1     | 1410 | 0.83   | 0.612    |
| 22_3102_14 | Brown Flesk River          | Ungaaged Transfer from Gauged                         | 92954   | 106148   | 113.7    | 35.605 | 125.127  | 1.1    | 5.072   | 1.309   | 0         | 0.999 | 1322 | 2.14   | 0.515    |
| 22_3340_10 | Flesk                      | Ungaaged Transfer from Gauged                         | 98945   | 90211    | 308.633  | 42.879 | 390.368  | 1.265  | 9.95171 | 0.73368 | 0         | 0.958 | 1854 | 0      | 0.381    |
| 22_3359_3  | Maine                      | Ungaaged Transfer from Gauged                         | 89139   | 104830   | 296.651  | 40.723 | 341.926  | 1.153  | 4.3904  | 0.92717 | 0.2077    | 1     | 1351 | 1.64   | 0.478    |

| NODE_ID    | WATERCOURSE           | PRELIMINARY HYDROLOGICAL APPROACH | EASTING | NORTHING | DTM_AREA | MSL    | NETLEN   | DRAIN2 | S1085   | TAYSLO  | ARTDRAIN2 | FARL  | SAAR | URBEXT  | BFISOILS |
|------------|-----------------------|-----------------------------------|---------|----------|----------|--------|----------|--------|---------|---------|-----------|-------|------|---------|----------|
| 22_3425_3  | Ashullish             | Ungauged Transfer from Gauged     | 83559   | 100554   | 3.28     | 1.137  | 1.137    | 0.347  | 23.1472 | 0.69808 | 0         | 1     | 1400 | 0       | 0.628    |
| 22_3437_1  | Dingle Stream         | Ungauged Transfer from Gauged     | 45670   | 102240   | 1.1      | 1.918  | 1.919    | 1.784  | 189.614 | 137.96  | 0         | 1     | 1596 | 0       | 0.466    |
| 22_3437_5  | Dingle Stream         | Ungauged Transfer from Gauged     | 44554   | 100883   | 5.2      | 3.818  | 3.818    | 0.727  | 73.56   | 42.812  | 0         | 1     | 1547 | 7.46    | 0.563    |
| 22_3452_2  | Maine                 | Ungauged Transfer from Gauged     | 98644   | 109344   | 60.354   | 12.537 | 76.866   | 1.274  | 14.5384 | 7.32595 | 0.1621    | 1     | 1349 | 2.78    | 0.464    |
| 22_3617_1  | Ashullish             | Ungauged Transfer from Gauged     | 81550   | 101250   | 8.961    | 3.744  | 8.486    | 0.947  | 17.0231 | 11.1972 | 0.1013    | 1     | 1578 | 4.33    | 0.614    |
| 22_3712_1  | Flesk                 | Ungauged Transfer from Gauged     | 109669  | 81795    | 70.894   | 24.02  | 94.002   | 1.326  | 13.6714 | 10.4875 | 0         | 0.999 | 1974 | 0       | 0.349    |
| 22_3712_4  | Flesk                 | Ungauged Transfer from Gauged     | 108478  | 81439    | 72.392   | 25.377 | 95.358   | 1.317  | 14.6997 | 10.5553 | 0         | 0.999 | 1978 | 0       | 0.349    |
| 22_3962_5  | Tralia                | Ungauged Transfer from Gauged     | 86699   | 103787   | 9.343    | 5.655  | 12.377   | 1.325  | 33.5874 | 11.1869 | 0.3356    | 1     | 1465 | 0       | 0.457    |
| 22_3972_3  | Castlemaine Tributary | Ungauged Transfer from Gauged     | 83348   | 103027   | 13.726   | 6.086  | 21.783   | 1.587  | 13.5545 | 1.86191 | 0.2626    | 1     | 1584 | 0.3     | 0.379    |
| 22_3999_2  | Milltown              | Ungauged Transfer from Gauged     | 43417   | 101307   | 28.852   | 9.91   | 34.338   | 1.19   | 25.3602 | 3.21273 | 0         | 1     | 1562 | 0.36    | 0.532    |
| 22_4003_4  | Deenagh               | Ungauged Transfer from Gauged     | 97448   | 93057    | 24.649   | 11.547 | 32.453   | 1.317  | 11.0489 | 2.58834 | 0         | 0.993 | 1125 | 0       | 0.609    |
| 22_3970_3+ | Maine                 | Ungauged Transfer from Gauged     | 85069   | 103163   | 813.071  | 89.052 | 1116.114 | 1.3726 | 6.82624 | 0.56016 | 0         | 0.801 | 1871 | 0.66145 | 0.609    |
| 22_3958_2  | Ashullish             | Ungauged Transfer from Gauged     | 81198   | 101460   | 9.466    | 4.157  | 9.202    | 0.972  | 14.933  | 11.267  | 0.1711    | 1     | 1603 | 4.1     | 0.614    |
| 22_4001_4+ | Laune                 | Ungauged Transfer from Gauged     | 77795   | 96666    | 817.93   | 95.914 | 1122.976 | 1.3728 | 6.82835 | 0.56394 | 0         | 0.801 | 1869 | 0.70398 | 0.609    |
| 22_3685_1  | Loo                   | Ungauged Transfer from Gauged     | 80190   | 107315   | 27.44    | 6.68   | 37.898   | 1.381  | 23.967  | 0.341   | 0         | 0.983 | 2791 | 0       | 0.399    |

Source: FSU Database 2012. Highlighted cells indicate modified physical catchment descriptors based on data review. The + sign after a FSU Node ID indicates a number of catchments lumped together, particularly for inflows in tidal reaches where there are no FSU node along the main river.

## Appendix C. Hydrometric Gauges

| Station Number | Name              | River Name     | Model         | Easting | Northing | Record Start | Years Data | Owner | Rating Curve | Comments   | Fit for Calibration Purposes? | Fit for Statistical Analysis?                  |
|----------------|-------------------|----------------|---------------|---------|----------|--------------|------------|-------|--------------|--|-------------------------------|--|
| 22001          | Riverville Bypass | Bypass channel | Maine reach 1 | 92950   | 105725   | 12/11/2008   | 3          | OPW   | No           | Short record, no flow available  | Yes post 2009                 | No   |
| 22003          | Riverville        | Maine          | Maine Reach 1 | 92650   | 106201   | 01/01/1971   | 40         | OPW   | Yes          | Majority of flows have been edited to be suitable for use, significant data gap from 2004 to 2007. Water levels recorded above 14 m pre-2004 have suspect high flows to be verified by model. Statistical analysis should consider the removal of 1974, 1984 and 1987 AMAX flows | Yes                           | Yes, use with caution                          |
| 22006          | Flesk Br.         | Flesk (Laune)  | Killarney     | 97283   | 89452    | 08/01/1947   | 64         | OPW   | Yes          | Numerous data gaps or poor data quality periods. Significant data gaps in the 1970's, 1980's and in 2006   | Yes                           | Yes, use with caution                          |
| 22009          | White Br.         | Deenagh/ Laune | Killarney     | 95291   | 90260    | 11/01/1982   | 29         | OPW   | Yes          | Numerous data gaps particularly in 1989, and post 2000   | Yes for events post-1982      | Yes, use with caution                          |
| 22014          | Castleisland      | Maine          | Castlemaine   | 99609   | 109506   | 04/02/2002   | 10         | EPA   | Yes          | Data gaps in 15 min data during 2006, 2007 and 2010. Peak flows available from 1985 to 1988 but data not at regular intervals. Rating curve will be reviewed during hydrological study.  | Yes, following rating review  | Yes, following rating review                   |
| 22022          | Milltown          | Milltown       | Dingle        | 93769   | 106440   | 24/01/2002   | 10         | EPA   | Yes          | Data gaps in 2006, 2007 and 2010.  | Yes                           | Yes, use with caution                          |
| 22035          | Laune Br.         | Laune          | Laune Reach 1 | 89143   | 91131    | 22/07/1991   | 20         | OPW   | Yes          | Data gap in 2010. Some flows have been edited to make suitable for use. However water level of good quality for assessment of Lough Leane  | Yes                           | Yes, use with caution                          |
| 22039          | Clydagh Br.       | Flesk          | Flesk Reach 1 | 93769   | 106440   | 26/01/2000   | 12         | EPA   | Yes          | Reasonable water level and flow but significant data gaps in 2001, 2004, 2007 and 2011   | Yes                           | Yes, use with caution                          |
| 22041          | Dromickbane       | Finow          | Flesk reach 2 | 93769   | 106440   | 02/12/1999   | 13         | EPA   | Yes          | Good quality and complete data record  | Yes                           | Yes  |
| 22061          | Castlemaine       | Maine          | Maine Reach 1 | 83544   | 103064   | 04/10/1989   | 23         | OPW   | No           | Reasonable AMAX series but digital records of 15 min water level data only available since 2007. Anomalous spike in early 2008 to be removed from data series and several months' data gap in late 2008.   | Yes                           | Yes, tidal and hydrograph shape analysis only. |
| 22071          | Tomies Pier       | L. Leane       | Lough Leane   | 89959   | 90589    | 01/10/1973   | 38         | OPW   | Yes          | 3 metre datum shift in 1990. Data series adjusted by -3 m prior to 1990 to match similar levels across the Lough. Significant data gaps in 1988, 2000 and post-2007  | Yes (after processing)        | Yes (after processing)                         |
| 22082          | Bvm Park          | L. Leane       | Lough Leane   | 96640   | 86719    | 25/11/2004   | 7          | OPW   | No           | Short record with significant data gaps in 2007, 2008 and 2011   | Yes                           | Yes, use with caution                          |
| 22004          | Owgarriff Weir    | Owgarriff      | N/A           | 100350  | 84803    | 09/02/1975   | 6          | EPA   | Yes          | Short record   | No                            |  |
| 22005          | Torc Weir         | Owengarriff    | N/A           | 96604   | 84219    | 01/08/1942   | 70         | OPW   | Yes          | Long record, but with significant data gaps. Potential pivotal site.   | No                            | Yes, post 2000 data                            |
| 22007          | Caragh            | Caragh         | N/A           | 71133   | 92349    | 06/10/1945   | 63         | EPA   | Yes          | Significant data gaps in 1960's and 1980-90's. Water level record only so unsuitable for study.  | No                            | No   |
| 22016          | Old Weir Bridge   | Long Range     | N/A           | 93657   | 84996    | 01/02/1982   | 31         | OPW   | Yes          | Long data record but not on a modelled reach.  | No                            |  |

|       |                    |                 |     |          |       |            |     |     |     |   |    |               |
|-------|--------------------|-----------------|-----|----------|-------|------------|-----|-----|-----|---|----|---------------|
| 22031 | Killarney S.W.     | L. Leane Trib   | N/A | 95592    | 89915 | 16/07/1985 | 27  | EPA | Yes | Lengthy record, very small catchment size (0.06km <sup>2</sup> ). Unsuitable for use                | No | Awaiting data |
| 22033 | Kilquane           | Quagmire        | N/A | 108628   | 90490 | 02/12/1999 | 13  | EPA | Yes | Potential pivotal site, data requested for further analysis.  | No | No            |
| 22042 | Cappagh            | Cappagh         | N/A | 103360   | 83861 | 02/12/1999 | 7   | EPA | Yes | Short record. Fair at low/mid range ratings and distance from modelled reach makes gauge unsuitable | No | No            |
| 22043 | Toormoor Br. Weir. | Stream          | N/A | 103353   | 96715 | 23/10/1999 | 7   | EPA | Yes | Gauge not in modelled reach and short record. Unsuitable  | No | No            |
| 22044 | Rahanane Weir      | Stream          | N/A | 101646   | 94969 | 23/10/1999 | 11  | EPA | Yes | Potential pivotal site, data requested for further analysis.  | No | Awaiting data |
| 22045 | Knockauncore Weir  | Stream          | N/A | 102205   | 95854 | 23/10/1999 | 8   | EPA | Yes | Gauge not part of model reach. Post March 2007 erroneous. 8 Years data insufficient                 | No | Yes           |
| 22047 | Hags Glen          | Gaddagh         | N/A | 82317.06 | 85804 | 11/10/2005 | 7   | EPA | No  | Water level only. Unsuitable for study as gauge does not form part of modelled reach                | No | No            |
| 22072 | Finow              | L. Guitane      | N/A | 101440   | 85112 | 25/08/1975 | 11  | EPA | Yes | Data gaps in 1975, 1977 and 1980 and not on model reach.  | No | No            |
| 22073 | O/L. Coomnacronia  | L. Coomnacronia | N/A | 60557    | 86037 | 07/09/1988 | 1   | ESB | N/A | Data unavailable. Water level only. Unsuitable for study  | No | No            |
| 22074 | L. Coomaglaslaw    | L. Coomaglaslaw | N/A | 61448    | 85758 | 23/06/1988 | 3   | ESB | N/A | Data unavailable. Water level only. Unsuitable for study  | No | No            |
| 22075 | Upper Lake         | Upper Lake      | N/A |          |       | 05/02/2010 | 2   | EPA | N/A | Water level only. Unsuitable for study as gauge does not form part of modelled reach                | No | No            |
| 22076 | L. Acoouse         | Acoouse         | N/A |          |       | N/A        | N/A | EPA | N/A | Water level only. Unsuitable for study as gauge does not form part of modelled reach                | No | No            |

| Type  | OPW gauges | EPA gauges<br>(operated by Kerry<br>County Council ) | Total Gauges<br>Available |
|---|------------|--|---------------------------|
| River Flow and<br>Water Level<br>Gauges             | 7          | 3  | 20                        |
| River Level<br>Gauges                               | 3          | 5  | 8                         |
| River Flow and<br>Level<br>Observation<br>Locations | 0          | 16   | 16                        |



## Appendix D. Rainfall Gauges

| Station Number | Name                           | Catchment              | Easting | Northing | Elevation (mAOD) | Opened | Usable Years Data | Data Interval | Comments   | Fit for Calibration? | Fit for Statistical Analysis? |
|----------------|--------------------------------|------------------------|---------|----------|------------------|--------|-------------------|---------------|--|----------------------|-------------------------------|
| 805            | Beaufort G.S.                  | Laune                  | 87800   | 91800    | 35               | 1941   | 54                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 1305           | Castleisland (Voc.Sch.)        | Shanowen–Maine         | 100400  | 110100   | 41               | 1944   | 44                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 2805           | Castleisland O.P.W.            | Maine                  | 100200  | 109400   | 30               | 1959   | 3                 | Daily         | Short record does not cover calibration events, average annual based on 2 water years  | No                   | No                            |
| 905            | Castlemaine G.S.               | Maine                  | 83900   | 103300   | 8                | 1941   | 45                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 4505           | Dereen                         | Dereen                 | 45800   | 74000    | 23               | 1995   | 17                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 4305           | Dingle (Milltown)              | Milltown               | 42900   | 101500   | 9                | 1989   | 6                 | Daily         | Short record does not cover calibration events   | No                   | No                            |
| 2405           | Dingle G.S.                    | On Coast               | 44600   | 100800   | 6                | 1950   | 38                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 2905           | Killarney (Drom Aaulinn)       | Lough Leane-Laune      | 97100   | 90200    | 32               | 1966   | 6                 | Daily         | Short record does not cover calibration events,  | No                   | No                            |
| 3505           | Killarney (Farm Centre)        | Deenagh–Lough Leane    | 96000   | 92100    | 49               | 1976   | 16                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 3005           | Killarney (Golf Club)          | Lough Leane–Laune      | 92800   | 91100    | 9                | 1967   | 5                 | Daily         | Short record does not cover calibration events   | No                   | No                            |
| 2705           | Killarney (Gt. Southern Hotel) | Lough Leane–Flesk      | 97500   | 90800    | 43               | 1958   | 10                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 3405           | Killarney (Lissivigeen N.S.)   | Flesk-Laune            | 100000  | 89700    | 69               | 1969   | 15                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 1105           | Killarney (Muckross For.Stn.)  | Lough Leane-Laune      | 97700   | 88200    | 32               | 1941   | 35                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 505            | Killarney (St.Finan's Hosp.)   | Lough Leane-Laune      | 96400   | 91600    | 55               | 1889   | 99                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 705            | Killorglin (Callinafercy)      | Laune                  | 77900   | 99400    | 14               | 1921   | 91                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 2605           | Killorglin (Voc.Sch.)          | Laune                  | 77500   | 96200    | 28               | 1952   | 30                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 3805           | Killorglin V.S. II             | Laune                  | 77900   | 95700    | 34               | 1982   | 6                 | Daily         | Short record does not cover calibration events   | No                   | No                            |
| 1905           | Portmagee g.s.                 | On Coast               | 37500   | 72800    | 6                | 1949   | 34                | Daily         | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 305            | Valentia Observatory           | On Coast               | 45700   | 78800    | 11               | 1866   | 146               | Hourly        | Reasonable record with no significant issues identified  | Yes                  | Yes                           |
| 1005           | Farranfore G.S.                | Brown Flesk-Maine      | 94000   | 103400   | 43               | 1941   | 48                | Daily         | Short periods missing throughout making it unreliable to record all events. Major gaps in 1941 and 1990 to 1991  | No                   | No                            |
| 105            | Ballymacelligot Rectory        | Little Maine-Maine     | 91900   | 112100   | 39               | 1941   | 3                 | Daily         | Short record insufficient for statistical analysis and does not cover calibration events,  | No                   | No                            |
| 1205           | Castleisland (Coom)            | Shanowen-Maine         | 107400  | 109900   | 157              | 1944   | 63                | Daily         | Largely complete record but missing data in 1987-88  | Yes                  | Yes                           |
| 2005           | Castleisland (Gloutaine)       | Glantaine-Brown Flesk  | 107800  | 107300   | 241              | 1950   | 60                | Daily         | Largely complete record with no significant data gaps  | Yes up to 2010       | Yes                           |
| 205            | Killarney (The Reeks)          | Laune                  | 83500   | 93700    | 15               | 1956   | 0                 | Daily         | Missing data for entire period   | No                   | No                            |
| 2105           | Farranfore (Scartaglin)        | Brown Flesk-Maine      | 104700  | 105000   | 213              | 1950   | 19                | Daily         | Largely complete except for significant gaps in 1950, 1979. Missing data over January 1952 but this does not include the annual maximum event according to Valentia records. Does not cover calibration events | No                   | Yes                           |
| 2205           | Farranfore (Clounelea)         | Dogue-Brown Flesk      | 104000  | 99900    | 177              | 1950   | 40                | Daily         | Numerous data gaps that miss annual maximum event according to Valentia records, particularly from 1984 to 1999. Data more reliable from 2001 to 2005 but does not cover calibration events                    | No                   | No                            |
| 3105           | Killarney (Gortdromkiery)      | Owgarrieff-Flesk-Luane | 101200  | 83800    | 181              | 1968   | 27                | Daily         | Incomplete water year in 1968. Missing data during November 1988 and January 1992 but records annual maximum event for these water years based on Valentia records. Does not cover calibration periods         | No                   | Yes                           |



|  |                             |                   |        |        |     |      |    |       |  |                             |                        |
|--|-----------------------------|-------------------|--------|--------|-----|------|----|-------|--|-----------------------------|------------------------|
| 3205   | Killarney (Muckross Hse.)   | Lough Leane-Luane | 97200  | 86200  | 58  | 1968 | 41 | Daily | Good complete record with only one incomplete water year in 1968.  | Yes up to 2010              | Yes                    |
| 3605   | Bawnaskehy Castleisland     | Maine             | 101700 | 106400 | 52  | 1982 | 21 | Daily | Several incomplete or missing years' data in 1982, 1992 to 1996 and 1998. Record more reliable since 2000.   | Yes for events 2000 to 2010 | Yes for limited record |
| 3705   | Ventry The Boat Slip        | On Coast          | 38400  | 100400 | 3   | 1982 | 25 | Daily | Incomplete water year in 1982, 1988 and 1990 water years missing the annual maximum events according to Valentia records   | Yes up to 2010              | Yes for limited record |
| 4405   | Farranfore (Knockaderry)    | Brown Flesk-Maine | 94000  | 1029   | 34  | 1993 | 8  | Daily | Short record insufficient for statistical analysis and does not cover calibration events,  | No                          | No                     |
| 4905   | Castleisland (Kilmurray)    | Shanowen-Maine    | 105900 | 110300 | 107 | 1998 | 14 | Daily | Complete good record with no significant data gaps.  | Yes up to 2010              | Yes                    |
| 605  | Killarney (B.V.M.Park)      | Lough Leane-Laune | 97000  | 85700  | 34  | 1941 | 45 | Daily | Incomplete water year in 1941, 1973 to 1976, 1978 and 1991 water years missing the annual maximum events according to Valentia records. Does not cover calibration periods | No                          | Yes for limited record |
| 8705   | M.Killarney (Dromdiralough) | Finow-Flesk       | 102000 | 85800  | 108 | 1968 | 0  | Daily | Missing data for entire period   | No                          | No                     |
| 8805, 9305, 9405, 9505, 9603, 9605,9703,9705, 9805, 9905 | M.Torc Mangerton No.1 to 7  | Torc-Laune        | 97000  | 83400  | 436 | 1966 | 25 | Daily | Missing data for entire period   | No                          | No                     |

| Type   | Met Éireann gauges within or used for subject catchments | Met Éireann gauges within or used for subject catchments | Total Gauges Available |
|--|--|--|------------------------|
| Daily Rainfall Gauges  | 35   | 0  | 20                     |
| Synoptic Stations (weather forecasting locations including rainfall) | 1  | 0  | 1                      |



# Glossary

|                     |  |
|---------------------|--|
| <b>AEP</b>          | Annual Exceedance Probability; this represents the probability of an event being exceeded in any one year and is an alternative method of defining flood probability to 'return periods'. The 10%, 1% and 0.1% AEP events are equivalent to 10-year, 100-year and 1000-year return period events respectively.                                       |
| <b>AFA</b>          | Area for Further Assessment – Areas where, based on the Preliminary Flood Risk Assessment and the CFRAMS Flood Risk Review, the risks associated with flooding are potentially significant, and where further, more detailed assessment is required to determine the degree of flood risk, and develop measures to manage and reduce the flood risk. |
| <b>AMAX</b>         | Annual Maximum Flood   |
| <b>ARR</b>          | Area for Risk Review   |
| <b>CAR</b>          | Community at Risk  |
| <b>CFRAM</b>        | Catchment Flood Risk Assessment and Management – The 'CFRAM' Studies will develop more detailed flood mapping and measures to manage and reduce the flood risk for the AFAs.   |
| <b>DAD</b>          | Defence Asset Database   |
| <b>DAS</b>          | Defence Asset Survey   |
| <b>DEFRA FD2308</b> | United Kingdom Government Department for Environment, Food and Rural Affairs, Joint probability - dependence mapping and best practice Report (2005)   |
| <b>DTM</b>          | Digital Terrain Model (often referred to as 'Bare Earth Model')  |
| <b>EPA</b>          | Environmental Protection Agency  |
| <b>EU WFD</b>       | European Union Water Framework Directive (2000)  |
| <b>EurOtop</b>      | European Wave Overtopping of Sea Defences and Related Structures Manual (HR Wallingford 2008)  |
| <b>FRI</b>          | Flood Risk Index - a metric that allows the risk to different types of assets (e.g., home, business, monument, utility asset, etc.) to be expressed numerically, but without attempting to assign monetary values to all types of damage.  |
| <b>FRMP</b>         | Flood Risk Management Plan. This is the final output of the CFRAM study. It will contain measures to mitigate flood risk in the AFAs.  |
| <b>FRR</b>          | Flood Risk Review – an appraisal of the output from the PFRA involving on site verification of the predictive flood extent mapping, the receptors and historic information.  |
| <b>FSU (WP)</b>     | Flood Studies Update (Work Package) (2008)   |
| <b>GIS</b>          | Geographical Information Systems   |
| <b>HA</b>           | Hydrometric Area. Ireland is divided up into 40 Hydrometric Areas.   |
| <b>HEP</b>          | Hydrological Estimation Point  |
| <b>HPW</b>          | High Priority Watercourse. A watercourse within an AFA.  |
| <b>ICPSS</b>        | Irish Coastal Protection Strategy Study (2012)   |
| <b>ICWWS</b>        | Irish Coastal Water Level and Wave Study (2013)  |
| <b>IRR</b>          | Individual Risk Receptors  |
| <b>ISIS</b>         | One dimensional hydraulic modelling software approved for the CFRAM framework  |
| <b>MPW</b>          | Medium Priority Watercourse. A watercourse between AFAs, and   |

|                 |   |
|-----------------|---|
|                 | between an AFA and the sea.   |
| <b>OPW</b>      | Office of Public Works, Ireland   |
| <b>OSI</b>      | Ordnance Survey Ireland   |
| <b>PFRA</b>     | Preliminary Flood Risk Assessment – A national screening exercise, based on available and readily-derivable information, to identify areas where there may be a significant risk associated with flooding.  |
| <b>SEA</b>      | Strategic Environmental Assessment. A high level assessment of the potential of the FRMPs to have an impact on the Environment within a UoM.  |
| <b>SW CFRAM</b> | South Western Catchment Flood Risk Assessment and Management study  |
| <b>UoM</b>      | Unit of Management. The divisions into which the RBD is split in order to study flood risk. In this case a HA.  |
| <b>WFD</b>      | Water Framework Directive. A European Directive for the protection of water bodies that aims to, prevent further deterioration of our waters, to enhance the quality of our waters, to promote sustainable water use, and to reduce chemical pollution of our waters. |